

# **Requirements Specification**

**Transport4You**

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## **1. Introduction**

### **1.1. Customer**

The customer of Transport 4 You is a Metropolitan Transportation Agency (MTA), which provides a public transportation service to citizens of a large metropolitan area. The MTA utilizes multiple forms of public transportations, but Transport 4 You solely focuses on busses.

### **1.2. Rationale (Why to develop the system?)**

Currently the MTA manages the transportation process (by bus) using manual management of routes. Tickets can be obtained from the Bus Driver and the payment service is also under the management of the Bus Driver. It is partly assisted by modern generation information technology, which includes a cashier machine and an automated voice tracking system.

To cope with the challenges and demands of their customers, the MTA requires a new integrated solution combining existing IT infrastructure with personalized services.

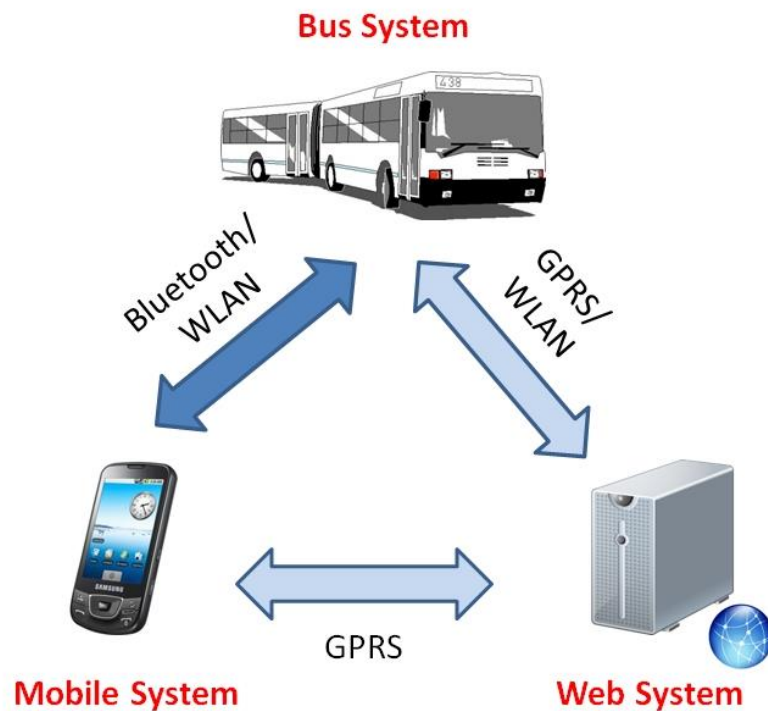
Some of the main challenges and requirements in this case are:

- Integrate the ubiquitous smartphone technology
- Automate the payment process
- Offer personalized services
- Focus on the usability of the service
- Deal with a complex, rapidly changing route system

### **1.3. System**

The idea is to develop an E-Ticket payment system, which can be used by Customers to pay their tickets. Additionally the system will be able to offer personalized services based on Customer profiling.

Looking at the overview in the figure below it is possible to see the basic way the system will work. A Customer has a mobile system on which tickets and other information is stored. To authenticate and pay E-Tickets, the mobile system communicates with the bus system using Bluetooth and WLAN. Additionally the mobile system will retrieve necessary updates and information by connecting to the web system through its own data connection. The bus system and the web system synchronize information through a GPRS data connection or a WLAN connection, if available.



**Figure 1: System Overview**

The whole system will be designed to minimize the information exchange propagated through GPRS data connections.

## **1.4. Organization**

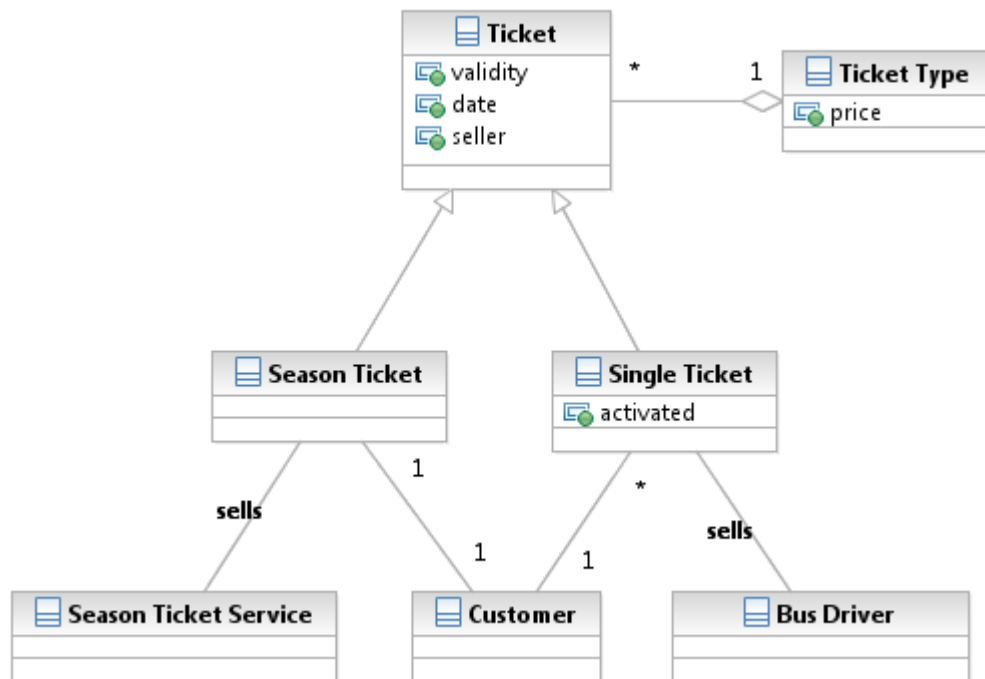
### **1.4.1. Tickets**

The customers need to buy tickets in order to be able to use the service. The MTA provides two different kinds of tickets: season tickets and single tickets.

A season ticket is a ticket, which a customer needs to order before he/she is using the service. The ordering process is handled by an already existing service; therefore the new system may have an interface to this service.

