Market Consultation
“Anders Betalen voor Mobiliteit”

Research Assignment 1:
Total Cost of System and Organization for the KMP

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Management Summary

This market consultation aims at an estimation of total costs for system and organization for the 'Kilometerprijs' (KMP) as specified in the draft Requirements Specification given by the Principal. It is based on a high-level design of system and processes elaborated by the Contractor.

A major focus of the system design and business model was cost efficiency so trade-offs in functionality were made where we see significant cost impacts.

The chosen system design and processes are described by following key characteristics:

- The GNSS-based OBU communicates via an accessible Storage Device (SD) and respective upload terminals/Internet with the central system (Variant SD). In addition an alternative with CN communication is discussed and calculated (Variant CN).

- The OBU is owned by the customer and once installed, stays with the vehicle, therefore distribution and maintenance will be covered by the user or normal sales channels respectively. The estimated *retail price* of the OBUs is included as *investment* since we assume OBUs will have to be subsidized.

- The billing and payment frequency is once a year with quarterly installments. A discussion of the delta cost to build and operate a system with monthly billing is included. The cost of payment collections includes coverage of lost receivables.

- The enforcement consists of stationary systems and vehicles which integrate portable systems and mobile devices for manual enforcement.

- The Occasional User Scheme is represented by a time-based vignette which can be purchased via terminals, Internet, affiliates and personnel.

- The KMP is rolled out in three phases depending on the vehicle type.

The total costs for system and organization for Variant SD are
~2.7 bil. EUR of initial costs and ~625 mil. EUR of annual operational costs.

The total costs for system and organization for Variant CN are
~3.0 bil. EUR of initial costs and 1,0 bil. EUR of annual operational costs.

Version History

Version	Date	Author	Comment
1.0	14.07.06	DaimlerChrysler Services Mobility Management GmbH	Draft
2.0	04.08.06	DaimlerChrysler Services Mobility Management GmbH	Final Report

Content

Management Summary II

Table of Figures VI

Table of Tables VII

Table of Abbreviations IX

Glossary XII

0 Introduction 1

1 Solution (Deliverable 2 + 3) 1

1.1 System Design 1
1.1.1 System Architecture Overview 1
1.1.2 OBU 2
1.1.3 Central System 5
1.1.4 Roadside Enforcement Unit 6
1.1.5 Enforcement Vehicle 7
1.1.6 Terminal 8
1.2 Organization 8
1.2.1 Design of Organization 9
1.2.2 Main entities 9
1.2.3 External Entities 11
1.3 Business Model/Revenue Model 12
1.3.1 OBU Ownership 13
1.3.2 Liabilities 14
1.3.3 Business Case 14
1.4 Recording of Road Usage 14
1.4.1 Measurement and Recording of Road Usage 15
1.4.2 Determination of Cost 18
1.4.3 Data Exchange with Central System 20
1.5 Comments on Tariff Scheme 28
1.5.1 Comments on Background 28
1.5.2 Comments on time and location scenarios 28
1.6 Billing and Payment 29
1.6.1 Billing 29
1.6.2 Payment 31
1.6.3 Monthly Billing 31
1.6.4 Business Process 33
1.7 Registration and Installation 34

1.7.1 User registration....35
1.7.2 Installation process....37
1.7.3 OBU check-up....39
1.7.4 Complaints process....41
1.8 Customer Care....42
1.8.1 System Design....42
1.8.2 Business Processes....43
1.8.3 Parameters and Assumptions....44
1.9 Enforcement....45
1.9.1 General enforcement principles....46
1.9.2 Pros and Cons of different enforcement methods....48
1.9.3 Processes....49
1.9.4 Optimization and additional aspects....53
1.9.5 Calculation of necessary enforcement sites....54
1.10 System Management....55
1.10.1 Relevant processes....55
1.11 Occasional User Scheme....56
1.11.1 Goal....56
1.11.2 System Design....57
1.11.3 Vignette via Terminals....57
1.11.4 Vignette via Internet/Affiliates....58
1.11.5 Vignette via Mobile Personnel....58
1.11.6 Enforcement....59
1.11.7 Parameters and Assumptions....59
2 Costs Estimate (Deliverable 4)....60
3 Migration Scenarios (Deliverable 5)....60
3.1 Introduction....60
3.1.1 Phase one: HGV, Busses and Vans....61
3.1.2 Phase two: passenger cars....62
3.1.3 Phase three: Motor bikes....63
3.2 Cost estimation....63
3.2.1 Phase one: HGV, Busses and Vans....64
3.2.2 Phase two: Passenger cars....64
3.2.3 Phase three: motor bikes....65
4 Risk Assessment (Deliverable 6)....65
4.1 Goal....65
4.2 Top-five Risks....65

Table of Figures

Fig. 1: Design of System Architecture 2

Fig. 2: OBU Design..3

Fig. 3: Central System Design 5

Fig. 4: Design of Roadside Enforcement Unit..6

Fig. 5: Design of Enforcement Vehicle 7

Fig. 6: Design of Terminal...8

Fig. 7: Design of Organization 9

Fig. 8: Measurement and Recording of Road Usage Process..................................16

Fig. 9: Determination of Cost Process 19

Fig. 10: Charge Data Transfer CN Process 21

Fig. 11: Update Info Transfer CN Process..22

Fig. 12: Process Exchange Data with Central System 24

Fig. 13: System Design of Billing and Payment...32

Fig. 14: Billing and Payment Process 33

Fig. 15: Registration Process..36

Fig. 16 : OBU installation Process 38

Fig. 17: OBU Check-up Process...40

Fig. 18: Complaints Process..41

Fig. 19: Customer Care System Design 43

Fig. 20: Roadside Enforcement Process 50

Fig. 21: Mobile Enforcement Process..52

Fig. 22: Processes and Related Systems..55

Table of Tables

Tab. 1: Prices of OBU subcomponents 4

Tab. 2: Process Activities of Measurement and Recording of Road Usage 17

Tab. 3: Process Activities of Determination of Cost and Tariff Determination............19

Tab. 4: Process Activities of Charge Data Transfer CN...21

Tab. 5: Process Activities of Update Info Transfer CN 22

Tab. 6: Volumes and Cost Estimations of Transfer of Charge Data 23

Tab. 7: Process Activities of Exchange Data with Central System 25

Tab. 8: Frequency of Update of Tariff Data 25

Tab. 9: Cost of Terminal 26

Tab. 10: Comments on Time and Location...29

Tab. 11: Invoicing Frequency 30

Tab. 12: Request Past Road Usage Information 30

Tab. 13: Installments Frequency 30

Tab. 14: Email to Mail Ratio...31

Tab. 15 Process Activities of Billing and Payment..34

Tab. 16: Volumes and Costs 35

Tab. 17: Basic data for the registration process 37

Tab. 18: Process Activities of OBU installation..39

Tab. 19: Process Activities of OBU check-up 40

Tab. 20: Process Activities of complaints process...42

Tab. 21: Vehicle Quantity to Customer Care Process Quantity/Year Parameter.......44

Tab. 22: Customer Care Process Quantity/Year to Current Service Agents/FTE Parameter 45

Tab. 23: Vehicle Quantity to Current Service Agents/FTE Parameter.......................45

Tab. 24: Scenario calculation for height of fines..47

Tab. 25: Scenario calculation: Total income out of fines 47

Tab. 26: Description of Roadside Enforcement Process Steps 51

Tab. 27: Description of Mobile Enforcement process steps......................................53

Tab. 28: Calculation Amount Enforcement Stationary 54

Tab. 29: Calculation Total Amount EnfPo...54

Tab. 30: Calculation Total Amount EnfMo 55

Tab. 31: Parameters and Assumptions OUS..59

Tab. 32: Initial Parameters...61

Tab. 33: Breakdown of OBUs to be installed..61

Tab. 34: Assumption / Parameter for the workshop network Phase one 62

Tab. 35: Assumption / Parameter for the workshop network Phase two, recommended 63

Tab. 36: Number Installations..63

Tab. 37: Costs for Training and Setup...64

Tab. 38: Initial costs phase I...64

Tab. 39: Initial Costs Phase II...64

Tab. 40: Initial Costs Phase III..65

Tab. 41: Top-Five Risks 66

Table of Abbreviations

ABvM	Anders Betalen voor Mobiliteit
ACD	Automatic Call Distribution
AD	Activity Diagram
ASP	Application Service Provider
BPM	Belasting van Personenautos en Motorrijwiken
ClieOP	Cliëntopdrachten
CN	Cellular Network
CPU	Central Processing Unit
CRM System	Customer Relationship Management System
CS	Central System
CTI	Computer Telephony Integration
DB	Database
DD	Deployment Diagram
DMS	Document Management System
DR Sensor	Dead-Reckoning Sensor
DSRC	Dedicated Short Range Communication
EnfMo	Mobile enforcement vehicles
EnfPo	Portable enforcement site
EnfSt	Stationery enforcement site
ERP	Enterprise Resource Planning
EUR	Currency of the European Monetary Union
FTE	Full Time Equivalent
Galileo	Name of the European Satellite System
GHz	Gigahertz
GNSS	Global Navigation Satellite System

GPS	Global Positioning System
h	Hour
HGVs	Heavy Goods Vehicles
HMI	Human-Machine Interface
IC	Integrated Circuit
ID	Identification
IEP	Incidental Expenditure Markup
ITIL	Information Technology Infrastructure Library
IVR	Interactive Voice Response
KB	Kilobyte
km	Kilometers
KMP	Kilometerprijs
LED	Light Emitting Diode
m	Metre, Million
MB	Megabyte
min	Minute
Mips	Million instructions per second
MRB	Motorrijtuigenbelasting
NL	Netherlands
OBU	On-Board-Unit
OCR	Optical Character Recognition
OUS	Occasional User Scheme
PBX	Private Automatic Branch Exchange
PC	Personal Computer
PDF	Portable Document Format
POS	Point Of Sale

PPP	Public Private Partnership
PR	Public Relations
RAM	Random Access Memory
RTC	Real Time Clock
SD	Storage Device
SD-card	Secure Digital Memory Card
SW	Software
UI	User Interface
USB-Stick	Universal Serial Bus-Stick
V	Voltage
VAT	Value Added Tax
VRM	Vehicle Registration Mark

Glossary

On-Board-Unit	Vehicle mounted device for using the KMP system
Central System	All equipment and processes necessary for managing the KMP system. Links all other parts of the system
Time-based vignette	Allows access the Netherlands' road network for a certain period of time
Mileage-based vignette	Allows access the Netherlands' road network for a certain amount of mileage
Affiliate	Partner organizations for selling vignettes for the OUS
Roadside Enforcement Unit	Stationary unit that covers several lanes e.g. of a motorway and automatically executes automatically enforcement processes
Service Provider	The organizational entity operating the technical infrastructure for the KMP system and interaction with the road owner(s) and one or several Contract Operators
Contract Operator	The organizational entity that closes and manages contracts with users and interacts with one or several Service Providers23. The Contract Operator also holds responsible for OBU specification and certification
Cellular Network	Mobile phone (cell phone) network, offering several communication services. Used for data exchange between the Central System and peripheral systems
Change Management	The process of triggering and implementing changes to systems and/or business processes. Change Management includes any development activities on an operational system.66
Fraud Management	The process of detecting, managing and inhibiting further incidences of fraud.66
Service Desk	Information and assistance resource that troubleshoots problems with computers and similar products.

Geo-Data	Data describing geographical objects and relation-ships, such as a road or the length of a road seg-ment. A map is an example of Geo-Data.15
Sensor Data	Data produced by a sensor such as an odometer or a GPS system.15
Charge Data	The Data defining the KMP charge15 due for a user.
Dead-Reckoning Sensor	Sensor for measuring the vehicle movement to de-termine the current vehicle position from its last known position (e.g. if no GNSS is available)
Crypto IC	IC for performing cryptographic operations
Gyro	Gyroscope, a device for measuring or maintaining orientation, based on the principle of conservation of angular momentum
Factoring	Form of commercial finance whereby a business sells its accounts receivable (in the form of in-voices) at a discount.
APK test	Annual vehicle check-up in the Netherlands
Service Center PC	PC used at the OBU Installation and Service Center for connecting to the toll operator’s Central System
Odometer	Device used for indicating distance traveled (mile-age) by an automobile or other vehicle
Document Management System	A document management system (DMS) is a com-puter program (or set of programs) used to track and store electronic documents and/or images of paper documents.54
White list	A list of vehicles that are allowed to use a road (e.g. exempt vehicles or vehicles of users that have bought a vignette)62
White label application	Software that can be custom-branded, e.g. for use by affiliates

0 Introduction

As defined in the work plan for the ABvM market consultation phase 2, this document works out the task for subject 1 “Total costs of system and organization for the KMP”. The task of subject 1 includes seven deliverables, of which the first activity “project plan” has been delivered separately. This document contains deliverables 2 to 6 and describes in detail the work packages of the project plan. Deliverable 7 "Comments on Requirements specification" will be delivered in a separate document.

This document includes a complete system design with the necessary organization and major business processes. A cost model estimates the initial and operating costs of the KMP. The calculation for the estimation of overall system costs is attached as a separate Excel-file. A migration scenario describes the stepwise introduction of the KMP and finally the major risks over the whole life cycle of the system are identified.

1 Solution (Deliverable 2 + 3)

1.1 System Design

This chapter gives an overview about the system design and describes the system components.

1.1.1 System Architecture Overview

The following picture gives an overview about the system architecture. The main components of the system are

- OBU
- Central System
- Enforcement Units and Vehicles

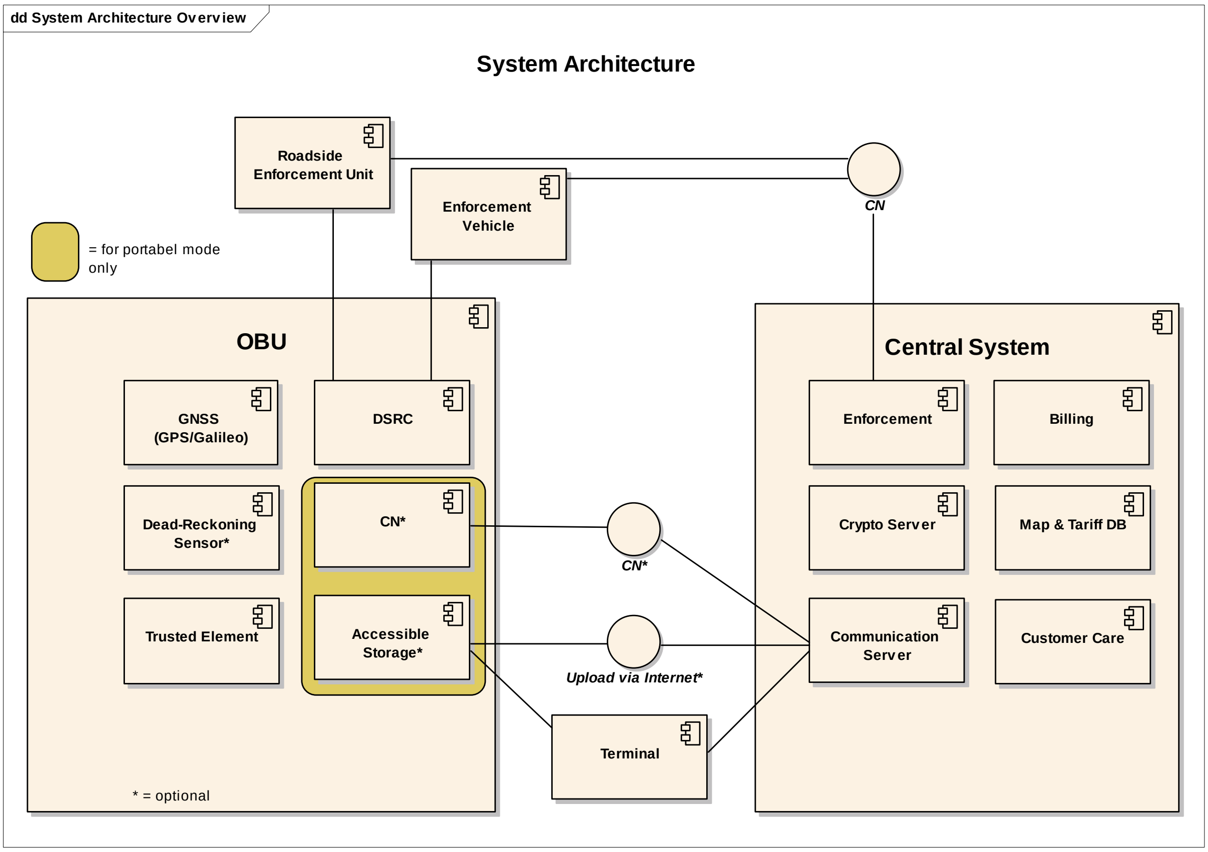

Fig. 1: Design of System Architecture

The data exchange between OBU is alternatively done via Cellular Network (Variant CN) or via Internet and a Terminal Network (Variant SD). The decision for one of these alternatives is a trade-off between costs, process complexity and user convenience (see chapter 1.4.3). The Terminals are necessary anyway as system access for occasional users. The data exchange between Enforcement and Central System is completely done via Cellular Network as this is the most flexible solution.