Single tickets are tickets that can be bought directly in the bus. A customer may buy one or more tickets when entering the bus, but only one ticket is devaluated. The others may be used anytime later.

Following figure represents the connection between these two types of tickets.



**Figure 2: Tickets offered by the MTA**

Basically both types of tickets are the same. They only differ in the way they are sold. Note that every ticket has a different validity. Season tickets mostly are valid till a specific date, while single tickets are valid a specific amount of time (T\_VAL) starting from the point in time they are activated/invalidated.

The MTA offers only one price category, so no distinction of different categories need to be made. That means, if a Customer has a valid ticket, he is allowed to use any bus service.

Due to the fact that there might be different kinds of tickets offered to the Customer (e.g. 5-Single Tickets for a lower price) a ticket belongs to a Ticket Type (see figure above). A Customer may buy a ticket type and get one or more single tickets. Single tickets always cost the same amount of money (T\_COST), while multiple tickets have an additional factor to the base cost of the ticket ( $j * T\_COST$ ).

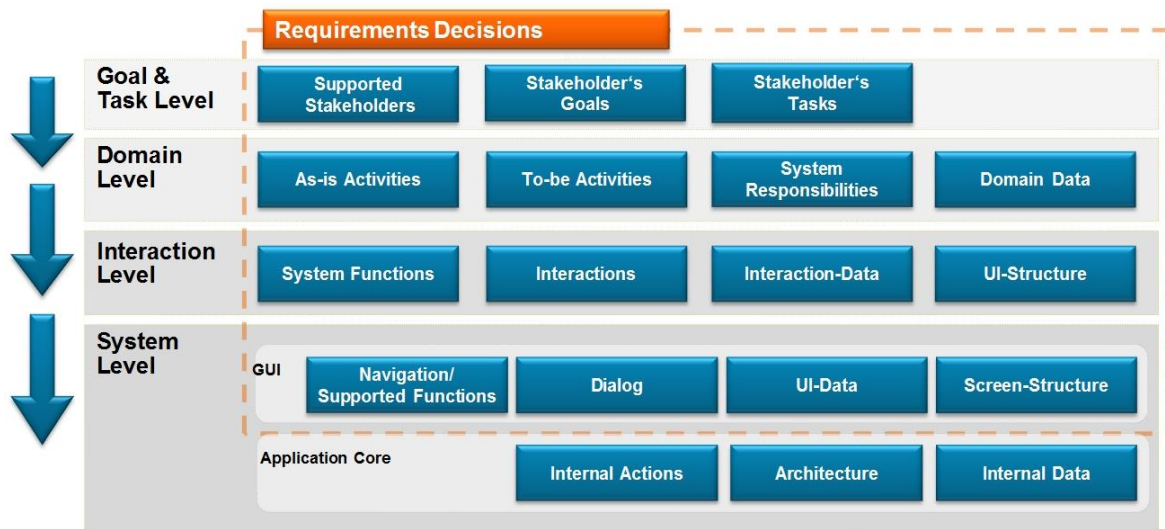
To ease the understanding of the requirements specification document, we talk only about tickets and E-Tickets (the electronical representation of a ticket) but mean the more complex ticket structure presented in this section.

## 1.5. Approach

To systematically elicit, analyze, specify and verify the requirements for the planned System, we use the TORE (Task and Object oriented Requirements Engineering) approach developed at Fraunhofer IESE. This approach combines requirements engineering method with methods of object oriented development and focuses on

information-intensive systems to document rationales, decisions and assumptions explicitly. Additionally TORE provides guidance to state usability constraints and offers the possibility to use mature software development notations (e.g. UML, Goal Modeling).

Due to the complex nature of the intended project and its focus on usability we see the TORE as perfectly suitable with the requirements and therefore use it as basis for the requirements engineering process.



**Figure 3: The TORE approach [Paech, Kohler 2002]**

The structure of this document follows exactly this approach by explaining each of the different steps in separate sections.



## 2. Stakeholder Goals

This section describes the stakeholders of the system and their related goals. First the relevant stakeholders are introduced and described. After that an analysis of their main goals is performed and then transformed into a set of tasks. In this context goal means the intention for the workflow a specific stakeholder performs. The output of this process, the tasks, is needed as input for the TORE approach.

To transfer goals to their respective stakeholder tasks we subdivide abstract goals into *Quality Goals*, which are goals describing high-level requirements on the quality of the workflow, and *Functional Goals*, which are goals that are derived from *Quality Goals* and focus on specific functional aspects for reaching the respective *Quality Goal*. Each *Functional Goal* is then derived into one or more *Tasks*. A *Task* focuses on a specific activity needed in order to reach the related *Functional Goal*.

The analysis presented in this section uses the syntax depicted in the figure below.





	QG = quality goal FG = functional goal T = task
	connector
	comment
	stakeholder

Figure 4: Goal Graph Legend

## 2.1. Manager

ID	Manager
Responsibility	Overseeing different variants of tickets (e.g. single tickets, seasonal tickets, special offers and combined train or bus tickets), planning of resources and routes, managing issues of the Bus Drivers (e.g. Bus failure or road condition), maintaining customer relationship and performing controlling of the purchases.
Success Criteria	Tickets purchased, revenue, Bus Driver satisfaction, Customer satisfaction
Typical Tasks	Plan resources, ticket costs and routes, solve issues of Bus Drivers and give advisories to all Bus Drivers, Send information about advertisements or advisories to Customers.
Communication Partner	Bus Drivers and Customers

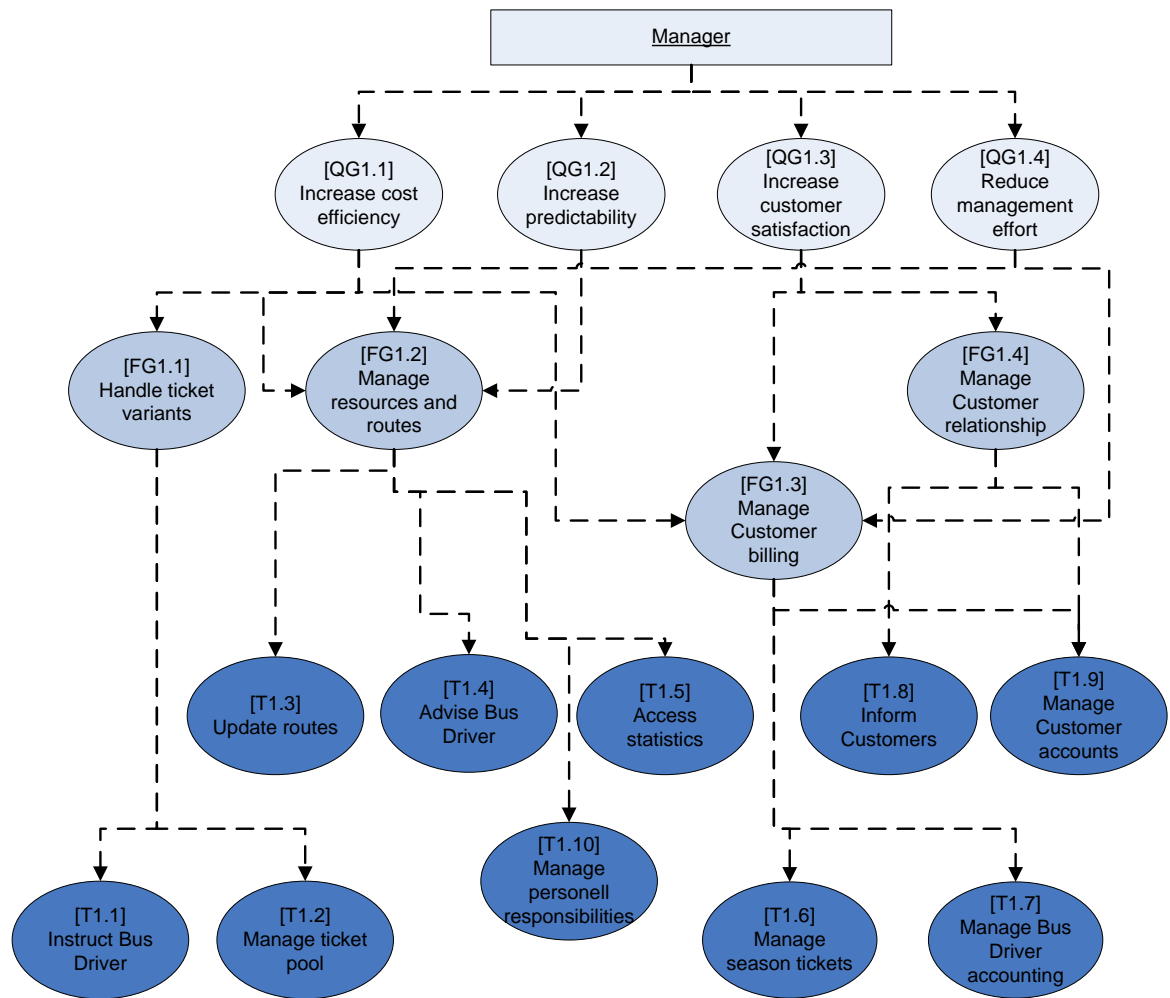
ID	FG1.1
Functional Goal	Handle ticket variants
Rationale	Tickets come in different variants such as single tickets, seasonal tickets, special offers and combined train or bus tickets and there is a pool of valid tickets managed by the Manager.
Strategy	Upon addition/change/deletion of a ticket variant to/from the pool all Bus Drivers are informed.
Success Criterion	All valid tickets are in the pool and known to all Bus Drivers
Priority (Reason)	3 (new ticket variants do not appear often)

ID	FG1.2
Functional Goal	Manage resources and routes
Rationale	Resources and routes need to be managed when problems such as blocked roads or locked areas occur, temporary rescheduling including sending additional busses to manage the problem and detour planning needs to be done. Additionally the responsibilities of the personnel have to be managed.
Strategy	Upon temporary schedule and/or route changes the change need to be propagated to the Bus Drivers and Customers immediately. Upon hiring/changing/firing of a Manager the changes are known.
Success Criterion	All Bus Drivers and Customers know the changes to the

	routes and schedules and all Managers are known.
<b>Priority (Reason)</b>	1 (Customers may need to revise their short time planning, Bus Drivers must know temporary changes immediately)

<b>ID</b>	<b>FG1.3</b>
<b>Functional Goal</b>	Manage Customer Billing
<b>Rationale</b>	Season tickets are managed by the manager. Additionally the manager is responsible for the controlling of the accounting of the Bus Drivers.
<b>Strategy</b>	Upon addition/change/deletion of a season ticket the ticket is given to/retrieved from the Customer. All Bus Drivers are accounted every time they return to the Company headquarters.
<b>Success Criterion</b>	All season ticket applicants have a season ticket, all season ticket holders have the correct information on their season ticket and all season ticket terminators have their ticket invalidated. Additionally all Bus Drivers are accounted immediately after return.
<b>Priority (Reason)</b>	2 (accounting of many Bus Drivers over a short time period required)

<b>ID</b>	<b>FG1.4</b>
<b>Functional Goal</b>	Manage Customer Relationship
<b>Rationale</b>	The Customer wants to be notified in case of a change and the manager wants to advertise to Customers. Messages to the customer include information about routes, schedules, pricing and advertisement. Additionally the list of all Customers needs to be managed.
<b>Strategy</b>	Upon request a message is sent to a group of or all Customers and upon addition/change/deletion of a Customer the list of Customers is updated.
<b>Success Criterion</b>	The message is received by the desired group of Customers and the Customer list is up to date.
<b>Priority (Reason)</b>	1 (Temporary route changes must be propagated to the passengers as soon as possible; Customer changes are frequent)