1.1.2 OBU

The OBU has the following primary functions:

- Get processed sensor data
- Compare with map data and locate
- Calculate charge data
- Exchange data with Central System

Secondary functions of the OBU are:

- Log events
- Monitor device functionality

- Update map-, tariff data & software
- Store and Update Configuration Data

To fulfill the functionality described above the OBU has to have the following sub-components:

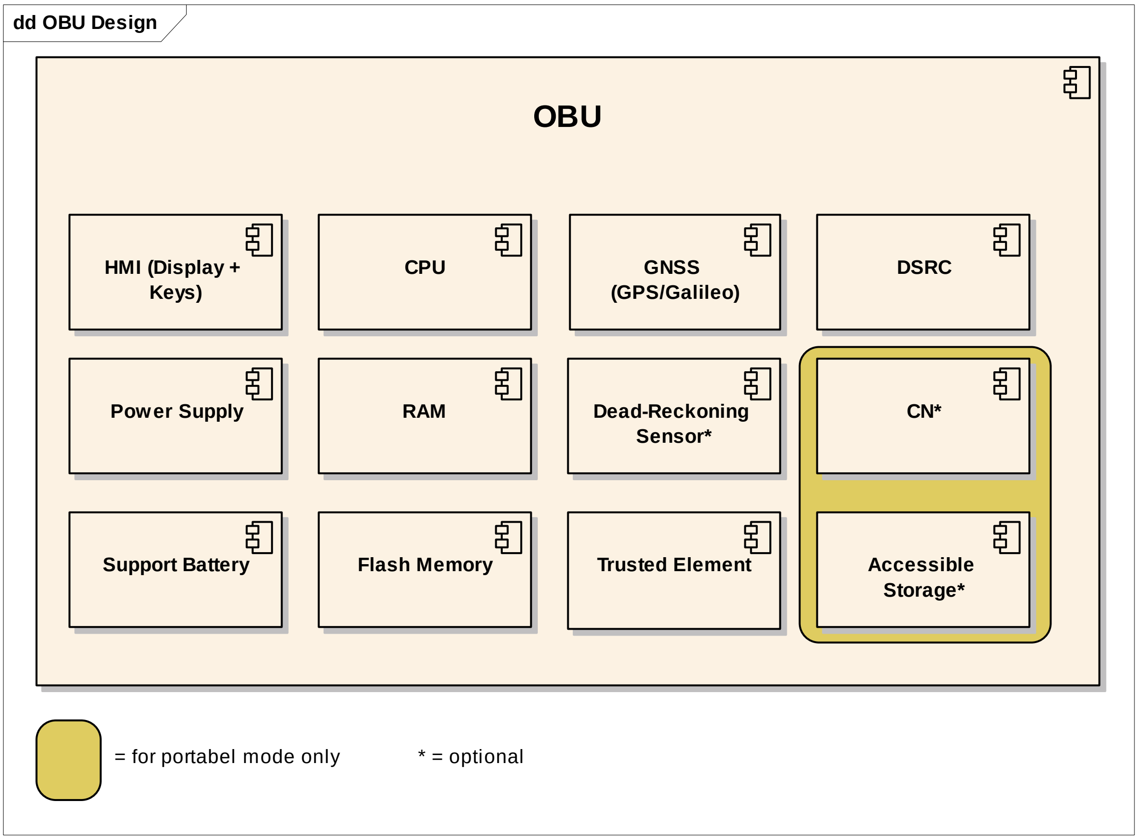

Fig. 2: OBU Design

- HMI: Display: 1 line with at least 16 characters. The key are for user input, mainly acknowledges, answering questions and navigation through lists and menus.
- Power supply: Input voltage range 9-36 V to allow OBU installation in passenger cars and HGVs
- Support Battery: Buffering power outages thus ensuring consistent data storage on the OBU. Alternatively a high capacity condenser can be used.
- CPU: >100 Mips processing power, preferably with a unique serial identification number
- RAM: >16 MB
- Flash Memory: >64 MB

- GNSS (GPS/Galileo): Standard GPS service will be sufficient in terms of accuracy and availability. The use of Galileo is merely a cost issue.
- Dead-Reckoning Sensor (DR) (optional): Gyro and acceleration sensor needed for tariff scenarios III, IIIA, IIIB, IV to improve road recognition
- Trusted Element: Chip card or crypto IC for signing and encrypting/decrypting data.
- DSRC: Microwave or infrared, for communication with Enforcement
- CN (optional): For communication with Central System. The CN service used is mainly a cost issue.
- Storage Device (optional): For communication with Central System. USB-stick, SD-card, chip card with appropriate reader/interface

The estimated OBU price ranges from 141 EUR to 206 EUR depending on the necessary subcomponents. There are four options:

Component	CN+DR	CN	SD+DR	SD
DR Sensor	26		26	
CN Module	39	39		
SD			13	13
DSRC	20	20	20	20
GNSS	26	26	26	26
Other including antennas	95	95	82	82
Total	**206**	**180**	**167**	**141**

Tab. 1: Prices of OBU subcomponents

All costs in the table above are in EUR and are estimation for a new development based on current price levels. Component costs include proportionate production and overhead mark-up.

1.1.3 Central System

The Central System has the following functional subcomponents:

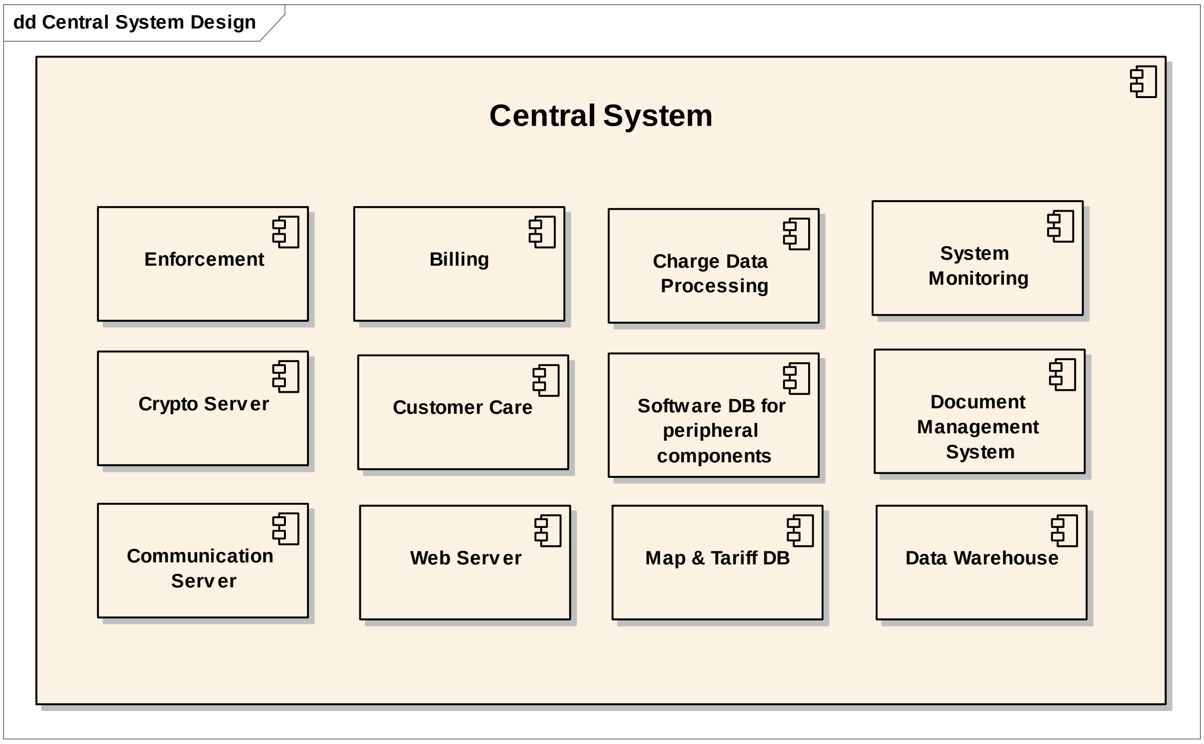

Fig. 3: Central System Design

- Enforcement: Enforcement post processing
- Crypto Server: Store up to date and future versions of encryption and signature keys and distribute them throughout the system
- Communication Server: Provide communication for interaction between CS and OBU, Enforcement Vehicles, Roadside Enforcement Units, Terminals
- Billing: Invoicing and payment process
- Customer Care: User and vehicle registration and deregistration and customer care
- Charge Data Processing: Acknowledge of reception of charge data, integrity and plausibility checks, pre processing of charge data for billing
- Software DB for peripheral components: Store up to date and future versions of software and distribute them to peripheral components, configuration management
- Map & Tariff DB: Store up to date and future versions of tariff and map data and distribute them throughout the system

- System Monitoring: Monitoring of Central System and peripheral units
- Document Management System: Management of any user related documents
- Data Warehouse: Analyze charge and monitoring data, statistics

Technically the Central System consists of numerous standard servers and the corresponding data processing equipment. For availability and data integrity reasons two identical independent systems with failover functionality are required. For testing and staging yet another system is needed, adding to a total of three identical systems.

1.1.4 Roadside Enforcement Unit

The Roadside Enforcement Unit is a stationary unit that covers several lanes e.g. of a motorway and executes automatically enforcement processes. It has the following functional subcomponents:

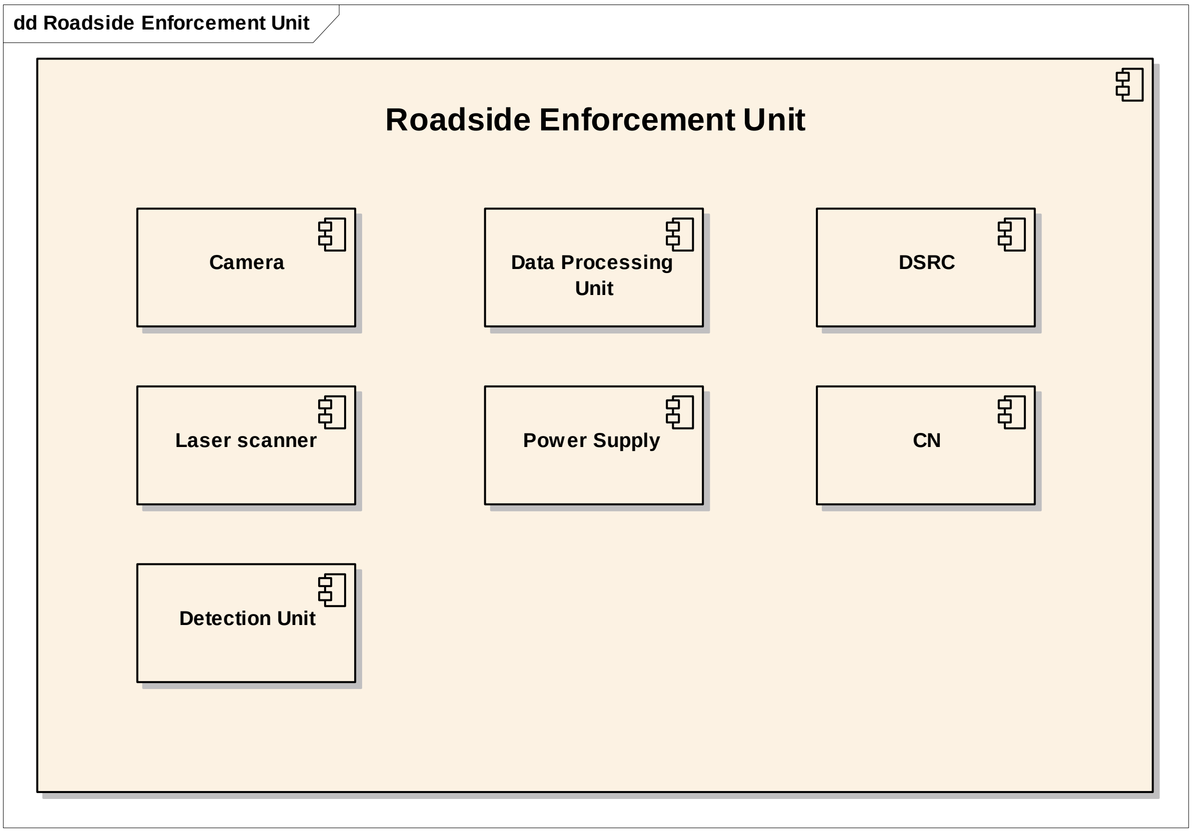

Fig. 4: Design of Roadside Enforcement Unit

- Camera: Taking overview and VRM pictures of passing vehicles
- Laser scanner: Determination of vehicle class (Van, bus, passenger car...)
- Detection Unit: Detection of vehicles approaching the enforcement site
- Data Processing Unit: OCR, incident classification, evidence collection

- DSRC: Microwave or infrared, for communication with OBU
- CN: For communication with Central System, high speed data service
- Power Supply: Connection to mains voltage

1.1.5 Enforcement Vehicle

The Enforcement Vehicle is equipped with enforcement devices to enforce manually while passing another vehicle. It can also act as a portable enforcement unit. It has the following functional subcomponents:

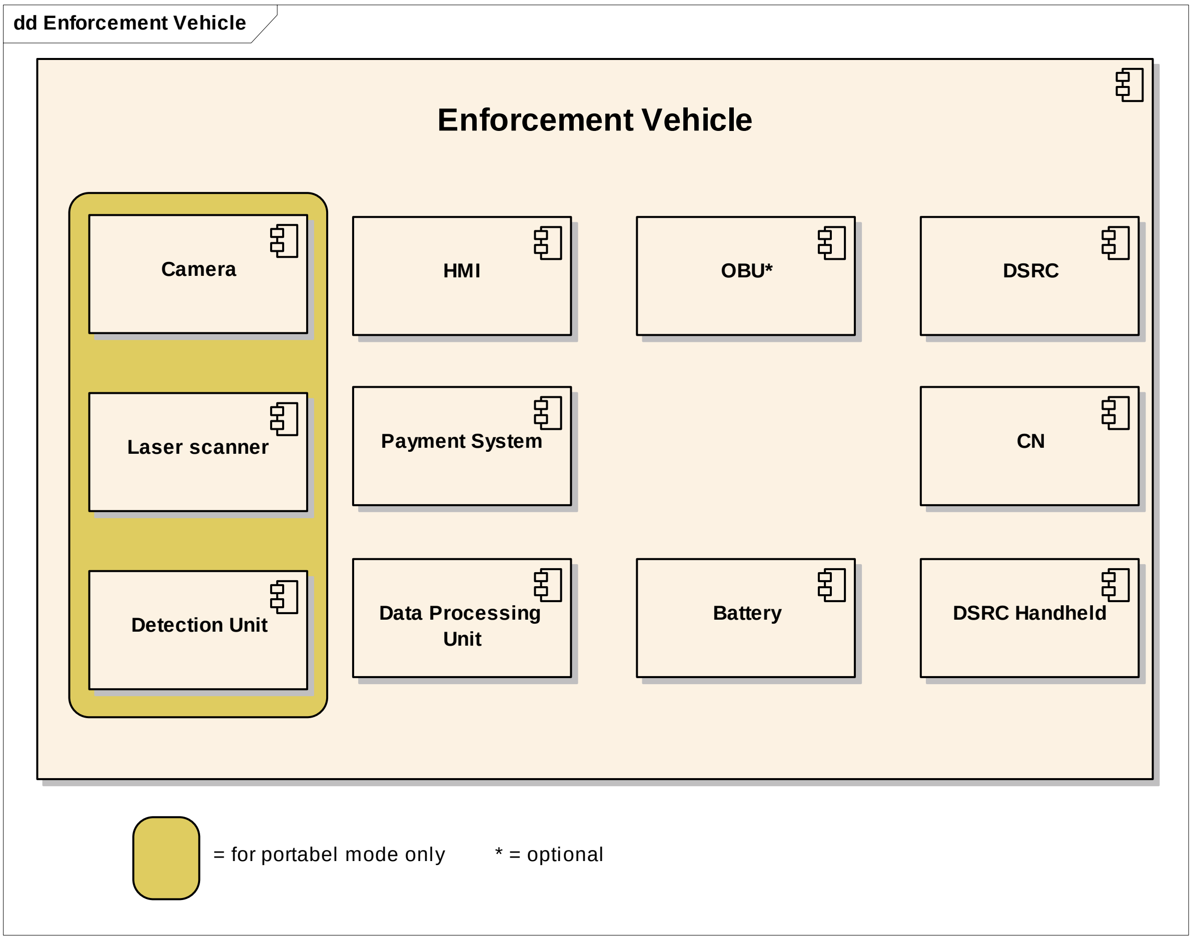

Fig. 5: Design of Enforcement Vehicle

- Camera: Taking overview and VRM pictures of passing vehicles
- Laser scanner: Determination of vehicle class (Van, bus, passenger car...)
- Detection Unit: Detection of vehicles approaching the enforcement site
- HMI: Interaction with enforcement personnel
- Payment System: Collecting fines from non compliant users

- Data Processing Unit: Process DSRC-data, evidence collection
- OBU: Checking segment/area identification (only needed for tariff scenarios III, IIIA, IIIB, IV)
- Battery: Supports vehicle battery
- DSRC: Microwave or infrared, for communication with OBU
- CN: For communication with Central System, high speed data service
- DSRC hand-held: Communication with OBU when vehicle is stopped

1.1.6 Terminal

The Terminal is a system access for occasional users and a communication gateway between OBU and Central System in case of the Storage Device solution. It has the following functional subcomponents:

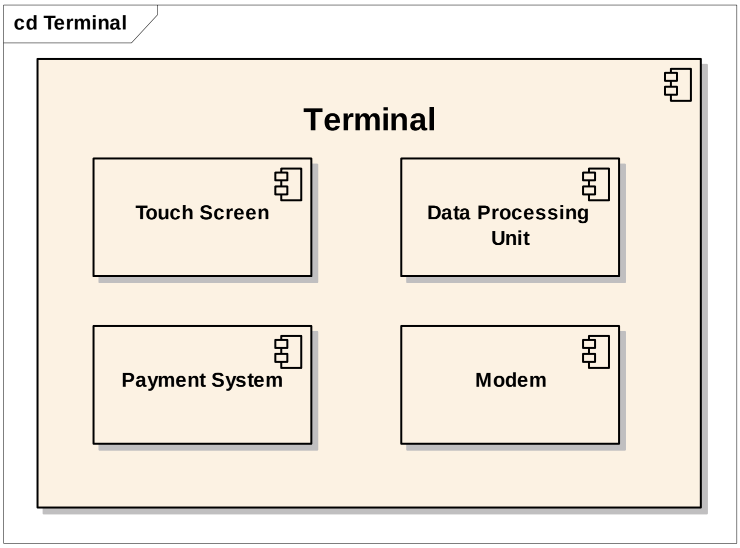

Fig. 6: Design of Terminal

- Touch Screen: User interaction
- Payment System: Credit an debit card payment for occasional users
- Data Processing Unit: Controls Terminal processes
- Modem: Communication with Central System via Internet

1.2 Organization

This chapter describes the key set of a possible organizational model with its logical relationships in order to express the relations between the business and the organizational model. It does not express all organizational processes of all entities but discusses the main roles and processes of the main entities of the organizational model.