**Figure 5: Goals and Tasks of the Manager**

## 2.2. Bus Driver

<b>ID</b>	<b>Bus Driver</b>
<b>Responsibility</b>	Operate the bus
<b>Success Criteria</b>	Schedule conformance, least possible number of reported problems, customer satisfaction
<b>Typical Tasks</b>	Drive bus from one station to another, escalate problems to the manager and retrieve advisories, check validity of Customer tickets, sell ticket(s) to Customers, check remaining bus capacity
<b>Communication Partner</b>	Manager and Customers

<b>ID</b>	<b>FG2.1</b>
<b>Functional Goal</b>	Escalate problems
<b>Rationale</b>	During Bus operation a problem such as a blocked road, an accident or a bus component failure can lead to delays and bus cancellations and thus the manager has to know about them to advise other Bus Drivers.
<b>Strategy</b>	Upon occurrence of a problem the Bus Driver reports the problem to the manager and all Bus Drivers receive an advisory how to deal with the problem.
<b>Success Criterion</b>	All Bus Drivers have the advisory.
<b>Priority (Reason)</b>	1 (blocked roads happen frequently and action)

<b>ID</b>	<b>FG2.2</b>
<b>Functional Goal</b>	Operate Bus
<b>Rationale</b>	The Bus Driver must drive the Bus from bus stop to bus stop until the route ends. Additionally he has to operate devices such as the ticket machine or the automated voice announcement system.
<b>Strategy</b>	The Bus Driver starts at the first Bus stop and drives the bus from bus stop to bus stop until reaching the last bus stop of the route.
<b>Success Criterion</b>	The Bus Driver has reached the end of the route.
<b>Priority (Reason)</b>	1 (must be done permanently)

<b>ID</b>	<b>FG2.2</b>
<b>Functional Goal</b>	Perform Customer access control
<b>Rationale</b>	The Bus Driver must check the validity of customer tickets and must bill customers wanting to purchase a ticket in order to verify that all customers on board have indeed paid for the bus ride.

Strategy	The Bus Driver checks tickets as Customers board at a bus stop and issues tickets to Customers without a ticket.
Success Criterion	All Customers at a bus stop have boarded and thus been checked.
Priority (Reason)	1 (must be done at every bus stop)

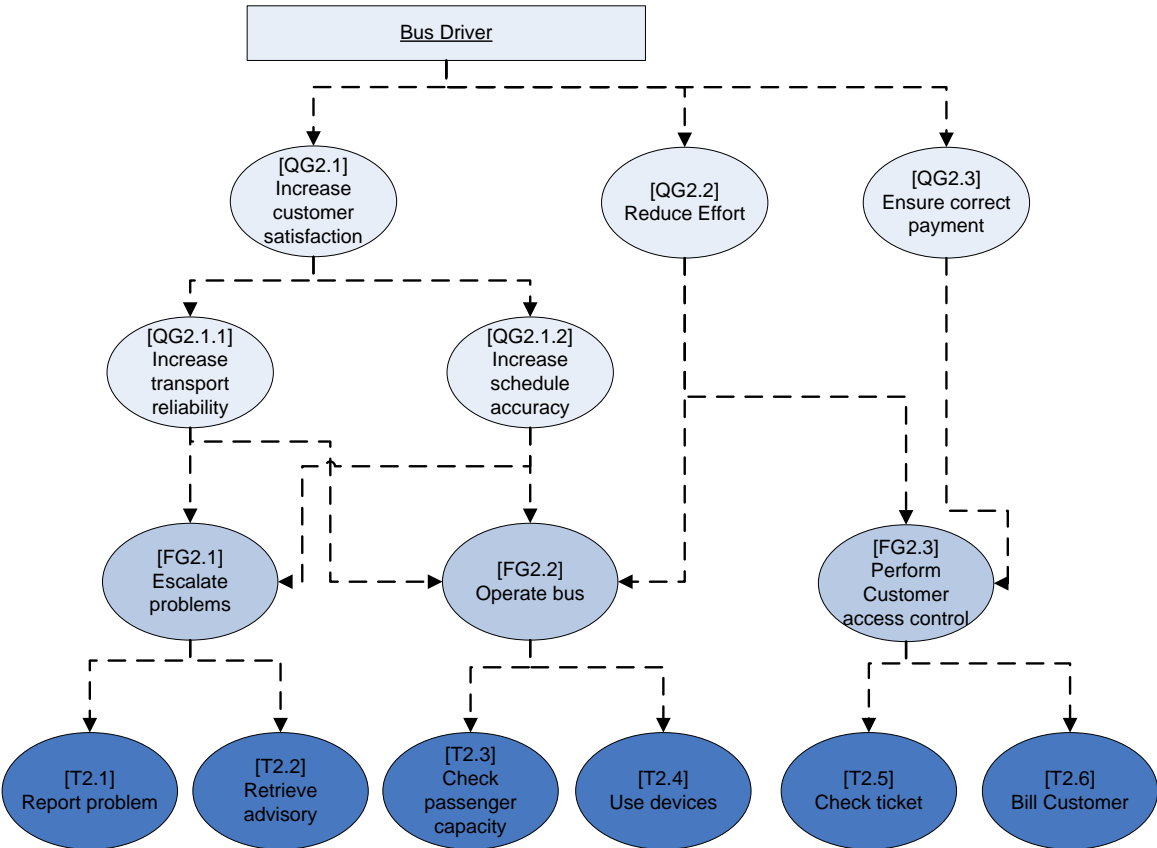


Figure 6: Goals and Tasks of the Bus Driver

### 2.3. Customer

<b>ID</b>	<b>Customer</b>
<b>Responsibility</b>	None
<b>Success Criteria</b>	Successful and reliable transport from origin to destination, ability to avoid canceled busses or reach rerouted ones
<b>Typical Tasks</b>	Board Bus, be onboard of Bus, exit Bus, change Bus
<b>Communication Partner</b>	Bus Driver

<b>ID</b>	<b>FG3.1</b>
<b>Functional Goal</b>	Obtain Information
<b>Rationale</b>	The Customer wants to be notified in case of a change in routes or schedules and wants to know the newest offers. Messages to the customer include information about routes, schedules, pricing and advertisement
<b>Strategy</b>	Gather information from services offered by the bus company
<b>Success Criterion</b>	Information is obtained and known to the Customer
<b>Priority (Reason)</b>	1 (short term decisions may depend on obtained information)

<b>ID</b>	<b>FG3.2</b>
<b>Functional Goal</b>	Obtain Ticket
<b>Rationale</b>	The Customer must to pay for the ride and thus wants to obtain a ticket. The Customer buys a ticket and pays for it.
<b>Strategy</b>	Obtain a ticket upon boarding a bus
<b>Success Criterion</b>	Ticket is received by customer
<b>Priority (Reason)</b>	1 (ticket is needed to travel via bus)

<b>ID</b>	<b>FG3.3</b>
<b>Functional Goal</b>	Use bus transportation service
<b>Rationale</b>	The Customer decides to use the bus companies services instead of a car or taxi
<b>Strategy</b>	Board bus at bus station
<b>Success Criterion</b>	Customer is onboard of bus
<b>Priority (Reason)</b>	1 (Customer may need to commute daily)

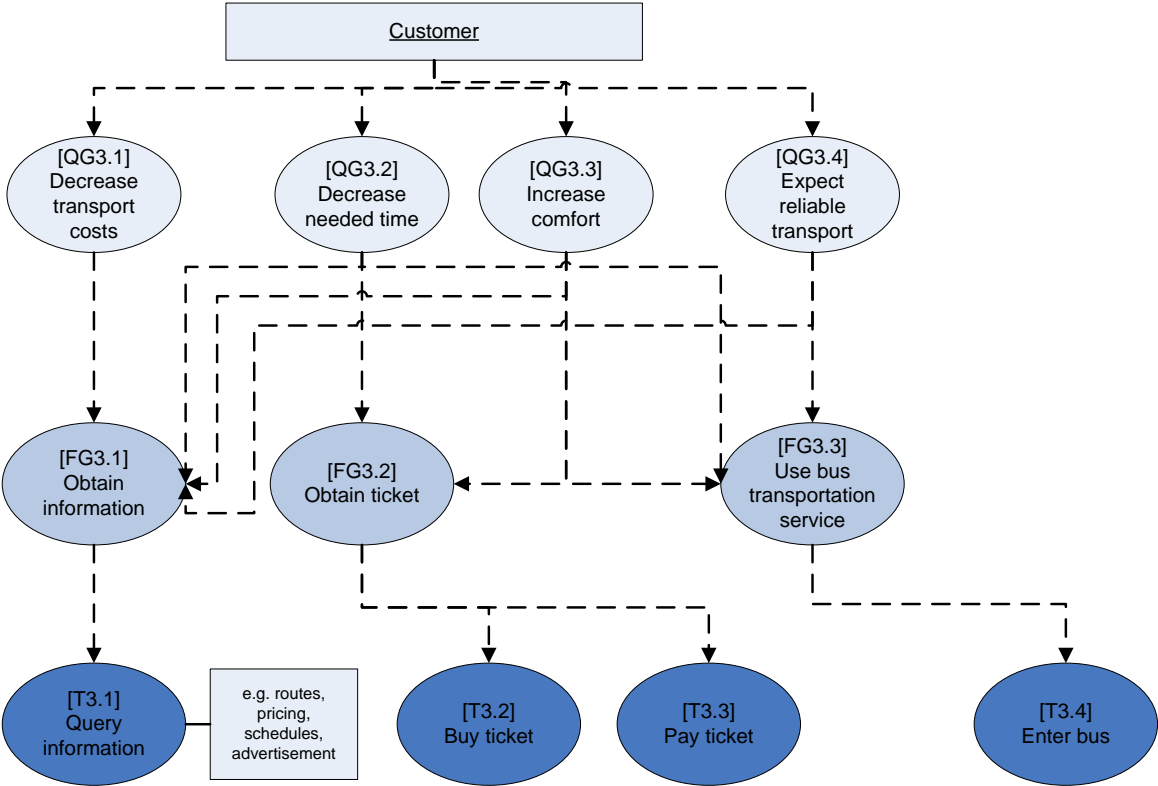


Figure 7: Goals and Tasks of the Customer



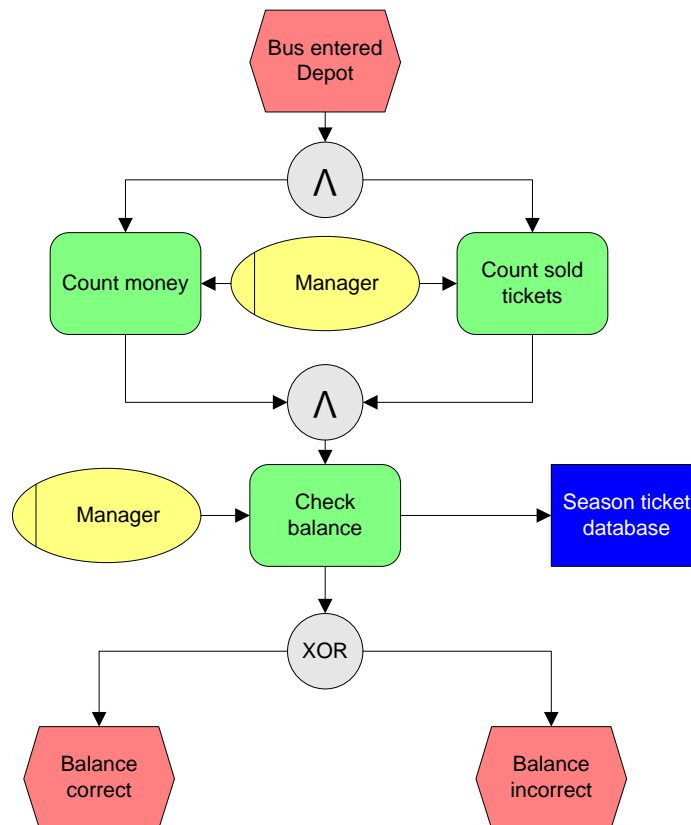
### **3. Task Description**

The current situation of the process (As Is) and the necessary needs (To Be) of the customer are described in this section. To illustrate the situation in an easily understandable way without sophisticated expertise, we use the Event-driven Process Chain (EPC) notation in the following figures.