1.2.1 Design of Organization

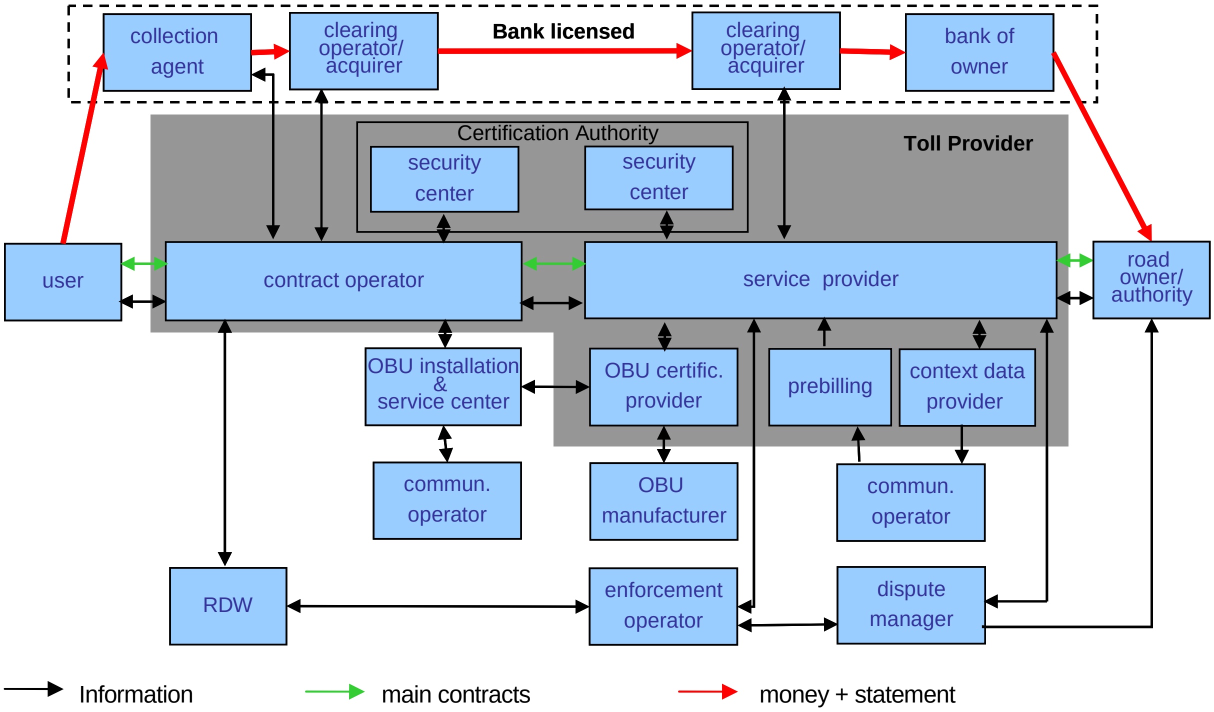

Fig. 7: Design of Organization

The main entities of the organizational design are shown:

- the contract operator
- the service provider

Although the contract operator and the service provider are part of the toll provider, they are displayed separately because of the possibility to divide them into two completely different entities in case of an interoperability scenario.

1.2.2 Main entities

The following chapter describes the main entities of the organizational model.

1.2.2.1 Contract operator

The contract operator

- acts on behalf of the user
- closes contracts with users (depends on the business model e.g. OBU ownership)
    - o operating a call centre and POSs

  - defining the payment means
  - checking the credibility at the collection agent
- defines OBU design
  - defines certification requirements for OBU and Installation Service Centers
  - certifies suppliers
  - certifies OBUs
- holds contracts with other operators in the regions visited by its customers (in case of an interoperability scenario)
  - accepting claims of the operators in form of charging records signed by its own OBUs
  - guarantying the payment to the operators
  - exchanging keys to secure the data exchange

1.2.2.2 Service Provider

The service provider

- acts on behalf of the road owner (or is part of the road owner itself)
  - the state authorities
  - the private road operators
- closes contracts with one or more road owners
  - defining the context including tariffs and vehicle classes
  - defining the strategy and task split of the enforcement
- closes contracts with all interested contract operators
  - defining the payment process of the contract operator
  - defining the risk allocation
  - exchanging required keys or trust certificates
- operates the payment process in its domain
  - supports the OBUs with context data
  - receives and confirms charging certificates of visited OBUs

  - claims the payment of the contract operator using the charging of certificates of the OBUs
  - receives black lists from the contract operator

1.2.3 External Entities

Every entity which is not part of the toll provider is an external entity. The external entities (excluding the users) will be defined by the toll provider and support the toll provider to ensure the service of a toll collection system for the Netherlands or uses the Dutch toll system.

- User
  - All domestic and foreign vehicle owners who uses the roads in the Netherlands
- OBU Installation & Service Center
  - Installs the OBUs in users´ vehicles
  - Executes the OBU checks
  - Contact person if users have problems with their OBU
- Communication Operator
  - Communication service provider of contract operator and service provider
- OBU Manufacturer
  - develops the specified OBUs
  - produces the specified OBUs
- Enforcement Operator
  - Needs to be an authorized organization of the road owner
  - executes mobile and roadside enforcement
  - responsible for roadside enforcement
  - responsible for mobile enforcement
  - has to deter the user from fraud
- Dispute Manager
  - Manages all problems and disputes regarding mobile and roadside enforcement between user, enforcement operator and service provider

- RDW
  - Admission office for vehicles in the Netherlands
- Road Owner/Authority
  - Owner of the Dutch roads

The following entities handle all cash flows between users, contract operator, service provider and road authority. All processes within and between these entities are subject to banking supervision.

- Collection agent
  - visit or telephone debtors to collect amounts due or to arrange for payments to be made
  - trace addresses of debtors who have moved
  - suggest legal action when collection cannot be made
  - record amounts collected and note any further action required
  - prepare statements of account for creditors or arrange for money collected to be transferred to their accounts
- Clearing operator/ acquirer
  - financial institution that issues merchant accounts for the acceptance of credit card transactions
  - exchange financial details between an acquirer and an issuer to facilitate posting of a cardholder's account and reconciliation of a merchant's settlement position
- Bank of owner
  - Bank of toll provider which handles all cash flows within the toll system

1.3 Business Model/Revenue Model

This chapter describes the key set of elements and their relationships in order to express the business logic of the organization. It does not represent a complete business model, but discusses on following topics with high revenue and efficiency impact:

- Revenue model
- Partner network
- Distribution channels

1.3.1 OBU Ownership

There is no need for a classic revenue model which generates revenue for covering the costs of service (actually the costs for building and maintaining the whole road infrastructure which is managed by a different organization) and profit.

A special revenue model is required in order to give incentives for partners and distribution channels for the OBUs. Basically, the revenue model drives third-parties to support and participate in several processes.

The ownership of the OBU has an impact on the revenue model. There are two alternatives concerning the OBU ownership.

- Alternative A
  The toll provider keeps the ownership of the OBU and authorizes the customer to use the given OBU. The customer never becomes the owner of the OBU.
- Alternative B
  The customers (and hence third-parties like resellers) have to buy the OBU and acquire the ownership of the OBU.

From a political point-of-view the first alternative has a higher acceptance and popularity, but has significant drawbacks as well. In case of loss, damage, etc. the provider has to replace the OBU or has to give a new OBU. Especially loss and reselling for different purposes can hardly be controlled, when the OBUs are given away for free.

With Alternative B the OBU can be lost, stolen and damaged without harming the provider. The customer has to buy a new OBU on his own expenses (except damages in the warranty period). Thus, the user acts differently with his own property than with given property (compare with rental and company cars).

Moreover Alternative B allows establishing affiliate systems which drive implicitly third-party distribution with lower installation costs. Giving the OBUs in high volumes to reseller and retailers with significant discount transfers distribution and installation to third-parties seamlessly.

Third-parties and market competition lead to distribution and installation at optimal costs in contrast to "planned" distribution and installation via contracted partners. E.g. large electronic retailers tend to offer the installation for free in order to sell high volumes (compare with navigation systems).

Political acceptance can be achieved with subsidization for the first OBU or OBUs for new vehicles. The OBU can be sold below cost (for instance) or at cost including free road usage for a specific time, range. etc. The subsidization must be lower than the real costs.

Alternative B can even go further: the toll provider does not sell the OBU. It just specifies and certifies the OBUs, which are produced by third-parties according to given specifications and time schedules. The toll provider could avoid the full initial invest for the OBUs, which would be provided by the OBU vendors. Though, the

OBU costs are entered in the Principal's and toll provider's balance sheet as subsidization and/or initial free road usage.

We recommend Alternative B because of mentioned reasons.

1.3.2 Liabilities

Liabilities for losses of claims/demands of payment can be assumed either by

- the electronic toll provider (private),
- third-parties (e.g. acquirers) or
- the Principal.

Following trade-off characterizes the decision (which has to be made by the Principal):

- Transferring the liability risk to a third party (factoring) leads to guaranteed and regular income and no risk of payments loss.
- Assuming the liabilities leads to maximum income with higher risk of payments loss.

A detailed benefit-cost-analysis for each alternative and offer has to be made in order to find the optimal solution. Usually the costs for factoring are higher but guarantee constant revenues.

We assume the loss of liabilities will be covered by the payment system provider (factoring).

1.3.3 Business Case

In our understanding the goal of the market consultation is to understand the *cost* of the set-up and operation of a KMP system, not to build a business case for an operating company. For this reason, we do not include cost of capital or profit margin assumptions in the cost calculations. However, depending on the risk allocation these factors, of course, can add significantly to the cost of a principal outsourcing a whole project including investment and risk.

The figures given in this paper thus represent the assumed costs of investment and operation for the operator of the KMP system, equivalent to the question: "What would be the cost if I wanted to build and operate it?".

1.4 Recording of Road Usage

This chapter describes all processes that are necessary to measure and record the road usage, determine the costs for road usage and exchange (charge) data with the Central System.

1.4.1 Measurement and Recording of Road Usage

This process describes how the road usage per vehicle is determined. It is completely executed by the OBU and needs no user interaction (at least not with the tariff models proposed). The process starts whenever the vehicle engine is started and stops when the vehicle engine is turned off. As a result the record of road usage is updated. The details of the process vary depending on the complexity of the tariff model regarding time and location. Therefore the process for the most complex tariff model (Scenario IIIB, see Principal's Tariff Model) is described as it includes all possible activities.

1.4.1.1 Pre-conditions

- OBU is installed
- OBU is configured/activated
- OBU is working (no malfunction, up to date software, map- and tariff data)

1.4.1.2 Post-conditions

- Record of road usage is updated

1.4.1.3 Process Description

The following chart gives an overview about the process.

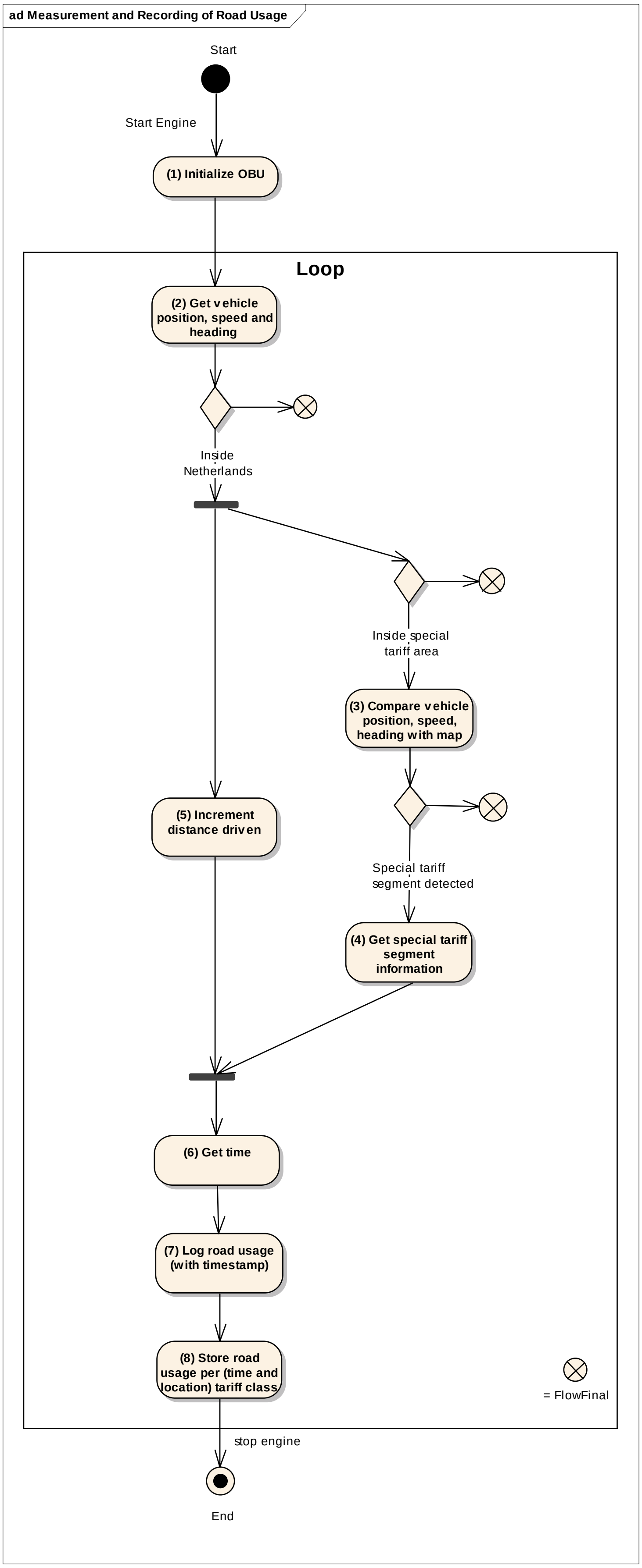

Fig. 8: Measurement and Recording of Road Usage Process

The following table describes the process activities in detail:

Activity	Description
(1) Initialize OBU	After starting the vehicle engine the OBU switches from a standby mode to the operating mode. During startup a self test is performed to make sure that all systems of the OBU are working properly.
(2) Get vehicle position, speed and heading	The OBU gets every second vehicle position, speed and heading from its GNSS-receiver. The data from the GNSS-receiver is optionally supported by dead-reckoning sensors in cases where no (valid) GNSS data is available (only necessary for complex tariff schemes).
(3) Compare vehicle position, speed, heading with map data	If the vehicle is inside a special tariff area (an area where for at least some of the road segments a tariff different from the standard off-peak tariff applies) vehicle position, speed, heading are compared with map data of that area to determine the road segment the vehicle is driving on.
(4) Get special tariff segment information	If the usage of a segment where a special tariff applies is detected the appropriate information (length of segment, point charge, peak markup, area) are determined.
(5) Increment distance driven	As long as the vehicle is inside the Netherlands the distance driven is continuously derived from GNSS-data. The distance driven in the lowest (off-peak) tariff class is equal to the offset between this distance and the distance driven on special tariff segments/in special tariff areas.
(6) Get time	The road usage is connected with the time from the RTC (equal to GNSS-time).
(7) Log road usage (with timestamp)	The road usage is logged periodically (for distance driven) or on event (use of special tariff segment) for further use in claims-management.
(8) Store road usage per (time and location) tariff class	The OBU has a buffer for each time and location dependent tariff class. The road usage is stored in the appropriate buffer for cost determination. The process continues with activity (2) as long as the vehicle engine isn't turned off.

Tab. 2: Process Activities of Measurement and Recording of Road Usage

<u>Example for tariff scenario IIIB</u>

A vehicle starts its journey outside Amsterdam during the morning peak time. The distance driven is measured and stored in the off peak tariff class buffer. As soon as the vehicle approaches the Amsterdam area the OBU starts to compare vehicle trajectory with map data of the Amsterdam area (map matching). The exact segments the vehicle is driving on are determined. If one of the segments is a peak tariff segment the length, markup and the region of that segment are determined. The usage of that segment is stored in the appropriate peak tariff buffer. A tolled bridge would be treated like a special tariff segment with a non time depended markup.

1.4.1.4 Volumes and Cost Estimation

The process volume is equal to the kilometers driven in the Netherlands by OBU equipped vehicles. As only the OBU is involved this process has no direct cost except for OBU depreciations (if applicable).

1.4.2 Determination of Cost

This process describes how the cost for the road usage is determined. It is completely executed by the OBU and needs no user interaction. The process is executed periodically whenever the OBU is in the operating mode.

1.4.2.1 Pre-conditions

- OBU is working (no malfunction, up to date software, map- and tariff data)
- Record of road usage is not empty

1.4.2.2 Post-conditions

- Record of cumulated charge sum per tariff class is updated

1.4.2.3 Process Description

The following chart gives an overview about the process.

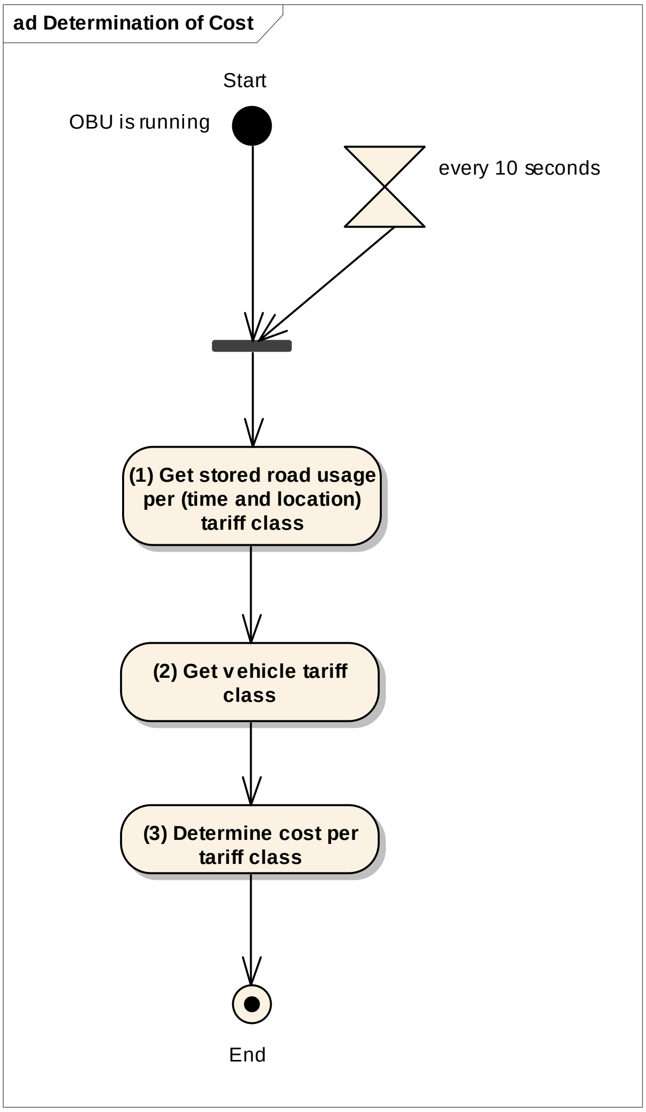

Fig. 9: Determination of Cost Process

The following table describes the process activities in detail:

Activity	Description
(1) Get stored road usage per (time and location) tariff class	Periodically (e.g. every 10 seconds) all tariff class buffers are read out.
(2) Get vehicle tariff class	The vehicle tariff class (stored in the OBU during installation) is read out.
(3) Determine cost per tariff class	The cost per tariff class is determined by combining time and location tariff class with the vehicle tariff class.

Tab. 3: Process Activities of Determination of Cost and Tariff Determination

1.4.2.4 Volumes and Cost Estimation

The process volume is equal to the kilometers driven in the Netherlands by OBU equipped vehicles. As only the OBU is involved this process has no direct cost except for OBU depreciations (if applicable).

1.4.3 Data Exchange with Central System

This process describes the transfer of charge data from the OBU to the Central System. The OBU transmits cumulated costs per tariff class to the Centrals System. The details of the process vary whether cellular Network or a Storage device is used. When using CN the OBU, the Central System and the CN are involved in the process. When using a Storage Device the OBU, the Central System, the Storage Device, the user and a Terminal or Internet PC are involved. In addition to the charge data updates of map- and tariff data and occasionally software are transferred from the Central System to the OBU. If using CN this is a separate process.

1.4.3.1 Pre-conditions

- OBU is working (no malfunction, up to date software, map- and tariff data)
- Record of cost per tariff class is not empty

1.4.3.2 Post-conditions

- Cumulated charge sums per tariff class are transferred to the Central System
- Updates of map- and tariff data and software (update info) are transferred to the OBU

1.4.3.3 Cellular Network

This section describes the data exchange process for the Cellular Network solution. It is divided in two sub-processes: Charge data transfer and update info transfer.

Process Description

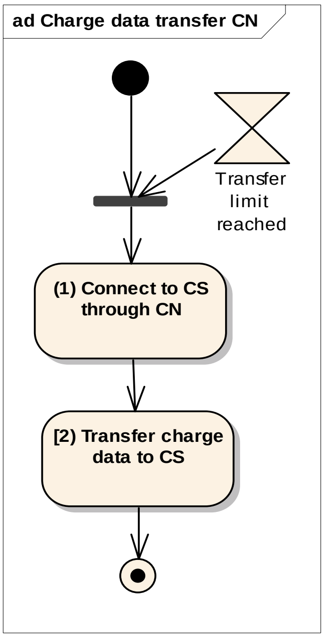

Fig. 10: Charge Data Transfer CN Process

Activity	**Description**
(1) Connect to CS through CN	When the transfer limit (see below) is reached, the OBU connects to the CS via CN.
[2) Transfer charge data to CS	The charge data are transferred to CS. The CS acknowledges the receipt.

Tab. 4: Process Activities of Charge Data Transfer CN

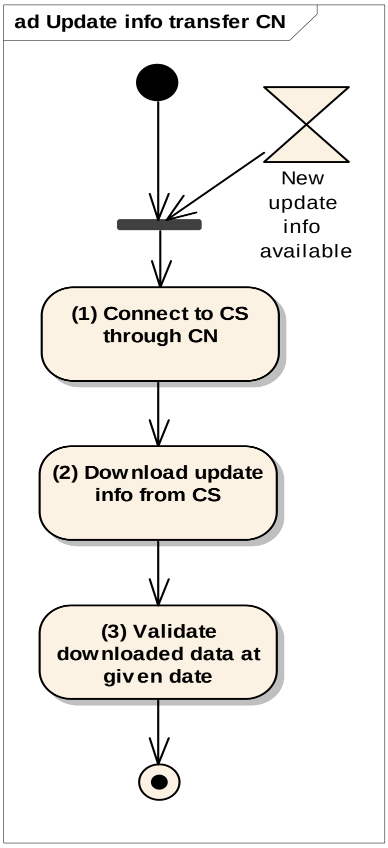

Fig. 11: Update Info Transfer CN Process

Activity	Description
(1) Connect to CS through CN	When the CS has informed the OBU that new update info (map-, tariff data or software) are available, the OBU connects to the CS via CN.
(2) Download update info from CS	The update info is downloaded and stored on the OBU.
(3) Validate downloaded data at given date	All downloaded data have a date when they be-come valid. The OBU starts to use these data from this date.

Tab. 5: Process Activities of Update Info Transfer CN

Volumes and Cost Estimation

Based on experiences we suggest that the transfer of charge data shall take place when a certain charge sum limit is reached (e.g. 10 Euro). Based on experience and the figures provided by the Principal the following assumptions can be made:

Average mileage per vehicle and year	17,000 km
Average charge per kilometer (all vehicle classes, including markups):	0.045 €
Average number of transfers between OBU and CS per year	76.5
Data volume per transfer	< 10 KB
Data volume per vehicle per year (charge data)	< 1MB
Update info data volume per year	< 5MB

Tab. 6: Volumes and Cost Estimations of Transfer of Charge Data

As the data volume per vehicle per year is very low the cost for it is included in the base fee for CN. We assume a yearly base fee of 36 EUR. Based on our current experience, with today's pricing levels (which we use throughout this document) this is to be seen as an aggressive pricing.

1.4.3.4 Storage Device

This section describes the data exchange process for the Storage Device solution.

Process Description

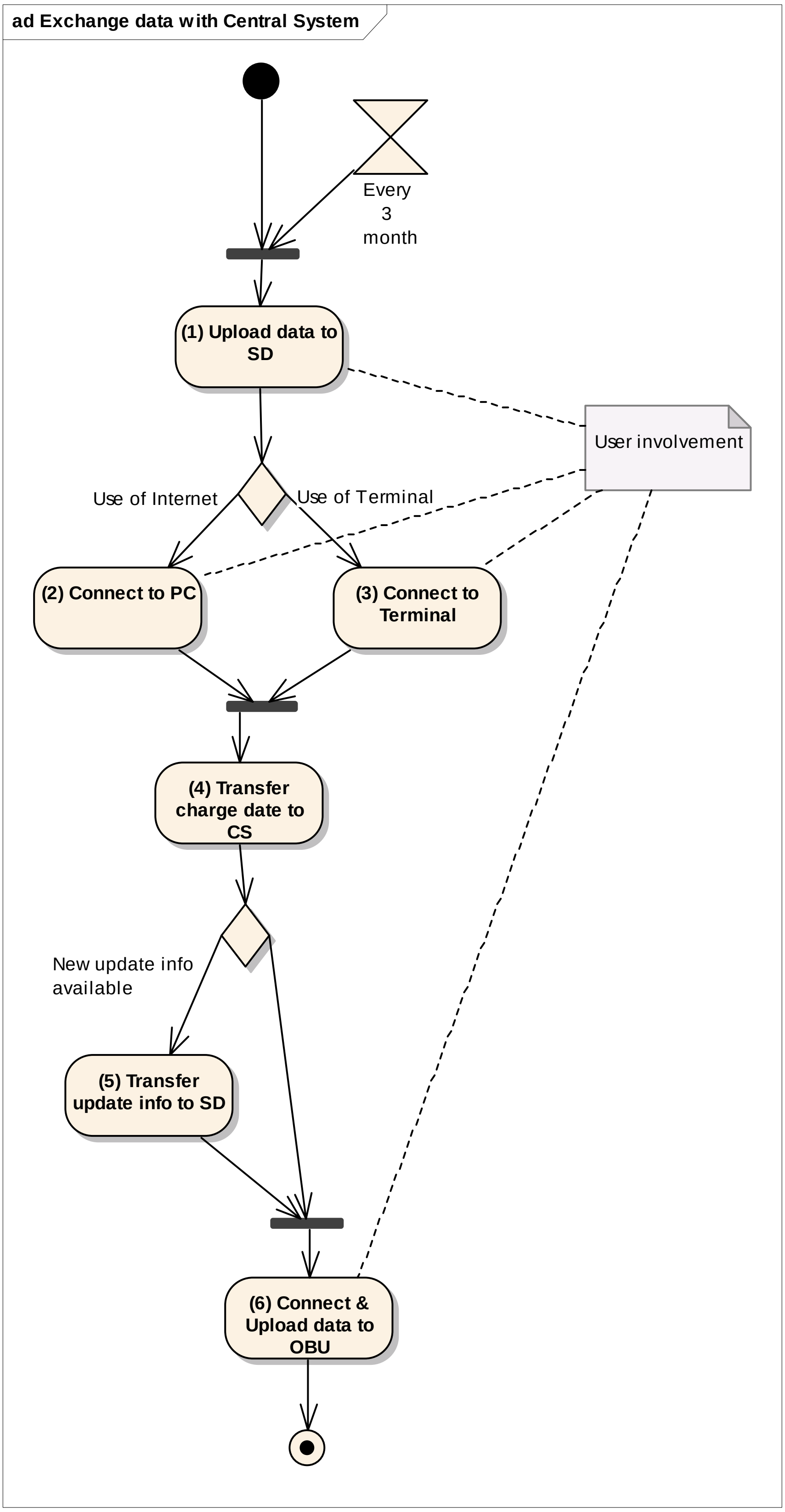

Fig. 12: Process Exchange Data with Central System

Activity	Description
(1) Upload data to SD	Periodically (e.g. every 3rd month) the user connects the SD to the OBU and initiates the upload of charge data to the SD.
(2) Connect to PC	If Internet is used for data transfer to Central System the user connects the SD to a PC.
(3) Connect to Terminal	If a Terminal is used for data transfer to Central System the user connects the SD to the Terminal.
(4) Transfer charge date to CS	Charge data are transferred from the SD via PC/Terminal and Internet to CS. The CS acknowledges the receipt.
(5) Transfer update info to SD	If new update info (map-, tariff data or software) are available, they are downloaded to the SD.
(6) Connect & Upload data to OBU	The SD is again connected to the OBU to upload the acknowledge of the CS and (if available) the update info to the OBU.

Tab. 7: Process Activities of Exchange Data with Central System

Volumes and Cost Estimation

As the data transfer using a Storage Device is more complex compared to Cellular Network it should happen with the least possible frequency. From a billing point of view that is once a year. But due to the fact that the data transfer is connected with update of tariff data that frequency is the limiting factor.

Required update frequency of tariff data	6 months
Transfer frequency for charge data	3 months

Tab. 8: Frequency of Update of Tariff Data

The data volume per transfer is very low (see CN) and isn't considered in further estimations.

The major risk of a low data transfer frequency is the loss of data if data storage in the OBU isn't accessible anymore (e.g. due to OBU malfunction or if the OBU got stolen). To mitigate that risk the cumulated charge sum (over all tariff classes) should be transmitted via DSRC at every enforcement action. If the OBU storage isn't accessible anymore that sum and/or the charge sum paid for the last period is used to determine the charge sum that has to be paid. If these OBU problems occur several times with the same user a fine has to be paid.

The main cost factor for the data transfer using a Storage Device is the Terminal Network that is needed in addition to the data transfer via internet. The figures are as follow:

Est. number of Terminals	5,000
Est. investment cost per Terminal including roll out	10,000 €
Est. operating cost per Terminal per year	7,500 €

Tab. 9: Cost of Terminal

This leads to investment cost of 50 m € and operating cost of 37.5 m EUR per year. The Terminal Network can be reused for the occasional user scheme.

User acceptance

There are several user involvements during data exchange with CS when using a Storage Device. Therefore it should be considered if the user effort is acceptable. To do so, the activities with user involvement are examined in more detail:

When using a Terminal for data transfer to CS the user has to perform the following activities:

1. Upload data to SD (estimated duration less than 1 minute)
    i. Connect the SD to the OBU
    ii. Press a button to start upload of data from the OBU to the SD
    iii. Wait until the OBU acknowledges the successful upload
    iv. Disconnect SD from OBU
2. Data transfer via Terminal (estimated duration less than 1 minute)
    i. Connect SD to Terminal (data exchange with CS starts automatically
    ii. Wait until the Terminal acknowledges the successful data exchange
    iii. Disconnect SD from Terminal
3. Upload data to OBU (estimated duration less than 1 minute)
    i. Connect the SD to the OBU
    ii. Press a button to start upload of data from the SD to the OBU
    iii. Wait until the OBU acknowledges the successful upload
    iv. Disconnect SD from OBU

When using a PC for data transfer to CS the following activities have t o be performed by the user:

1. Upload data to SD → see Terminal
2. Data transfer via PC (estimated duration 5 minutes)
   i. Connect the SD to the PC
   ii. Open URL of the upload application (no authentication necessary)
   iii. Start the data upload
   iv. Specify the path for upload data
   v. Wait until the application acknowledges the successful upload
   vi. Specify the path for download data (should be the same as for upload)
   vii. Wait until the application acknowledges the successful download
   viii. Disconnect SD from PC
3. Upload data to OBU → see Terminal

This leads to an overall time need of three minutes (in case of using a Terminal) or seven minutes (in case of using a PC) every three months, which is, from our point of view, acceptable. It has to be noticed that the three steps do not have to be performed back-to-back. Instead it is possible to have some days between each of the steps. Furthermore the data exchange process has not to be performed exactly every three months but can be initiated by the user within the three month period whenever deemed convenient. For example the user can perform the data exchange when he is refueling his car anyway.

To prevent the loss of Storage Devices there will be a bracket on the OBU to store the Storage Device when it is not in use. Even if the SD got lost this is no great deal as any other Storage Device can be used as long as it meets the specifications. Neither when using a Terminal nor a PC an authentication is necessary as the data on the Storage device is signed by the OBU and includes the OBU-ID. Therefore the Central System can check the data integrity and assign data to the user.

If users are not able to perform the data exchange process, which is in case of using a Terminal roughly equivalent to the use of an account statement printer, he might get help from the fuel station personnel.

Due to the fact that the use of Terminals takes less time and is easier compared to the use of a PC we assume a ratio Terminals/PCs of 70/30. If an equal distribution of data exchange processes between the Terminals and time is assumed (which is not the truth but ok for an estimation of magnitude) this leads to an average of 13 data exchange processes per terminal per day, which is in no way a problem.

1.5 Comments on Tariff Scheme

This chapter gives comments on the tariff options provided by the Principal with regard to feasibility and cost impact.

1.5.1 Comments on Background

- Who has to pay: If all motor vehicles had to pay according to the same (time and locations differentiated) tariff scheme, it would be required to equip all vehicles with an OBU. Such a solution might be possible, but there are some open questions that cannot be answered reliably today. If not all vehicles are equipped with an OBU, the vehicles without an OBU can not be charged with a time and locations differentiated tariff. If only vehicles with a Dutch license plate are subject to the KMP, enforcement will become easier as all vehicles are registered in the RDW and it is more likely that all vehicles can be equipped with an OBU.

- Which roads/kilometers are subject to the KMP: From our point of view it is only feasible that all kilometers in the Netherlands are subject to the KMP. Otherwise all private properties had to be modeled in detail for recognition by the OBU. This would lead to very high efforts especially for keeping this data up to date.

- Tariff differentiation by vehicle type: A high number of vehicle classes deducted from fixed vehicle parameters is no technical challenge as long as only registered vehicles are subject to the charge, because the parameters can be checked during the registration process (e.g. with vehicle registration certificate or RDW data). For non registered foreign vehicles it is impossible to check these parameters. Therefore only parameters that can be clearly and easily distinguished during enforcement can be used for differentiation, e.g. only vehicle type (van, passenger car, HGV, bus).

1.5.2 Comments on time and location scenarios

The main differences between the proposed scenarios regarding system design and related cost are the complexity of the OBU and of the map data on the OBU.

Scenario	Complexity	OBU	Map data	Comment
I (Flat rate)	Easy	No DR	No	
IA (Flat rate plus tolls)	Easy	No DR	Only for toll points easy to model	
II (Uniform peak off-peak)	Easy	No DR	No	GNSS time is used for time differentiation.

Scenario	Complexity	OBU	Map data	Comment
III (Peak tariff on congested segments)	Difficult	DR needed	Detailed map data of peak tariff segments and surrounding areas	Segment identification esp. for urban secondary roads is difficult, as well as keeping maps up to date.
IIIA (Different peak tariffs + apportionment)	Difficult (same level as III)	DR needed	Detailed map data of peak tariff segments and surrounding areas	Segment identification esp. for urban secondary roads is difficult, as well as keeping maps up to date.
IIIB (Different peak mark-ups + tolls)	Difficult (same level as III)	DR needed	Detailed map data of peak tariff segments and surrounding areas	Segment identification esp. for urban secondary roads is difficult, as well as keeping maps up to date.
IV (Urban-interurban)	Medium	DR needed	Definition of city areas and detailed map data of ring roads	Identification of ring roads might be challenging, depending on the complexity of the surrounding network.

Tab. 10: Comments on Time and Location

The additional cost for a Dead Reckoning Sensor is 26 EUR per OBU (see chapter 1.1.2). The effort for providing the OBU with up to date maps is estimated with at least 1 m EUR per year (personnel, vehicles, post processing). Buying the map data from a commercial supplier is not deemed feasible because the update frequency is not suitable (at least today) and the accuracy may not fit requirements of the road identification algorithm.

From a system design perspective a time differentiation is no problem as long as non OBU equipped users don't have to be treated equally. A differentiation in location should be kept as simple as possible, e.g. using areas or clearly identifiable road segments like motorways.

1.6 Billing and Payment

This chapter describes the system and process design of the billing and payment functionalities.

1.6.1 Billing

A higher invoicing frequency leads to higher operational costs for billing and payment. A monthly invoice for 8,159,000 users has strong costs impacts because of multiple process steps in several systems (see system following system design and processes).

The cost assumptions made for the billing are based on benchmark data from several different businesses including electronic fee collection and telecommunication and are adapted with the special characteristics of the KMP system solution in mind. We assume the cost of processing one yearly bill at roughly 10€. This does include all IT infrastructure needed but not the cost of fulfillment (printing and sending of bills) which is another 0.8-1€.

Thus the system is designed for a yearly invoicing.

Parameter	Value	Unit	Source/Rationale
Invoicing	1/year	freq.	Cost efficiency

Tab. 11: Invoicing Frequency

Additionally the user has the possibility to request information about past road usage on-demand (as an amount filtered by tariff classes and time, but not by detailed information about road segment usage).

Parameter	Value	Unit	Source/Rationale
Request past road usage information	On-demand	freq.	Customer’s need for information

Tab. 12: Request Past Road Usage Information

In order to avoid loss of interests the customer has to pay quarterly installments which are offset after the yearly invoice. Installments should not be requested too often because they cause costs as well. Quarterly installments are a proven comprise between a loss of interests and additional costs (compare energy sector e.g.).

Parameter	Value	Unit	Source/Rationale
Installments	quarterly	freq.	Avoiding loss of interest

Tab. 13: Installments Frequency

We decided against monthly installments due to following thought:

An expected 7 billion Euro toll income leads to 1.75 billion Euro toll income per quarter. 4% loss of interests (inflation rate and/or other opportunity costs) leads to 1% per quarter theoretic loss of income. Theoretic because the later the road usage within a billing period is, the lower the loss of interest is. Thus, an average loss of interest of 0.5% or 8,750,000 Euro per quarter is assumed.

Further, we assume that 10% of the installments and bills cause further cost of 10,- Euro (very optimistic) for follow-up communication, etc. because of irregularities. With approx. 8,000,000 users, 800,000 installment irregularities causing 8,000,000 Euro additional installments costs per month are expected. Subsequently, just the costs for irregularities cause 16,000,000 Euro additional costs compared to a quarterly installment which has 8,750,000 Euro loss of interest.

A further step to cost reduction is the usage of e-mail invoices with lower costs. Mail invoices have to be provided due to discrimination reasons.

Parameter	Value	Unit	Source/Rationale
E-mail to mail ratio	70:30	ratio	Assumption based on variant 5

Tab. 14: Email to Mail Ratio

Our current experience shows much less e-mail invoices compared to mail. Thus, a 70:30 e-mail to mail ratio is challenging, but can be achieved with initial incentives for customers.