The traceability matrix, which describes the relation between tasks and EPCs can be found in **Appendix -> Traceability -> Tasks EPC Matrix.**

### 3.1. As Is Situation

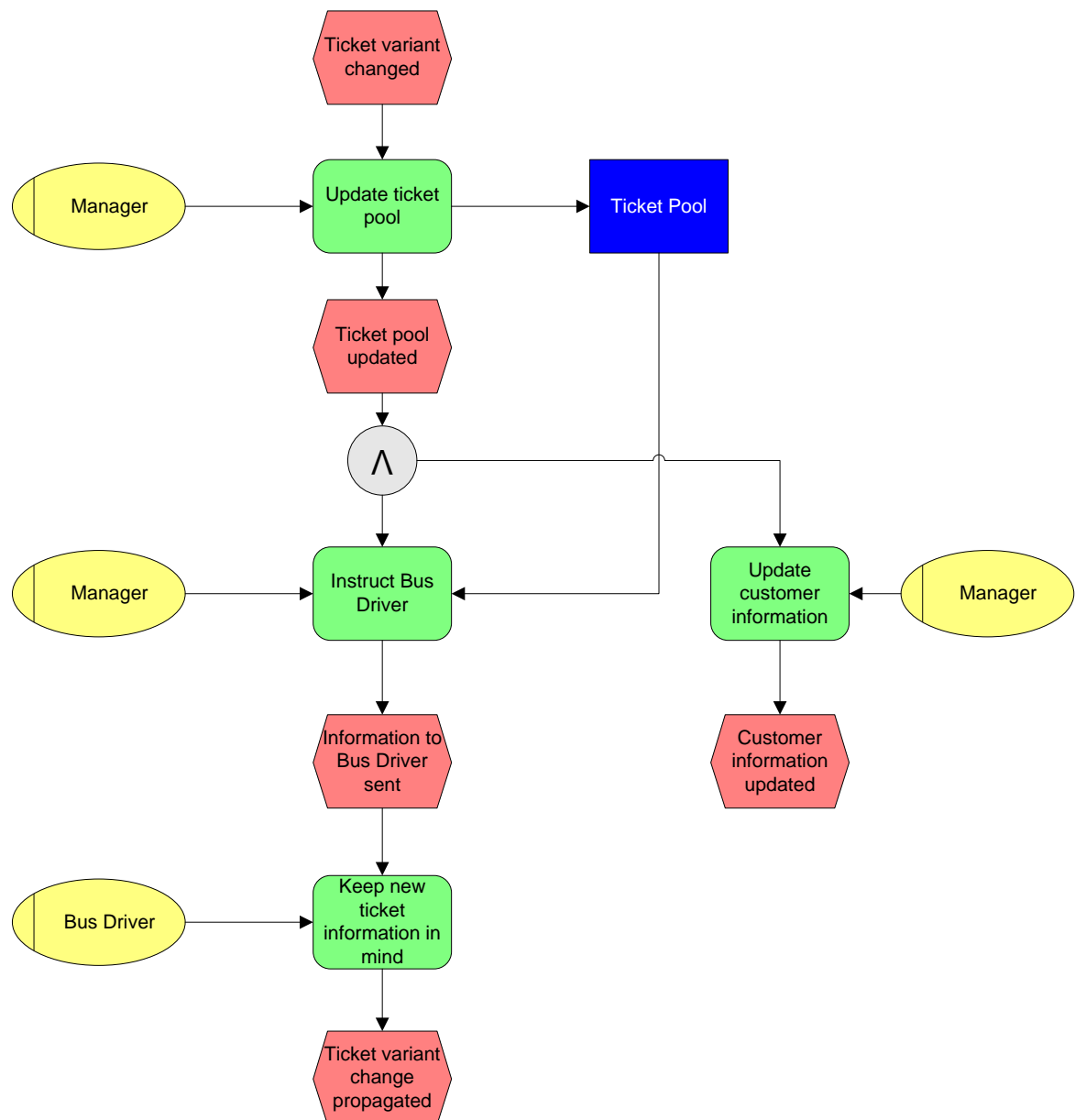
#### 3.1.1. Accounting



**Figure 8: As-Is – EPC – Accounting**

In Accounting the Bus Driver steers the Bus into its parking position after a completed shift and turns over change and a storage device containing sold tickets to the Manager. The Manager counts the money, reads the storage device to count the sold tickets and checks whether the overall balance is correct.