1.6.2 Payment

The system offers multiple payment possibilities:

- Direct debit/ClieOp (Cliëntopdrachten)
- Credit cards via acquirers (only for occasional users)
- Fuel card via acquirers (only for occasional users)
- Cash through vouchers (only for occasional users)
- New payment channels (e.g. Paypal, etc.)

Direct debit/ClieOp is the only payment method for Dutch OBU-based vehicles because of cost efficiency. Credit cards, fuel cards, new payment channels and voucher payments are possible payment methods for the OUS scheme. The additional costs for credit and fuel cards have not to be paid by the customer. New payment channels may be especially interesting for foreign user using internet booking with the OUS.

The cost calculations for the Payment process assume a full factoring of the receivables, that is, not only the cost on the bank transfer or direct debit but the full collection costs and losses due to non-payment are covered by the cost of Payment processing. The cost parameters used are based on past and current experience and benchmarks from several projects. We assume the full cost of the payment collection including loss coverage to be at 2% of KMP revenue. Given the fact that the KMP system will have to accept every vehicle owner (or user for foreign vehicles) as a customer we regard this cost assumption as being aggressive.

1.6.3 Monthly Billing

The Main cost driver for billing is the operation of the ERP system. The given number of bills (8.159 mil/year) requires a billing system of considerable size without leaving excess capacity, if the system is to run invoicing processes at 10 days a month this requires ~68,000 bills to be processed per day.

Scaling the system to process monthly bills (that is almost 100 mil. bills/year!) and assuming 20 billing runs per month (which will be organizationally challenging due to the limited availability of spare days to compensate for problems, performing system maintenance etc.) requires more than 400,000 bills to be processed every day. This requires a correspondingly larger system and the cost for the bill processing will increase respectively.

We assume the full cost for the processing (without fulfillment) could be reduced for a monthly bill (due to common overhead) to about 8€.

The number of payments will increase by a factor of 3 (we previously assumed quarterly installments) which will have an impact on processing costs for the installments. Processing costs for the installments include the collection itself (e.g. direct debit) as well as the systems and staff needed to trigger the transfer and to process exceptions (such as non-payments). We assume these process costs to be around 0.5€.

Another cost driver will be follow-up costs. Follow-up costs for the installments (and, actually, for non-payments) are covered in the 2% collection charge, but customer complaints against the bill will still have to be processed. Even if we assume that the rate of follow-ups will halve compared to yearly bills monthly billing leads to a 500% increase in follow-up costs.

Apart from cost considerations, we do not consider monthly billing feasible for the SD based solution from a user acceptance perspective, so monthly billing could only be provided for the CN solution.

1.6.3.1 System Design Billing & Payment

The system design is shown in the following architecture.

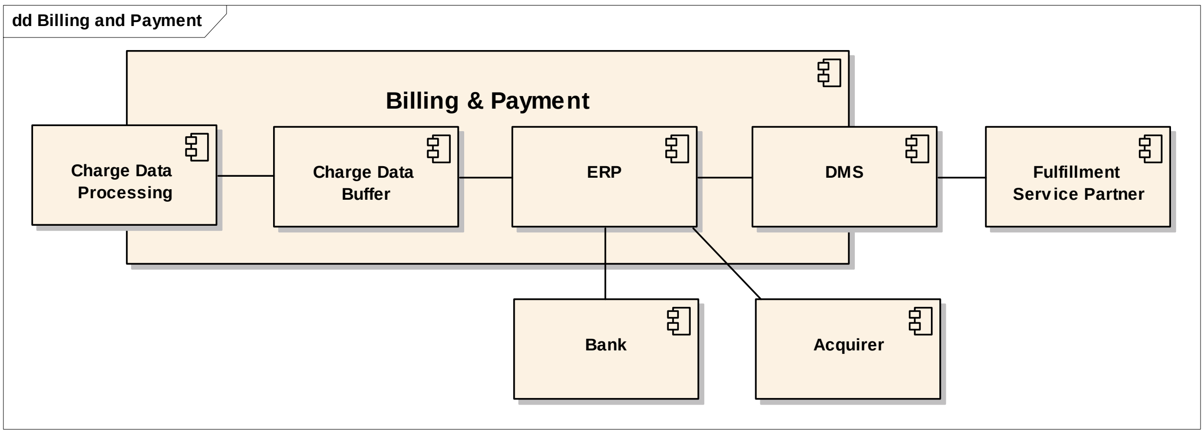

Fig. 13: System Design of Billing and Payment

The center of billing and payment is an ERP system (Enterprise Resource Planning) which gets the charging data from the Charge Data process System via a Charge Data buffer. The DMS (Document Management Systems) which serves also the Customer Care system archives the invoice documents. The invoice mails are finally sent by the Fulfillment Service Partner to the costumers. E-mail invoice are directly sent by the DMS via a communication server.

The customer can check the past road usage as defined above with his OBU and by accessing the web server.

1.6.4 Business Process

The general business process for billing and payment (without installments payments) is shown in the following graph:

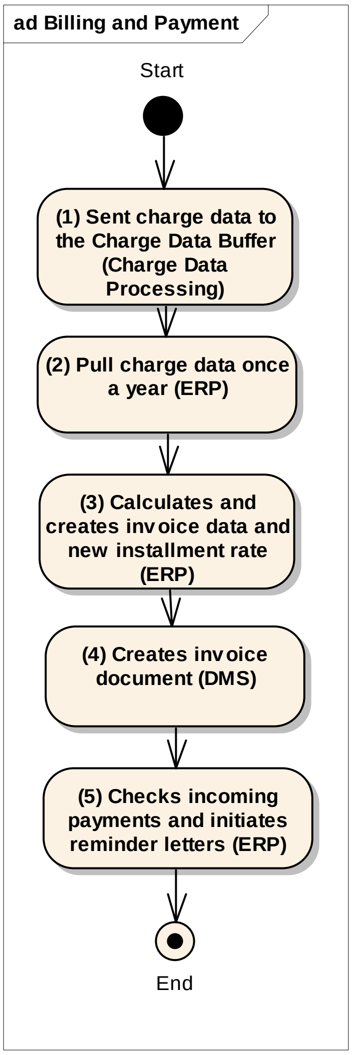

Fig. 14: Billing and Payment Process

The following table describes the process activities in detail:

Activity	Description
(1) Sent charge data to the Charge Data Buffer (Charge Data Processing)	The Charge Data Processing sends the charge data to the Charge Data Buffer **continuously.**

Activity	Description
(1) Sent charge data to the Charge Data Buffer (Charge Data Processing)	The Charge Data Processing sends the charge data to the Charge Data Buffer **continuously.**
(2) Pull charge data once a year (ERP)	The ERP system pulls the charge data for further invoicing **once a year** from the Charge Data Buffer.
(3) Calculates and creates invoice data and new installment rate (ERP)	The ERP system calculates and creates the invoices and the respective accountings **once a year.** Additionally a new installment rate based on the past road usage is calculated.
(4) Creates invoice document (DMS)	The DMS creates and archives the invoice documents and sends them via e-mail or mail (through a Fulfillment Service Partner) **once a year.**
(5) Checks incoming payments and initiates reminder letters (ERP)	The ERP system checks incoming payments (for the difference between paid installment and real road usage) from Banks and Acquirers and initiates the follow process **once a year.** The follow-up process includes multiple reminder letters and a manual collection process when required.

Tab. 15 Process Activities of Billing and Payment

1.7 Registration and Installation

The registration and installation process will be used for vehicles which permanently use the NL road network. For the OUS neither a registration nor the installation of equipment will be necessary.

Therefore, the next chapters describe the standard use case for using the KMP in NL.

The following main processes are considered:

- User registration
- OBU installation
- OBU check-up
- Complaints process

For purpose of this study, we assume that every workshop with a certification to do the APK test will also do OBU installation and check-ups. These will be called Certified Installation & Service Centers.

Every Installation and Service Center will have to have a PC with a broadband online connection and it will get a support application for OBU personalization. The Main Service Station Application will be an ASP solution hosted in the Toll Provider's Service Center and accessed by the Installation & Service Center through the Internet.

The same processes will be used independent of the type of OBU used (with Cellular Network (CN) support or data transfer through Storage Device). In any case, a Storage Device (SD) will be used for data transfers to and from the OBU in the service center.

Assumption	Volume	Comment
# of OBUs	8,159,000	Number of OBUs during regular operation
Installation & Service Centers	9,191	All workshops with a certification for the APK test
Cost of Installation	45 €	Principal's assumption
Cost of OBU	182 €	Calculation. OBU price with SD including distribution & sales
New installations per year	20% of fleet	10% new vehicles plus OBU exchange
Cost of OBU check-up	8 €	Assumption based on process time
Cost of registration process	20 €	Assumption based on process complexity

Tab. 16: Volumes and Costs

1.7.1 User registration

To use the OBU a user registration is always necessary. The user has to declare his name, VRM and means of payment (bank account information for direct debit, billing address for bank transfer).

Vehicle specific information will be imported from the RDW data base for domestic users and have to be declared by foreign users. We assume an interface to the RDW database will be present. Privacy will have to be considered for the use of this interface.

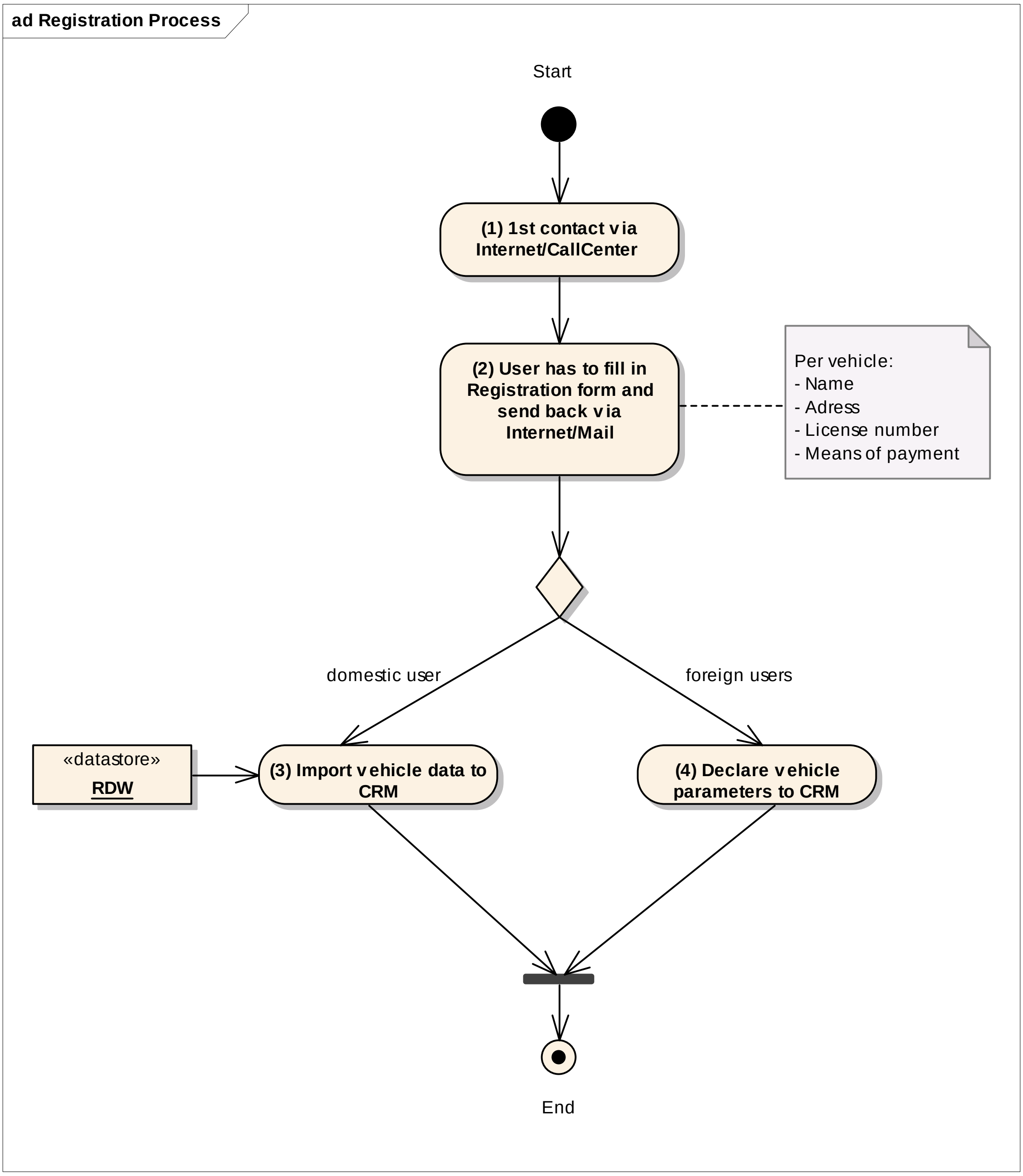

Fig. 15: Registration Process

The registration can be used the following ways:

- Internet application mask
- A registration form can be downloaded as .pdf file, printed by the user and sent to the operator via mail.
- The user can request a registration form through a call center.

The registration process also formally closes a contract between the user and the Toll Provider. In case of internet registration a separate signature may be required. In this case the signature can be brought at OBU installation.

If the principal decides to subsidize OBUs, the subsidy will be booked on the user's account (once) after registration.

Data description	Datatyp	Data source
Name/company/address	Basic data registered owner	Customer, RDW
Bank account	Basic data registered owner	Customer
Vehicle type	derived data relevant to the KMP	Customer, RDW
License number	Reference data registered vehicle	Customer, RDW (check)
Overall weight	derived data relevant to the KMP	Customer, RDW
Emission class	derived data relevant to the KMP	Customer, RDW
Fuel type	derived data relevant to the KMP	Customer, RDW
User Reference ID	Customer Basic data	CRM system

Tab. 17: Basic data for the registration process

1.7.2 Installation process

This is the process to physically and logically install an OBU into the vehicle of an (already) registered user.

We assume 1 hour of workshop time for the whole installation process.

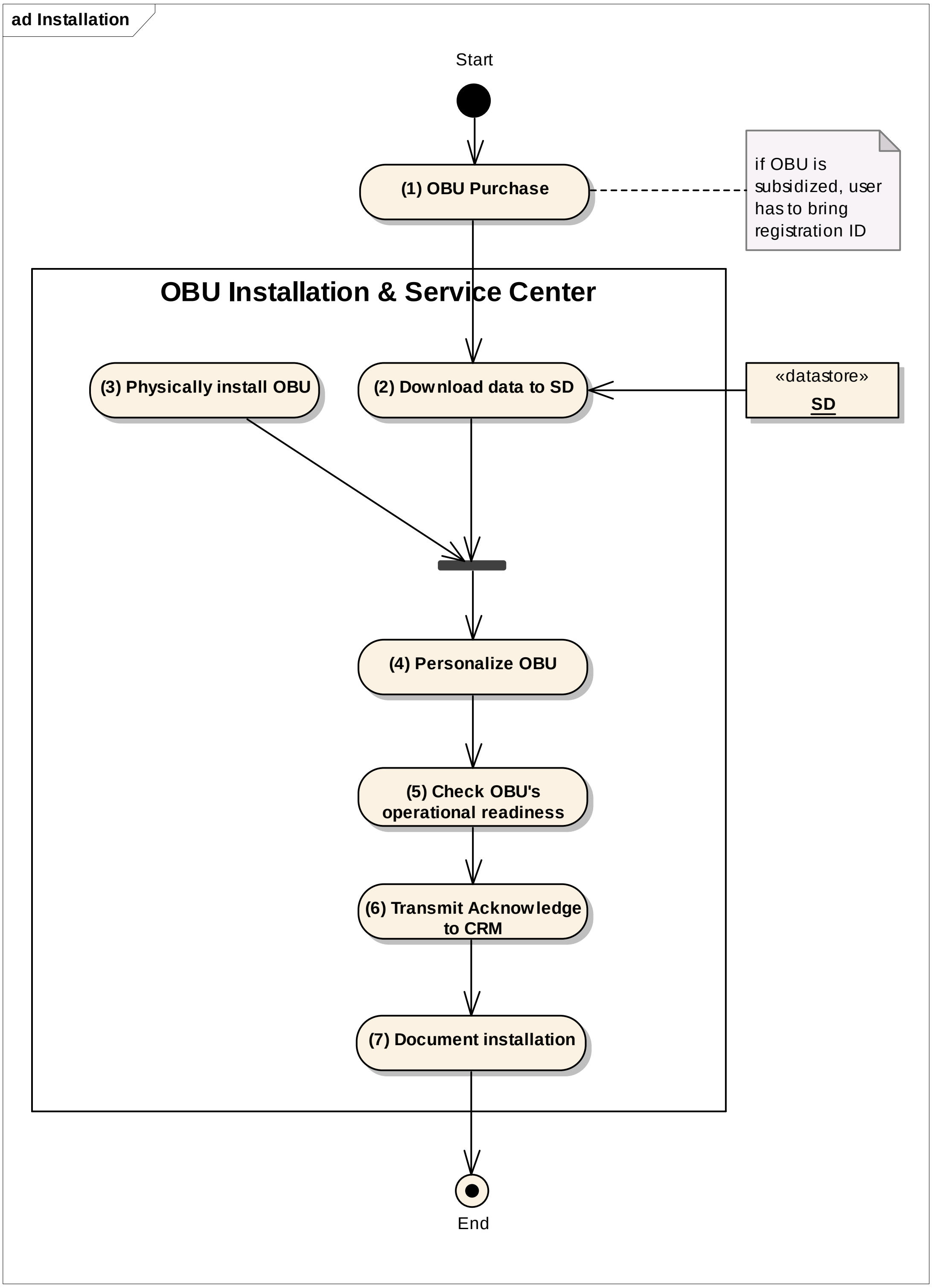

Fig. 16 : OBU installation Process

The following table describes the process activities in detail:

Activity	Description
(1) OBU Purchase	The user starts the process by purchasing a certified OBU. This can be done e.g. at retailers or gas stations. The installation and activation of the OBU has to be done at a certified installation center.
(2) Download data to SD	The Installation & Service Center personnel logs into the Service Center application using the license plate number of the user. Then a personalization certificate is downloaded and transferred to a Storage Device along with the latest software updates, Map and Tariff information and the vehicle specific data.
(3) Physically install OBU	In parallel, the OBU is being installed into the vehicle.
(4) Personalize OBU	The personalization of the OBU starts by connecting the Storage Device to the OBU. An automatic installation process will install the software and distribute the data to the OBU.
(5) Check OBU's operational readiness	The OBU's operational readiness is checked by a function test. The result of the function test is written to the Storage Device. After successful function test the OBU will be activated and is ready for use.
(6) Transmit Acknowledge to CRM	The correct installation and activation of the OBU will be document by an acknowledge, furthermore the Service Center personnel document the current mileage as read from the odometer. It will be transferred to the CRM by connection the mass storage device to the Service Center PC and uploading it to the Toll Provider's Central System.
(7) Document installation	The installation of the OBU can be documented with a protocol. It will be paid for by the user.

Tab. 18: Process Activities of OBU installation

1.7.3 OBU check-up

This process will be handled by the certified installation & service center and will be done during the annual vehicle check-up.

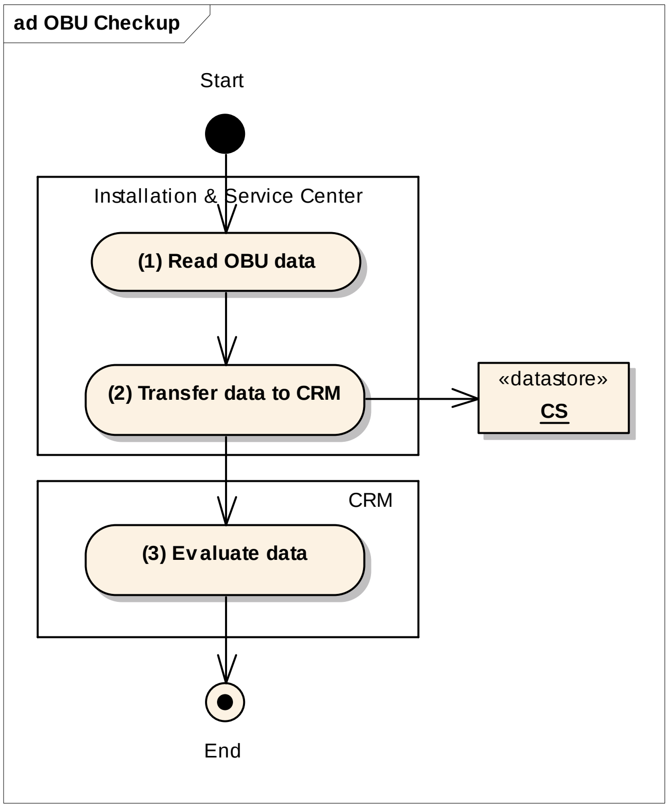

Fig. 17: OBU Check-up Process

The following table describes the process activities in detail:

Activity	Description
(1) Read OBU data	The check-up starts with the connection of the SD with the OBU. The Installation and Service Center personnel starts a self-test procedure and any error logs will be transferred to the SD along with a certificate. Also, the last KMP reading will be transferred.
(2) Transfer data to CRM	The Storage Device will be connected to the Service Center PC and the OBU readings will be transferred to the user account (identified by the license plate number). Along with this information, the current odometer reading will be entered.
(3) Evaluate data	Any OBU defects will immediately be reported back to the Installation and Service Center personnel; later, fraud detection and plausibility checks can be run on the data transferred in the Central System of the Toll Provider.

Tab. 19: Process Activities of OBU check-up

We assume that no detailed billing information (like roads used etc.) will be transferred during this process.

1.7.4 Complaints process

Another process that involves the Installation and Service Center is the complaints process (to manage user complaints about incorrect KMP bills). The reason for this is that no detailed billing information will be sent to the Central System during the regular operation of the KMP, but only aggregated information (toll due per tariff class). However, detailed billing information will be stored on the OBU for one year. If a complaint has to be processed, the detailed billing records have to be read through the Installation & Service Center. This way, the regular billing process is kept simple and routine user complaints are being disencouraged.

If the OBU is using a CN connection to transfer data, this process could also be handled without the Installation and Service Center via a Central System request to upload data through the network. However, this has some privacy impacts, since theoretically the user does not have full control over the upload process for detailed billing information.

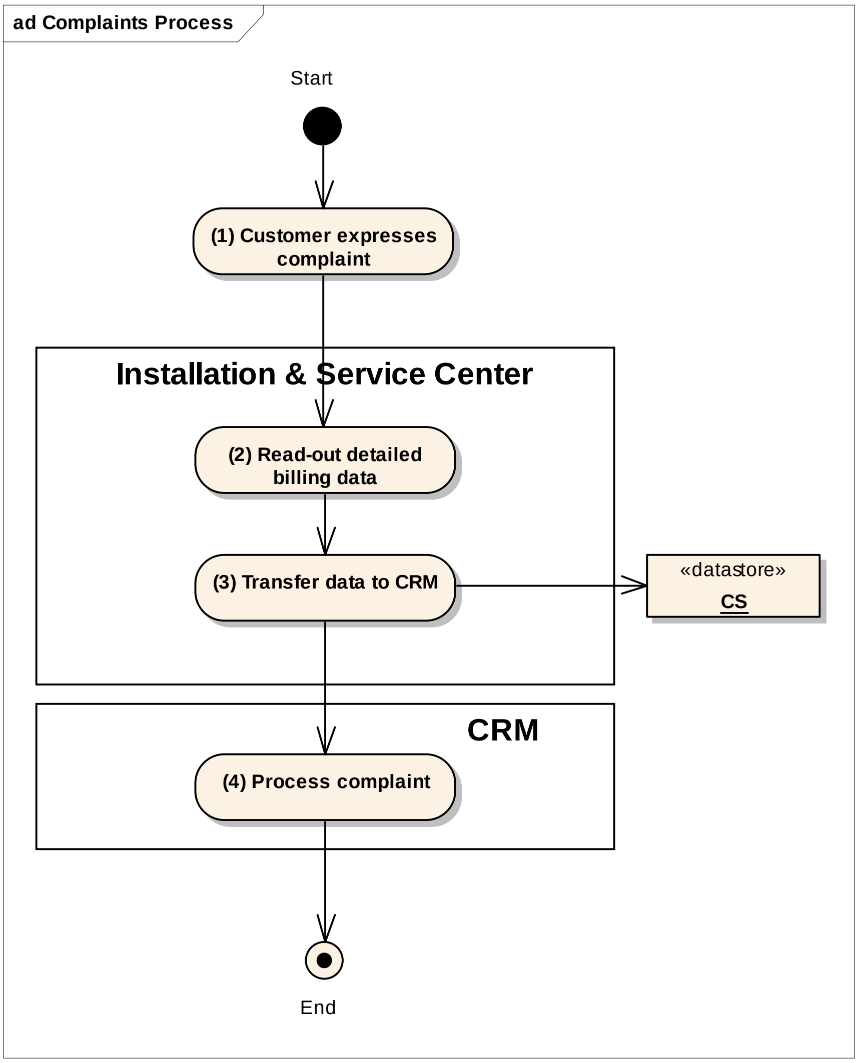

Fig. 18: Complaints Process

The following table describes the process activities in detail:

Activity	Description
(1) Customer expresses complaint	The user files a complaint through a call-center, the internet or by mail. Then, he will be sent to the Installation and Service Center to read out his detailed billing data.
(2) Read-out detailed billing data	The SD is connected to the OBU. The Installation and Service Center personnel activate the download functionality of the OBU and all detailed billing information stored on the OBU will be transferred to the SD along with a certificate.
(3) Transfer data to CRM	The Storage Device will be connected to the Service Center PC and the data will be uploaded to the Toll Provider's CRM system.
(4) Process complaint	The Complaint will be managed by the Toll Provider's CRM staff.

Tab. 20: Process Activities of complaints process

1.8 Customer Care

The primary goal of this chapter is the determination of the sizing of the customer care organization. The system design of the customer care system is described briefly, because of its triviality. The business processes are identified, but not described due to their plurality.

1.8.1 System Design

The system design for a customer care organization is clearly laid out and proven: A CRM system forms the center, a PBX (private automatic branch exchange) connects the system to the external telecommunications providers, ACD (automatic call distribution) delivers the calls to the agents, an IVR (interactive voice response) can reduce the required number of agents and a CTI (computer telephony integration) integrates the PBX with the CRM system.

The DMS (document management system) is a crucial system for many customer care processes, because all offline communication is managed by the DMS. The DMS is a dedicated system serving the billing and payment processes as well.

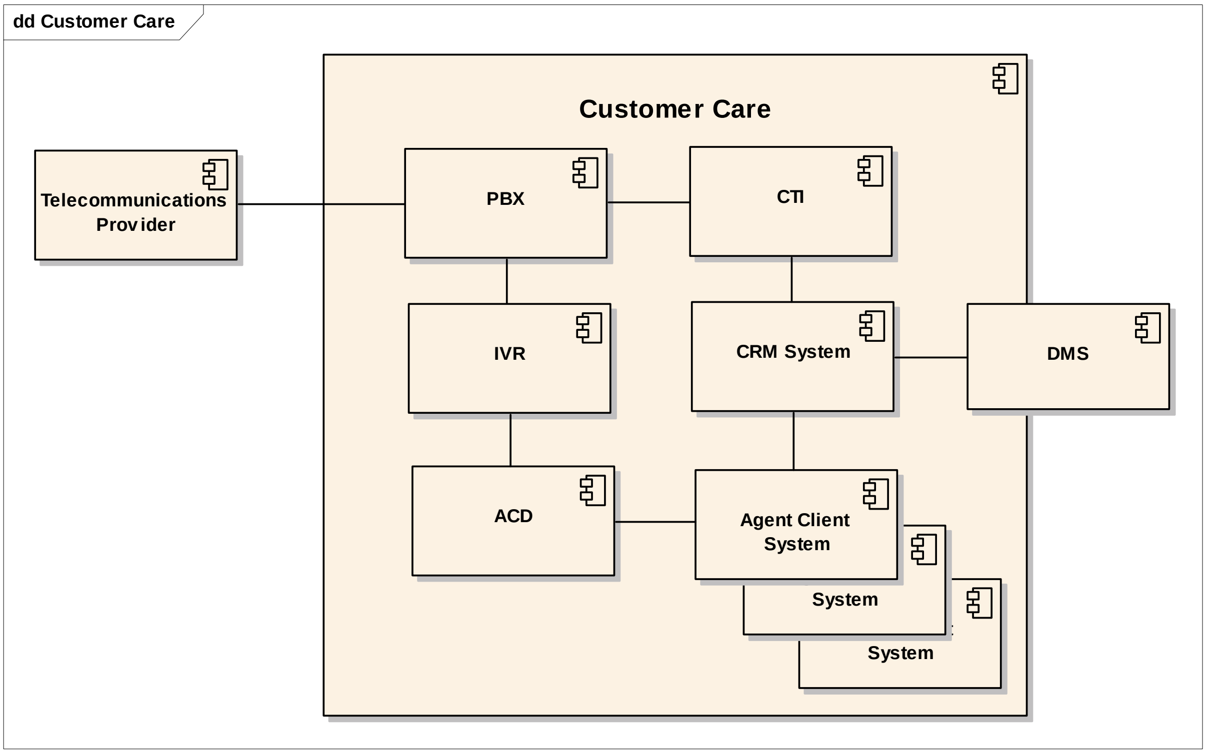

Fig. 19: Customer Care System Design

1.8.2 Business Processes

1.8.2.1 General Business Processes:

- In-bound contact
- General helpdesk online, offline
- Requesting general information package
- Requesting information about user data
- Requesting Information about road/map data
- Returns of mails and e-mails
- Contract termination
- New classification, optional
- User registration
- Credit rating check
- Changing standing data
    - o Contact

  - Vehicle
  - Payment

- Request second invoice/receipt
- Mail import in DMS (document management system)

1.8.2.2 OBU-based Business Processes

- Vehicle declaration
- Vehicle deregistration
- Loss of OBU
- Lock OBU
- Unlock OBU
- OBU inspection

1.8.2.3 Customer Complaint Business Processes

- General complaint online, offline
- Technical complaint
- Billing complaint
- Compensation request

1.8.3 Parameters and Assumptions

It is experienced that all the customer care business processes have a similar workload for the call center agents and the systems. A few exceptions cause more workload, but occur fewer times.

Thus an aggregation of all customer care processes can be made.
A generic customer care process represents all customer care processes mentioned above.

Parameter	Value	Unit	Source/Rationale
Vehicle quantity to customer care process quantity/year	1.5 to 1	ratio	Assumption based on experience/benchmarks

Tab. 21: Vehicle Quantity to Customer Care Process Quantity/Year Parameter

Explanation: This ratio describes the correlation between the number of vehicles to the total number of expected generic customer care processes per year.

Example: A total vehicle number of 8,000,000 vehicles would lead to 5,333,333 customer care processes per year.

Parameter	Value	Unit	Source/Rationale
Customer care process quantity/year to Concurrent service agents/FTE	7,700 to 1	ratio	Assumption based on experience/benchmarks

Tab. 22: Customer Care Process Quantity/Year to Current Service Agents/FTE Parameter

Example: A total customer care process number of 5,333,333 processes per year would require approximately 693 FTE of service agents.

Those ratios and figures are average figures determined for an overall cost calculation. The operative planning and operation of a customer care organization has to be controlled short-termed according to the current and expected user behavior.

Finally, both parameters can be aggregated to one meta parameter:

Parameter	Value	Unit	Source/Rationale
Vehicle quantity to Concurrent service agents/FTE	11,550 to 1	ratio	Derivation

Tab. 23: Vehicle Quantity to Current Service Agents/FTE Parameter

Those ratios are based on conservative calculations and current experiences and benchmarks. They could be optimized by

- using existing organizations and facilities for several processes (e.g. registration),
- giving incentives for using online service or IVR based services and/or
- reducing the concurrent agent number, which leads to longer wafting times for the customers.

1.9 Enforcement

Clarification of wording:

- Stationary enforcement site (EnfSt): fixed installed facilities covering several lanes e.g. of a motorway and execute automatically enforcement processes after activation by the enforcement center.
- Portable enforcement site (EnfPo): enforcement facility that can be placed temporarily beside the road and executes enforcement processes automatically. Automated processes of EnfPo similar to EnfSt, but integration of EnfPo technology into the enforcement vehicle is reasonable (high flexibility).

- Mobile enforcement vehicles (EnfMo): Vehicles equipped with technical devices to enforce manually e.g. while passing another vehicle. With integration of EnfPo technology the enforcement vehicle will be able to operate in two modes: EnfMo and EnfPo.

1.9.1 General enforcement principles

Enforcement has to be as cost-effective as any other component. Major cost drivers are direct costs for enforcement as personnel, equipment and software and the loss of toll revenues. Additionally the collected fines should be considered as well. Cost efficiency can be reached between these two extreme solutions: No enforcement at all will cause high rates of non-paying users, “100% enforcement” will be too expensive.

As a conclusion enforcement has to deter the user from fraud. The chance of being caught has to be high enough on every road (enforcement frequency). The fines need to be in a magnitude that makes fraudulent use unattractive as well. Repeat offenders should be charged with rising fines. Both factors influence each other: Lower fines demand more enforcement and the other way round. For deterrence even psychological effects can be used, like visibility of enforcement vehicles on the roads or time gap between offence and prosecution (directly after EnfMo, but with time gap after EnfSt). For foreign users it is necessary that fraud can be prosecuted even if they do not stay in the country. Otherwise this would lead to bad payment behavior.

For the technical implementation, especially for the enforcement system, privacy issues have to be considered: Important details are encrypted communication, encrypted storage of data and authentication before data access as well as to make data anonymous or delete them completely as soon as they are not necessary any more.

1.9.1.1 Calculation: height of fines

The table in this chapter presents an example for calculation of the necessary height of fines. Therefore the following assumptions have been made:

- Average charge per kilometer (all vehicle classes, including markups): 0,045 EUR (assumption based on figures provided by the Principal in tariff scenario II)
- EnfSt: average distance between enforcement stations of 40 km, active time of 5% (rationale see chapter 1.9.5 and 1.9.2.)
- EnfPo: average distance between enforcement sites 3,000 km; active about 8h/day (33%)

The following scenarios are examined:

- Scenario 1: regional commuter - passenger car

- Scenario 2: HGV - traveling mostly in Netherlands
- Scenario 3: foreigner - holiday trip

	Scenario 1	Scenario 2	Scenario 3	source
avg. distance travelled per year	17,000	50,000	1,000	assumption
ratio of use of motorways / other roads	20:80	80:20	70:30	assumption
# of times of enforcement per year (statistical probability)	5.75	51.10	0.91	calculated
total toll per year (EUR)	765	2,250	45	calculated
necessary height of fines to deter from fraud	133	44	50	calculated

Tab. 24: Scenario calculation for height of fines

Note: Influence of EnfMo and annual checks is not considered in the calculation above but will only support other enforcement strategies. Especially local residents will have to fulfill the annual check. This will lead to a higher number of times the vehicles are enforced and in consequence also lower fines. Therefore the values above are the result of a very conservative calculation.

As a conclusion we recommend to start with fines of about 80 to 100 EUR for passenger cars and then rise about 50% for every consecutive detected fraud. For example: 1st fine: 80; 2nd fine 120; 3rd fine 180. For HGV fines should be higher (e.g. double) as the fines of passenger cars to take into account that companies in logistics are professionals and should be highly informed about new regulations on the road network.

1.9.1.2 Calculation: total income out of fines

The income out of fines is calculated in the following table:

		Source
# of users	8,159,000	Provided by the Principal; Assumption for simplicity: #OBUs = #vehicles
Fraction of fraudulent users	2%	Assumption based on variant 5
fraction of enforced traffic	10%	Assumption based on experience: proposed enforcement system should have a fraction between 7 to 10% (measurement of this fraction difficult)
# of detected fraudulent users per year	16,318	Calculation
# of times of detection of fraudulent use per user	3	Assumption: Some users will be regular fraudulent users and will be detected more than 3 times a year, others e.g. those who forgot to pay will only cause singular incidents
avg. height of fines (EUR)	160	derived from chapter above
total income out of fines per year (EUR)	7,832,640	Calculation

Tab. 25: Scenario calculation: Total income out of fines

1.9.2 Pros and Cons of different enforcement methods

A positive aspect for EnfSt and EnfPo is the possibility to enforce large numbers of vehicles. Automated processes allow enforcing especially on highly frequented roads where enforcement vehicles would be able to enforce only a small percentage of traffic. EnfSt and EnfPo collect evidence data like overview picture, VRM picture and DSRC-data. Out of these data the enforcement site is clustering enforcement records in different categories, which have to be checked manually in the enforcement centre. Therefore not all EnfSt should enforce and send evidence data all the time (high effort for manual checks). Activating about 5 to 10% of all EnfSt, dependent on traffic situation, is recommendable.

The manual checks, afterwards are necessary because of different reasons: The impact of weather conditions especially on VRM picture cause higher error rates in OCR processes and laser scanners are also affected by weather conditions. Another reason for manual checks is the following legal prosecution of offences which can be proved by the collected enforcement data. A legal process should not be started automatically. For calculations these costs for manual checks have to be considered.

To minimize manual checks the enforcement facilities we recommend categorizing every vehicle and processing those categories in different ways in the enforcement center. Categories with a higher fraction of fraud incidents have to be processed first for example.