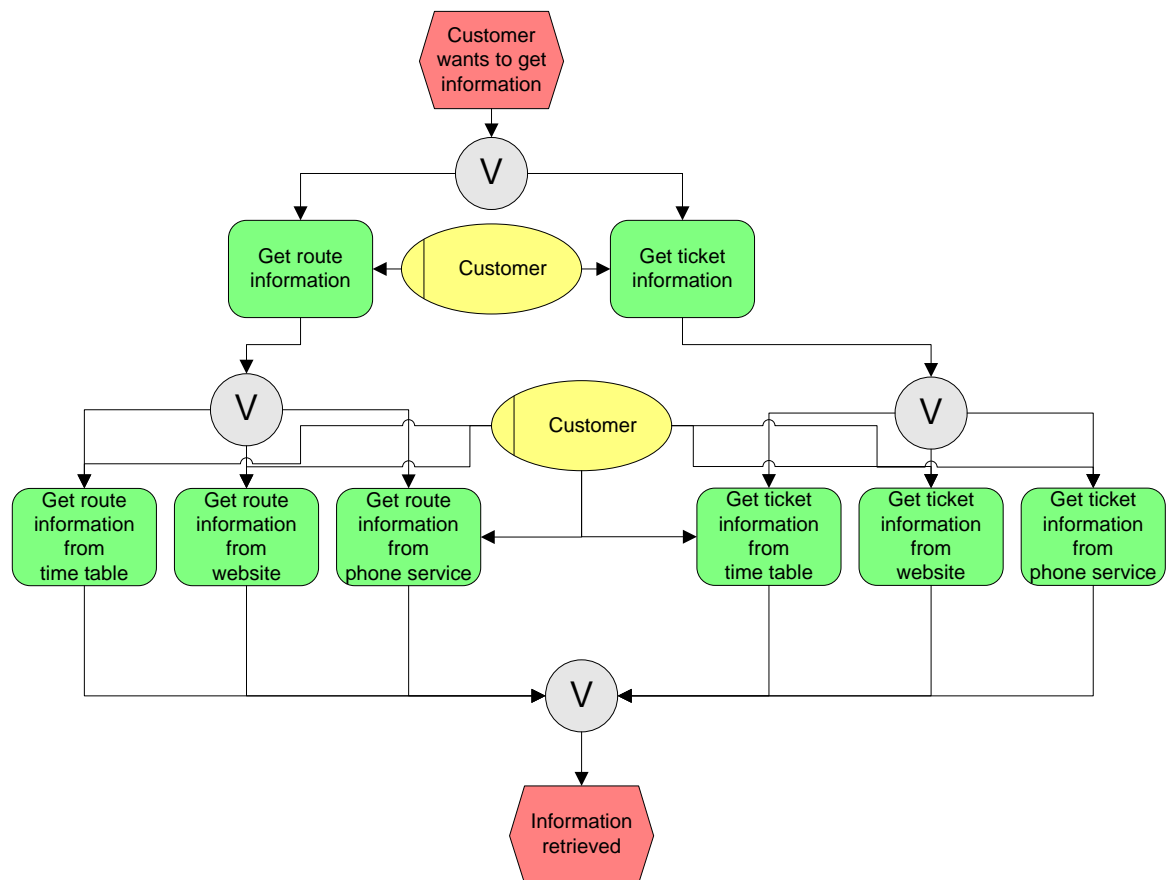
### 3.1.2. Bus Driver Instruction



**Figure 9: As-Is – EPC – Bus Driver Instruction**

In Figure 9 the Manager changes one or more ticket variants in the ticket pool (large blackboard in bus depot). The Manager informs all Bus Driver's about the change in ticket variants pointing them to the ticket pool and updates all related Customer Information (bus stop notices, advertisements). Bus Drivers must keep all changes to the ticket variants in mind.

### 3.1.3. Customer Information



**Figure 10: As-Is – EPC – Customer Information**

In Figure 10 the Customer is interested in using the bus service and thus wants information on routes or ticket variants of the bus service. The Customer can receive this information from the bus station notice, the bus service's website or by calling the bus service via phone.