Differences between EnfSt and EnfPo are the fixed installation of EnfSt whereas the EnfPo will be able to operate at various locations. This leads to less accuracy of the EnfPo, because of fewer possibilities to adjust the enforcement facility exactly. That is why there should be expected more effort in manual check after an EnfPo (trade-off between accuracy and setup time). Due to the fact that an EnfPo will be located besides the road it will be difficult to enforce more than 1 lane. Vehicles on the first lane, regularly trucks will disturb enforcement on further lanes. The whole set up effort and as well the logistic efforts of changing locations of the EnfPo have to be considered in operating costs. Additional costs can arise because EnfPo is not protected as good as EnfSt against vandalism or theft.

As a conclusion EnfSt should be installed on highly frequented roads, especially motorways. There also will be enough space to install the EnfSt. On highly frequented motorways all strengths of an EnfSt can be used. On lowly frequented roads the EnfSt is not working to full capacity. For those roads the better solution are EnfPo.

Another conclusion out of first cost calculation is high costs of logistics and maintenance of EnfPo. That is why we recommend integrating EnfPo into the enforcement vehicle. The integrated EnfMo/EnfPo can be placed beside the road (rapid set-up) and data is processed similar to EnfSt processes (DSRC data, picture). The enforcement personnel can check the incoming data as if they were examined in the enforcement center. There are several other advantages of this integration of two enforcement methods:

- no additional costs for logistics: integrated EnfPo can easily change locations, whereas only-EnfPo needs special logistic personnel
- enforcement personnel can check data directly inside the vehicle, no additional personnel in enforcement center for incoming EnfPo data necessary
- almost no vandalism and theft risks
- Enforcement is highly flexible: Easy shifting between EnfMo and EnfPo mode possible

Mobile enforcement is the most flexible method in enforcement. For potential fraudulent users EnfMo is not foreseeable like stationary enforcement facilities which are fixed. So EnfMo is highly useful for deterrence of abuse, even if it is not possible to enforce high amounts of vehicles. As a cost factor of EnfMo the enforcement personnel has to be considered. In general two persons are needed in one EnfMo. Additional advantage of an EnfMo is the possibility to charge foreigners directly after an offence, so that problems with legal processes in foreign countries can be avoided. This also implies an important precondition for an EnfMo: A parking area is necessary to stop the vehicle.

Therefore enforcement vehicle in EnfMo-mode should be focused on areas with high percentage of foreign users, and for deterrence it is useful to have random checks on all roads.

1.9.3 Processes

The first process shows the automated processing of enforcement data as it occurs in the EnfSt and the EnfPo-mode of enforcement vehicles. The second process describes the mobile enforcement:

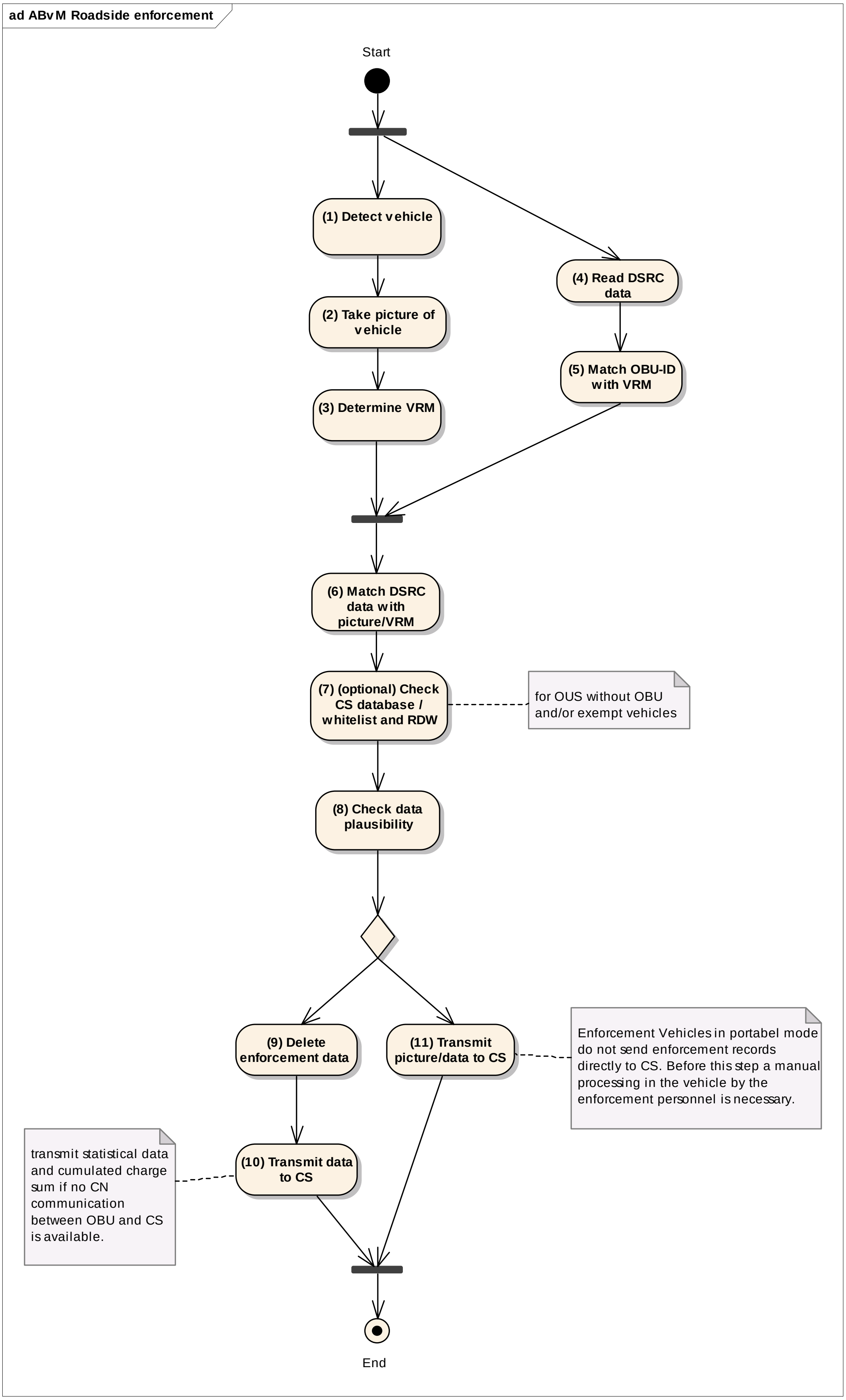

Fig. 20: Roadside Enforcement Process

Process step	Description
(1) Detect vehicle	The enforcement facility has to detect the approaching vehicles; following steps will be triggered by detection.
(2) Take picture of vehicle	Scan vehicle; Take overview and VRM picture
(3) Determine VRM	Determine VRM out of VRM picture by using OCR SW
(4) Read DSRC-data	Parallel to process steps above DSRC data is received
(5) Match OBU-ID with VRM	OBU-ID provided by DSRC data is matched to the associated VRM (matching table)
(6) Match DSRC data with picture VRM	Data of step 1-3 is matched to DSRC-data (step 4-5) via VRM or by time-based method (comparison of timestamps)
(7) (optional) check CS database / whitelist and RDW	For OUS users no DSRC data is available; valid vignette data needs to be checked in CS database; For OBU equipped vehicles plausibility of data can be checked with RDW or white list.
(8) Check data plausibility	Plausibility check of all data; categorizing data in groups.
(9) Delete enforcement data	Delete enforcement data of users who paid toll, especially pictures (in consideration of privacy) whereas data of suspicious users is stored.
(10) Transmit data to CS	To support Central Systems selected DSRC data can be transmitted to CS. Data can be used to calculate toll if OBU is damaged, etc. Statistical data of the enforced traffic can be transmitted, too (due to privacy reasons in an anonymous way, not user related).
(11) Transmit picture / data to CS	Data of suspicious users is transmitted to the CS, in the EnfPo-mode of the Enforcement vehicle data is checked manually before transmission to CS.

Tab. 26: Description of Roadside Enforcement Process Steps

As an additional comment on the enforcement of motorbikes we like to point out that automated processes like VRM recognition is not possible for motorbikes in the same way as for other vehicles. Especially for HGV the picture has to be made from the front side whereas for motorbikes the VRM can only determined from the back and with much more difficulties. With regard to the expected additional cost e.g. for additional cameras, we recommend to abandon on the automatic stationary enforcement of motorbikes and to focus on the enforcement vehicle.

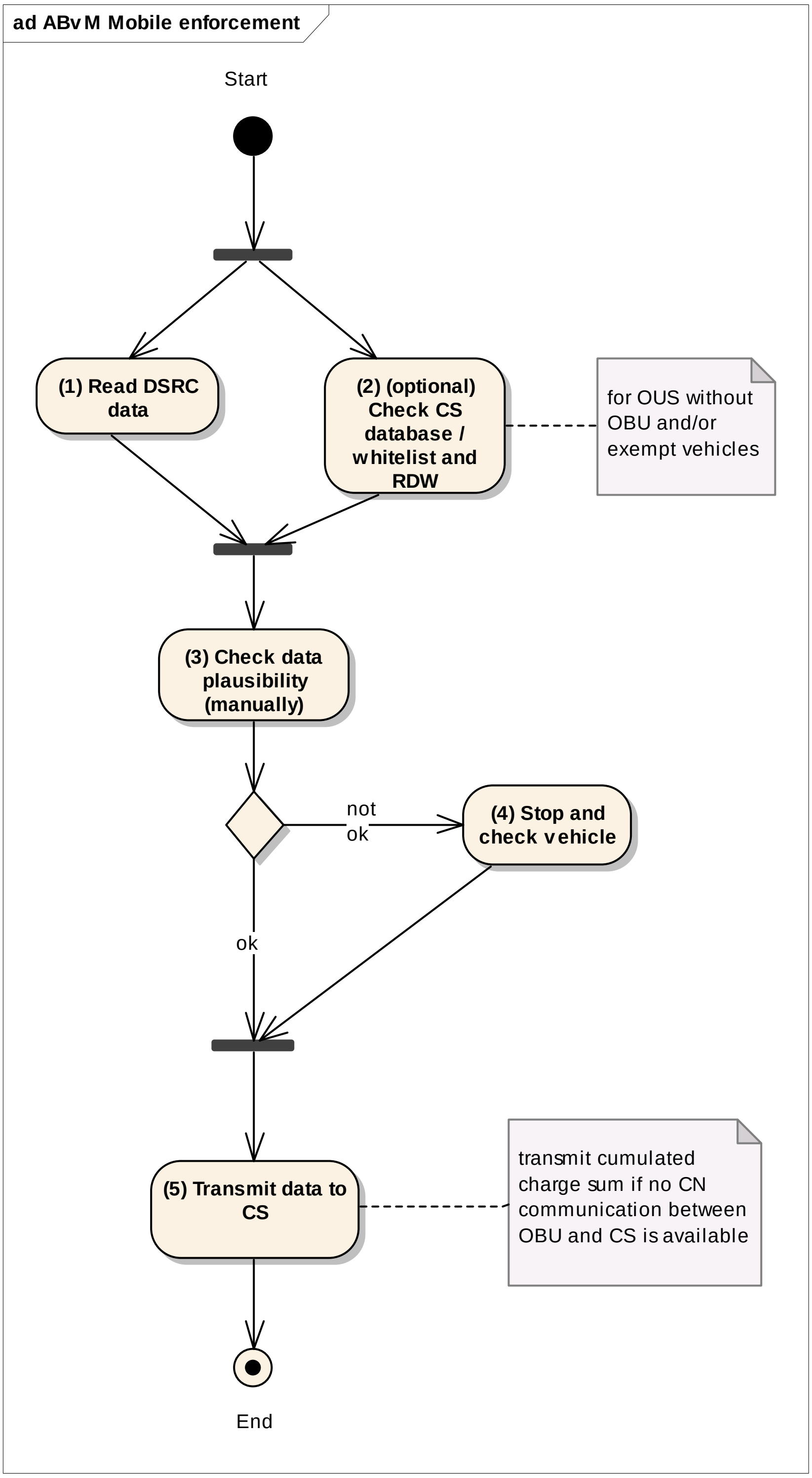

Fig. 21: Mobile Enforcement Process

Process step	Description
(1) Read DSRC data	Read out DSRC data when passing the vehicle which has to be checked

Process step	Description
(2) (optional) check CS data-base / whitelist and RDW	For OUS users no DSRC data is available; valid vignette data needs to be checked in CS database; For OBU equipped vehicles plausibility of data can be checked with RDW or white list
(3) Check data plausibility (manually)	The collected data is presented by the SW e.g. on notebook to the enforcement personnel. The data is checked manually (plausibility of data).
(4) Stop and check vehicle	If the enforcement personnel find indices for fraudulent use, they stop the vehicle to charge the user. The SW supports as well during the documentation of the incident.
(5) Transmit data to CS	Data of fraudulent users and statistical data (due to privacy reasons in an anonymous way, not user related) is transmitted to the CS. To support Central Systems selected DSRC data can be transmitted to CS. Data can be used to calculate toll if OBU is damaged, etc.

Tab. 27: Description of Mobile Enforcement process steps

1.9.4 Optimization and additional aspects

As an additional aspect the enforcement system can be supported by “(toll) system immanent enforcement”: With regard to the high number of users classical enforce-ment, as described above, could become very extensive. Therefore the following supporting solutions are possible:

- Especially for domestic users annual checks can be used to check plausibility of OBU data (distance traveled, odometer). If solutions like this one make abuse nearly impossible, enforcement can be sized smaller and needs to cover only foreigners and other special cases.
- Very simple and quick possibility (e.g. LED) to check OBU Status. This would make quick checks possible for example for waiting vehicles at a red traffic light. As well the police could be equipped with hand-helds that read out basic enforcement data (in consideration of privacy all communication is encrypted). Those quick checks for example at traffic lights or parking lots could be a method to enforce in cities where en-forcement via EnfSt and EnfMo will be difficult.
- The transfer of OBU data to the Central System can also support the enforcement system. If the OBU detects fraud or other problems this could be logged and after transmission to the back office those informa-tion can be filtered and the user can be invited to an additional check at an Installation and Service Center.
- Statistical data of the composition of traffic can be provided by EnfSt and EnfPo. These data give useful hints to control enforcement activi-ties (best places for enforcement, e.g. high fraudulent use)

The first bullet point is considered in system sizing and cost calculation. The second is not included, but an additional idea that can be worked out if necessary. Point three and four are possibilities to use existing data more efficient. No additional costs are expected for these points.

1.9.5 Calculation of necessary enforcement sites

As described above EnfSt is the best solution for the motorway network. Variant 5 recommends in average one EnfSt every 35km. With regard to our experience this is a reasonable magnitude, but 40 km, which is our calculation base, is sufficient as well. The total length of road network that could be equipped with EnfSt consists in about 2600 km motorways and an additional length of approximately 700 km (source: figures provided by the Principal) of other suitable highly frequented roads (no separate directions).

	total length	necessary gantries per location	avg. distance of enforcement locations	amount of EnfSt
motorways	**2,600**	**2**	**40**	**130**
additional roads	**700**	**1**	**40**	**18**
Total:	**3,300**			**148**

Tab. 28: Calculation Amount Enforcement Stationary

Whereas EnfSt covers about 3,300 km of the road network, EnfPo has to cover the rest of about 127,000 km (source: parameter provided by the Principal in cost sheet). With an average mileage per vehicle per year of 17.000 km one EnfPo every 3,000 km will statistically lead to 5-6 times of enforcement within one year per vehicle. This will be sufficient to show the users, that enforcement is consequently implemented. To consider both directions two EnfPo are necessary per enforcement location. Considering these principles 86 EnfPo are necessary.

Relevant total km	**127,000**
avg. distance of EnfPo	**3,000**
Directions per EnfPo site	**2**
total amount of EnfPo	**85**

Tab. 29: Calculation Total Amount EnfPo

Enforcement by mobile vehicles is applicable for all types of roads, where it is possible to stop another vehicle. Because of the high amount of users EnfMo will never reach high enforcement rates, but has a high effect of deterrence. The suggested coverage of 1.600 square km per mobile enforcement vehicle is sufficient for our scenario because the EnfPo-mode is one additional, not foreseeable risk for fraudulent users.

Total amount square km	**36,000**
coverage per EnfMo	**1,600**
total amount of EnfMo	**23**

Tab. 30: Calculation Total Amount EnfMo

As described above EnfMo and EnfPo should be integrated into one vehicle. In total there will be needed 108 fully equipped vehicles (85+23).

1.10 System Management

The primary goal of this chapter is to identify the relevant system management processes. Additionally the most relevant processes that are not covered in other chapters are briefly described and their costs are estimated.

1.10.1 Relevant processes

Where applicable the system management processes shall be planned and deployed according to international standards such as ITIL (Information Technology Infrastructure Library). The following mind map gives an overview about the most relevant processes and related systems.

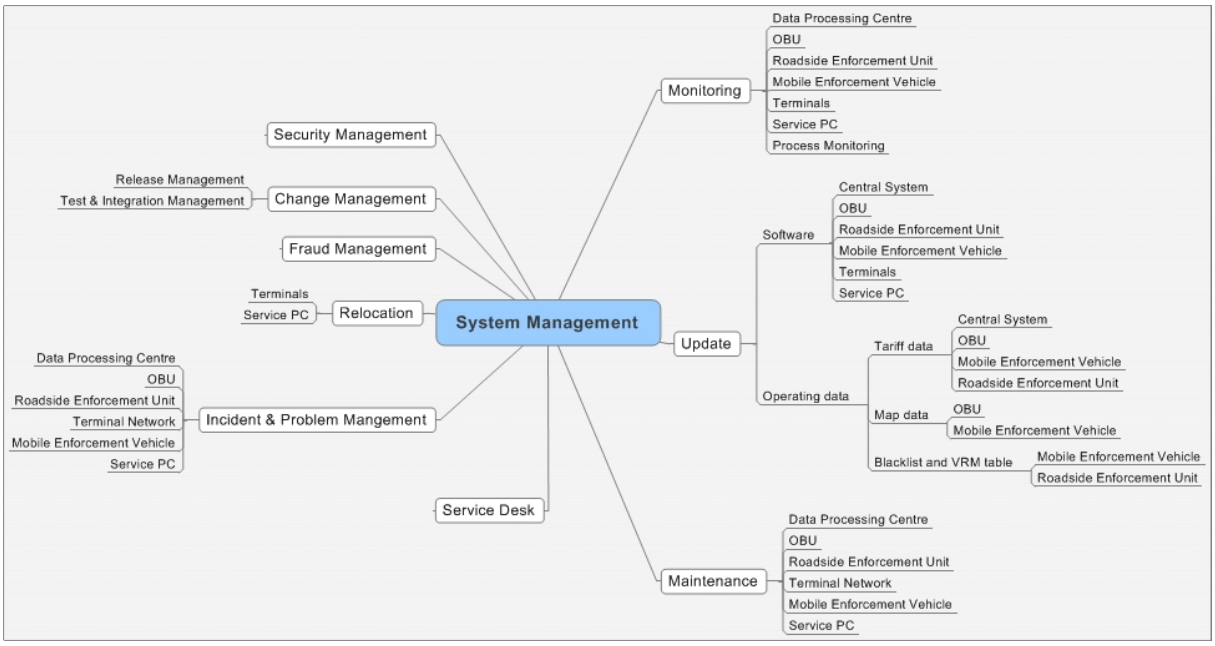

Fig. 22: Processes and Related Systems

The system management processes are closely linked together. Information from on process may be input for several other processes.

1.10.1.1 Change Management

As the overall System is very complex the impact of any change must be considered very carefully. Hence a dedicated change management organization has to be established which is responsible for:

- Collecting change request
- Evaluating change request
- Approving change request
- Bundling change request to system releases
- Tracking implantation of changes including test and integration management

Based on experience we estimate that 5 FTE are necessary for a change management organization.

1.10.1.2 Fraud management

Due to the fact that a lot of payment transactions with a high overall volume and sensitive data are handled by the system fraud is a serious issue. To reduce fraud to a minimum a dedicated fraud management organization is needed. It does not necessary consists solely of dedicated personnel. Rather part time fraud coordinators are appointed within the organization and are able to contribute with a variety of areas of expertise to the fraud organization. Based on experience we estimate that an overall sum of 6 FTE is necessary for an efficient fraud management.

1.10.1.3 Service desk

The personnel within the KMP need a single point of contact for all problems with their equipment and applications, the service desk. This functionality can be outsourced to a service provider or handled within the organization. Whatever option is chosen, we estimate yearly cost of 1 m EUR.

1.10.1.4 Security management

To achieve a high level of security throughout the system a security organization and a security or trust center is needed. We estimate that that 3 FTE are needed to plan, implement and monitor the security policies.

1.11 Occasional User Scheme

1.11.1 Goal

This chapter describes the Occasional User Scheme (OUS). The OUS serves as a second access to the KMP for

- Dutch users without an OBU and
- foreign users.

Further it absorbs high usage peaks in launching phases.

1.11.2 System Design

The OUS is driven by a time-based vignette.

A mileage-based vignette could be used as well but has several disadvantages: The declaration of mileage at borders, a more complex booking process, a complex distribution are necessary and it's difficult to enforce. A time-based vignette has disadvantages too: It's not related to distance driven, heavy users have a price advantage and it's completely different to the tariff scheme of an automatic toll collection system. Later aspect could lead to discrimination issues.

The occasional user can purchase the vignette via terminals, the Internet, personnel with mobile devices or affiliates (e.g. car clubs). In all cases no user registration is offered in order to get frequent users into the main scheme.

The following figure shows the system design:

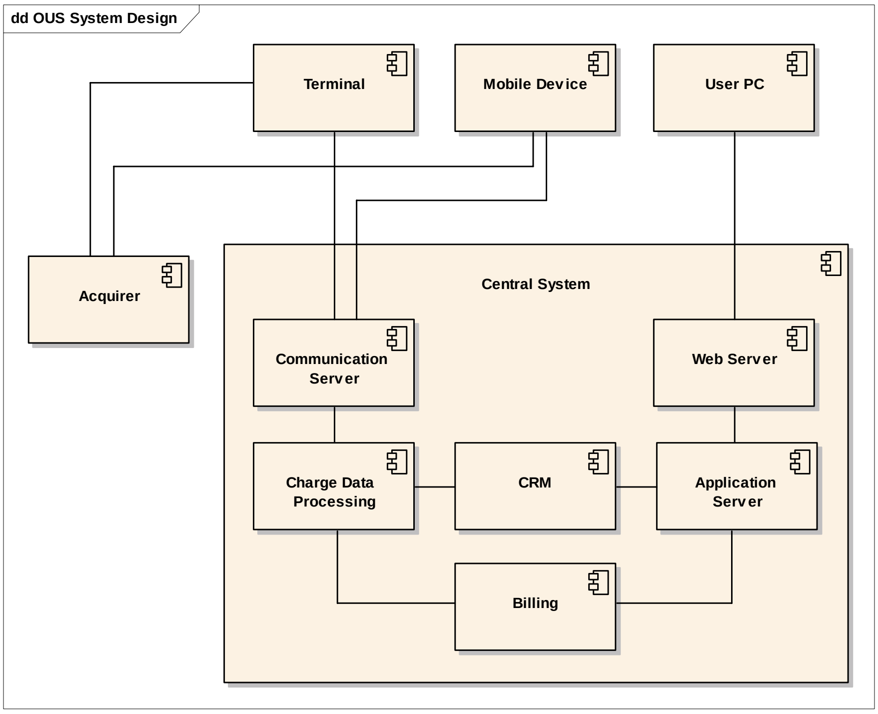

Fig. 19: OUS System Design

1.11.3 Vignette via Terminals

The user buys prepaid vouchers at petrol stations used for payment at the OUS terminals. The terminals are combined terminals for OUS and data upload (in case of a non-CN OBU, Variant SD). Thus the costs are located in the OBU communication calculation section (Variant SD) and for CN-OBUs in the OUS-section (Variant CN).

The voucher has a hidden code, which has to be entered at the terminal for payments means.

Thus, the user enters

- the license plate number
- expected road usage dates
- vehicle class and
- payment information
    - either the hidden code of the voucher
    - or number of credit, fuel or debit cards (via card reader).

As a result he receives a receipt.

1.11.4 Vignette via Internet/Affiliates

The user provides

- the license plate number
- expected road usage dates
- vehicle class
- payment information (credit cards, direct debit or voucher)

and gets an electronic receipt document, which can be printed. Affiliates, like car clubs, can sell Vignettes via the same Internet application as a white label application.

1.11.5 Vignette via Mobile Personnel

In order to handle peaks in launching phase, personnel with mobile devices sell directly the vignettes to customers. Especially in launching phases personnel can support new users much better than any terminal: They can help with usability problems and they are flexible concerning their location (in contrast to terminals).

They ask the customers for

- the license plate number
- expected road usage dates
- vehicle class and
- credit card or cash payment.

As a result the customer receives a receipt, printed by the mobile devices.

1.11.6 Enforcement

The data collected via Internet, terminals and personnel with mobile devices is transferred to the Central System. The OUS data is used in form of white lists by the enforcement systems.

1.11.7 Parameters and Assumptions

The key question designing an OUS is the sizing of the different OUS access possibilities. It's hard to foresee the users' behaviors and further circumstances. Goal is to avoid delivery bottlenecks with a sufficient amount of terminals, mobile staff and the sizing of the Internet web and application server. A software simulation considering users' behaviors should determine those sizing values; here we assume following parameters and a basic calculation to simplify matters.

Parameter	Value	Unit	Source/Rationale
Dutch OUS users in phase 2 launch, with high usage frequency	4.6 m	users	Assumption
Foreign OUS users p.a. with low usage frequency	1 m	users	Assumption
Time needed for purchasing a vignette at a terminal	2	min	Assumption
Main usage time range of an terminal	12	h	Assumption
Average time range purchased for Dutch OUS users	4	days	Assumption
OUS vehicles in launch of phase 2 at an average annual rate	2.3 m	users	Based in first assumption
Number of OUS personnel in launch of phase 2	600	persons	Assumption
Number of mobile devices	600	devices	Assumption

Tab. 31: Parameters and Assumptions OUS

Next example calculation demonstrates that the chosen sizing for terminals (5,000 terminals, see chapter OBU communication) and the number of mobile devices is already sufficient to absorb usage peaks:

The 4.6 m Dutch users with high usage frequency purchase every forth day a vignette at an average. 50% are purchased via terminals. Thus, 575,000 users demand vignettes at the same day. A main usage time of 12 h and 2 min per purchase leads to 1,597 required terminals. With 5,000 terminals **plus** mobile personnel **plus** Internet access high usage peaks should be manageable.

2 Costs Estimate (Deliverable 4)

The costs estimates are enclosed as an attachment (two XLS-Files):

- Costs calculation Summary Variant SD
- Costs calculation Summary Variant CN.

3 Migration Scenarios (Deliverable 5)

3.1 Introduction

This chapter describes a scenario to introduce a KMP in the Netherlands. Due to the large number of vehicles to be equipped, we recommend to use a stepwise introduction scenario introducing the KMP for different vehicle types at different times. Also we assume that an Occasional User Scheme (OUS) will be available to support introduction of the KMP and to allow for an alternative booking scheme during at least the first 9 month of operation.

The migration scenario is mainly being discussed on the basis of technical, financial and the user acceptance criteria. Political aspects are not being considered.

The initial parameters of the scenarios are shown in Tab. 32.

Parameter	Value	Source
Target value for OBU's	8,159,000	Reference Architecture, Memo from April 12th
2004, # NL passenger cars	6,909,000	Excel sheet Cost Format phase 2 v1.0, provided by the Principal
2004, # NL vans	867,000	Excel sheet Cost Format phase 2 v1.0, provided by the Principal
2004, # NL heavy goods vehicles, incl. lorries and special vehicles	192,000	Excel sheet Cost Format phase 2 v1.0, provided by the Principal
2004, # NL motor cycles	517,000	Excel sheet Cost Format phase 2 v1.0, provided by the Principal
2004, # NL old timers and vehicles for export (no OBU assumed)	301,000	Excel sheet Cost Format phase 2 v1.0, provided by the Principal
Cost of installation per OBU	45 EUR (62 EUR incl. VAT and IEP)	Reference Architecture, Memo from April 12
Duration of installation procedure of the OBU:	1 hour	Reference Architecture, Memo from April 12
Inspection certified workshops for the APK test:	9,191 (in 2005)	Email Stefan Eisses, 28 June 2006

Parameter	Value	Source
Working days per month	20 days	Excel sheet Cost Format phase 2 v1.0, provided by the Principal

Tab. 32: Initial Parameters

It has to be noted, that the number of workshops discussed in the scenario below is the number REQUIRED to guarantee the introduction in the given time frame, if resource allocation in the workshops could be controlled. We recommend using an open market scenario for the introduction of the OBU (see section Registration and Installation). This scenario would allow for a much higher number of Installation and Service Centers to be supported and we actually assume the availability of more than 9,000 Installation & Service Centers. However, excess capacity will be needed in this scenario because resource allocation in the Installation & Service Centers can not be controlled. The figures below give a calculated number of Service Centers REQUIRED and the assumption of a higher number of Service Centers actually available shows the feasibility of the scenario.

Description:

The introduction of the KMP in NL should be split into 3 phases to reduce the technical and financial risks. We recommend to start in 2012 with HGVs/Vans/Busses and to extend the scheme to passenger cars and motorbikes in 2013 and 2014.

This scenario allows for a smoother introduction of the overall scheme, since phase 1 volumes are lower (~1 m vehicles) than phase 2 (~ 7 m vehicles)

Year	OBU units	Vehicle type	Source: Excel sheet Cost Format phase 2 v1.0, provided by the Principal
2012	192,000+867,000	HGV Bus/Vans	
2013	6,909,000	cars	
2014	517,000	motorbike	

Tab. 33: Breakdown of OBUs to be installed

3.1.1 Phase one: HGV, Busses and Vans

In the first step, beginning in 2012, HGV, busses and vans participate in the KMP. It is assumed that all domestic users will be equipped with an OBU.

It will be necessary to begin the roll-out at least 6 month prior to system start. The network of certificated workshop must be prepared to install an overall volume of 1 m OBUs.

Year of KMP introduction	Duration of Roll-out	Total number of OBU Installation per day an per Certified installation center	Total number of Certified installation center	Total number of OBU's equipped in vehicles
2011	6 month	4	First 3 month=1,500 Last 3 month=3,000	192,000 + 867,000 = 1,059,000

Tab. 34: Assumption / Parameter for the workshop network Phase one

Benchmarks point towards a total number of OBU installation per day and per certified Installation & Service Center of 4 units. It is assumed that an OBU installation rate of 30% can be reached in the first 3 month and most of the OBU installation (70%) will be done in the last three month. Therefore it is necessary to raise the number of certified Installation and Service Centers from 1,500 to 3,000.

One advantage of this approach is that all of these Installation Centers will have gone through a significant learning curve when phase 2 installation begin after 3 months of operation of phase 1 which significantly increases installation capacity.

In addition to this, early operation of the KMP could be supported by the use of an Occasional User Scheme already in phase 1. This is not reflected in this scenario, however, the use of an Occasional User Scheme for infrequent foreign users is assumed.

3.1.2 Phase two: passenger cars

The next phase is very ambitious because about 7 million (6,909,000) OBUs will have to be installed in passenger cars. The existing workshop network in NL of about 12,305 facilities would not allow for a roll out time of 6 month.

At the same time, experience shows that it will be very difficult to motivate users to install an OBU more than 6 month in advance of the introduction of a toll collection scheme.

Therefore, to mitigate risk and to release the workshop network, we recommended stretching the roll-out period into the operational phase of the KMP. Users without an OBU have to use the Occasional User System (OUS) for about 9 month. With the introduction of a transition phase it is possible to reduce the workload during the peak time (3 month prior to start), see Tab. 35. In the main scenario of this study, which does not use a Cellular Network but a Terminal Network to transfer usage data to the central system, the network used for the introduction phase will be re-used during the operational phase for the system as part of the main scheme.

Year	Duration of Rollout	Total number of OBU Installation per day and per Certified instal-lation center	Total number of Certified installation center	Total number of OBU's equipped in vehicles
2013	18 month	6	Months 1 to 9=2,400 Months 9 to 12=6,400 Months 12 to 18=3,200	Months 1 to 9=2,3000,000 Months 9 to 12=2,300,000 Months 12 to 18=2,3000,000

Tab. 35: Assumption / Parameter for the workshop network Phase two, recommended

With a transition phase it is possible to reduce the number of required workshops (see Tab. 35). Furthermore to smooth the distribution during the roll-out phase, it is recommended to have an OBU installation mandatory for all newly registered cars within 9 months before the operational start of phase 2. The OBU installation could be done during series production of the vehicles (factory installation). It can be esti-mated that every year 10% of the overall fleet will be newly registered vehicles.

This scenario assumes that with the start of the KMP for cars, only about one third of the vehicles will be equipped with an OBU (2.3 m). However, since the ramp up in the Installation & Service Centers has been done at this time (learning curve), we assume that another 2.3 m vehicle will be equipped during the first 3 months of op-eration. At this point the installation rate will drop because the ratio of infrequent us-ers among the last third of users will be relatively high which leads to a lower motiva-tion to install an OBU. We assume that the use of a domestic car after the introduc-tion period of 9 month will require the installation of an OBU and the OUS at this point will only be used for foreign users.

3.1.3 Phase three: Motor bikes

The last and third phase introduces KMP for motor bikes. Because of the heavy use of the workshops in the second phase the workshops are already trained for the OBU installation. In this phase it is only necessary to handle about 500,000 units and therefore the number of workshop can be reduced to 2,800 units (with a roll-out time of 3 month)

Year	Duration of Roll-out	Total number of OBU Installa-tion per day and per certified Installation Center	Total number of Certi-fied Installation Cen-ter	Total number of OBU's equipped in vehicles
2014	3 month	3	2,800	517,000

Tab. 36: Number Installations

3.2 Cost estimation

The cost of installation of OBUs in the vehicle (~45 EUR) will be covered by the user, however, user registration and setup of the workshop network will have to be covered. In the open market scenario, cost sharing with the Service & Installation Center for Training and Setup Costs could be discussed; however, we assume that at least the cost to train and setup the required number of Service & Installation Centers will have to be covered by the Toll Provider.

Cost of installation per OBU	45 € (62 € incl. VAT and IE)	Reference Architecture, Memo from 12 April
Duration of OBU installation procedure	1 hour	Reference Architecture, Memo from 12 April 2006
Costs staff training in the Installation & Service Center	1,000 € per training unit	Assumption
Costs Certification Procedure	1,000 € per certification	Assumption

Tab. 37: Costs for Training and Setup

3.2.1 Phase one: HGV, Busses and Vans

Activity	Price per Unit	Quantity	Total
Costs staff training in the certification center	1000 € per training unit	3,000 units	3,000,000
Costs certification procedure	1000 e per Certification	3,000	3,000,000

Tab. 38: Initial costs phase I

It is assumed that every certified workshop in NL will be trained one time, so 3,000 units of training are required.

3.2.2 Phase two: Passenger cars

Activity	Price per Unit	Quantity	Total
Costs staff training in the certification center	1000 € per training unit	3,400	3,400,000
Costs certification procedure	1000 € per Certification	3,400	3,400,000

Tab. 39: Initial Costs Phase II

The number of training units can be reduced from 6,400 (total number of workshops) to 3,400 units because in the first phase 3,000 workshops are already trained. The certification procedure can also be reduced from 6,400 to 3,400.

3.2.3 Phase three: motor bikes

Activity	Price per Unit	Quantity	Total
Costs staff training in the certification center	1000 € per training unit	0	0
Costs certification procedure	1000 € per Certification	0	0

Tab. 40: Initial Costs Phase III

There is no need for training or certification, because in phase three it is possible to use the existing network of certified workshops. In the end all APK workshops will be trained and certified with costs of about 18.4 m EUR.

4 Risk Assessment (Deliverable 6)

4.1 Goal

This chapter presents the top five high impact risks for a GNSS based toll project. The prioritization is based rather on neutral market experiences than on monetary values. Later approach would just gives pseudo accuracy.

The following risks are common risks for big projects based on new technology, especially in constellation of PPP.

4.2 Top-five Risks

Risk Event	Risk Source(s)	Consequence	Project Phase	Mitigation Measure	Risk Owner
Delay	New technologies, unclear requirements, wrong assumptions, testing, negotiations, integration, legal framework, roll-out	Income shortfall, image and reputation problems, low customer acceptance	Event is visible in later stages: testing, integration and roll-out	General contractor with strong and professional project management kills, clear responsibilities within project organization	Principal and contractor
Low customer acceptance	Bad usability/HMI/UI, complex tariff model, information lack, low privacy, low enforcement rates	Image and reputation problems, higher fraud	Launch	Sufficient budget for marketing, PR and customer information, sufficient enforcement, considering of usability and privacy in system design	Principal and contractor

Risk Event	Risk Source(s)	Consequence	Project Phase	Mitigation Measure	Risk Owner
Malfunction OBU	Wrong installation, wrong usage, quality problems, loss GPS signal, manipulation	Higher cost for service and customer care, low customer acceptance	Testing, integration, roll-out, launch	Multiple OBU suppliers, sufficient time buffer for development and testing of OBU	Contractor and its suppliers
Legal risks	Non-compliant to EU regulations, interoperability and privacy regulations	Change request after launch, new development and operational costs	Roll-out, launch	Early communication and lobbying with respective authorities	Principal
No market created, no optimal costs	Wrong business model, wrong revenue model	Key services (manufacturing OBUs, distributions, installations, etc.) could not be transferred to the market and have to be done by the provider at high costs	Roll-out, launch	Early market studies	Principal

Tab. 41: Top-Five Risks