### 3.1.4. Handle Route Problems

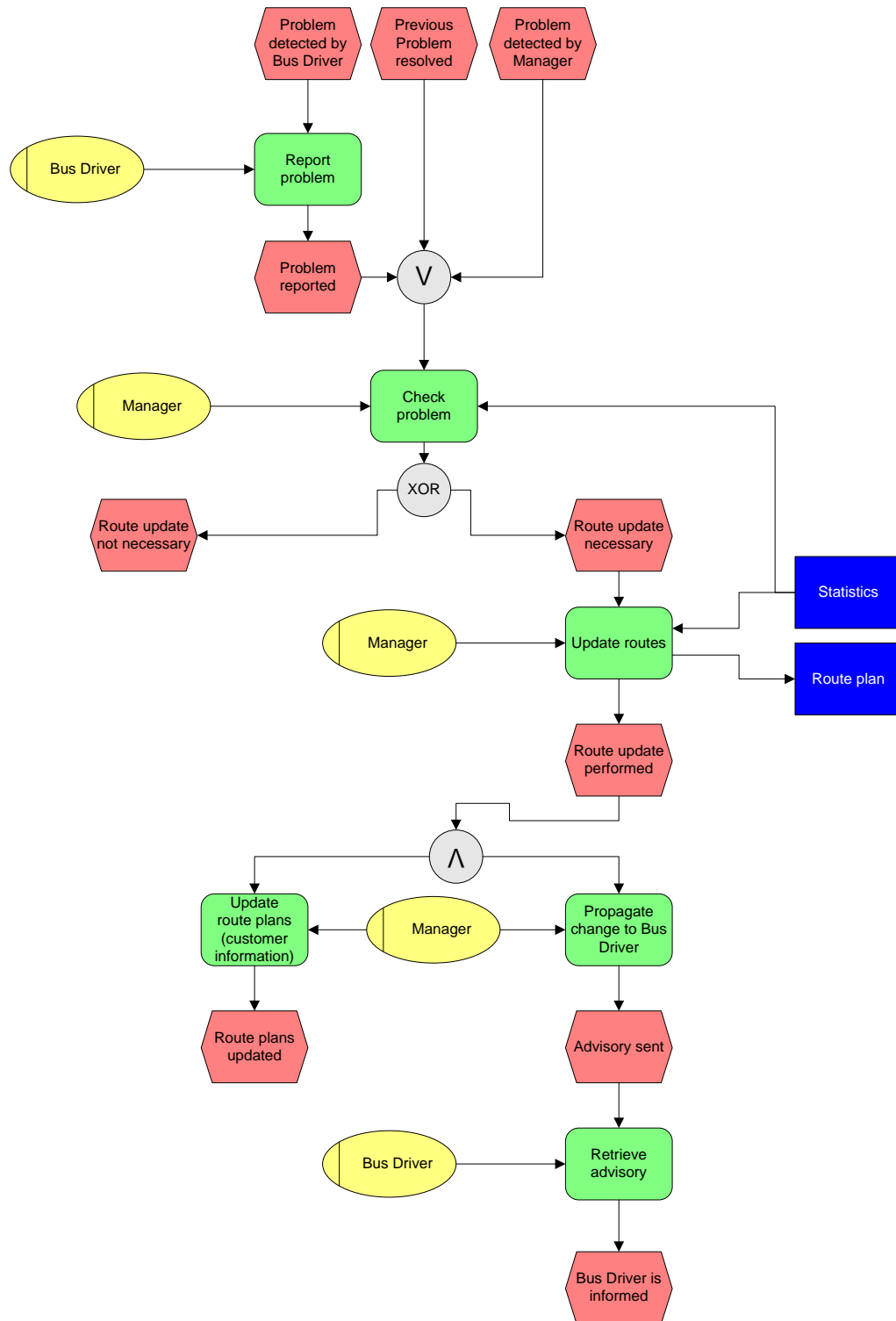
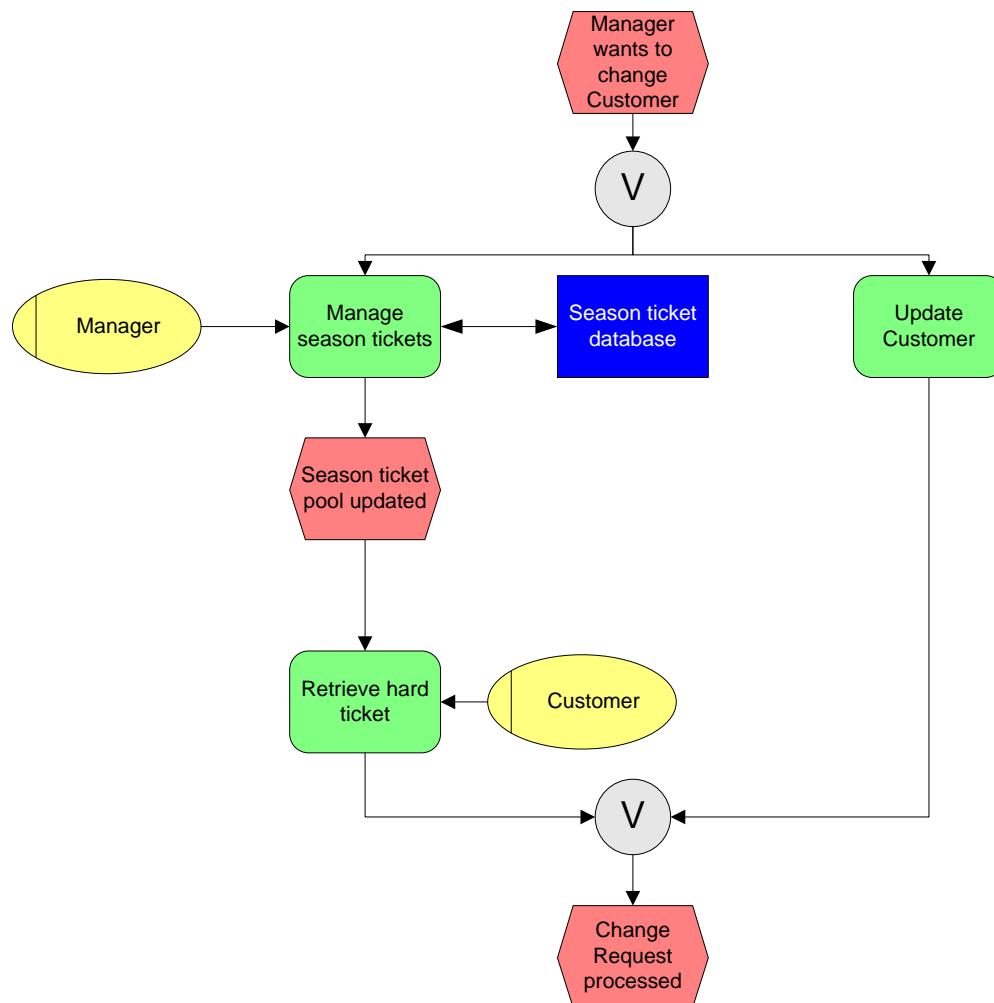


Figure 11: As-Is – EPC – Handle Route Problems

In Handle Route Problems a problem is detected by either the Manager or the Bus Driver. In case the Bus Driver detects a problem, the Bus Driver must report it to the Manager immediately. The Manager must check, which of the routes are affected by the problem and temporarily change those routes. The changes are propagated to the Bus Drivers in an advisory and to the Customers in the Customer Information.

### 3.1.5. Ticket Management



**Figure 12: As-Is – EPC – Ticket Management**

In

Figure 12 the Manager manages the season tickets and Customer data in the system. A Customer may want a new season ticket, a change of a season ticket or cancel a season ticket and/or a change to the Customer's data such as change of address due to moving. The Manager executes these changes.

### 3.1.6. Transportation

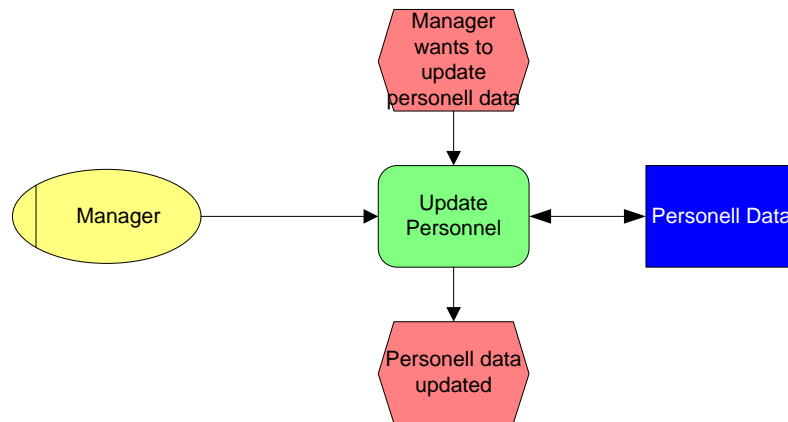


Figure 13: As-Is – EPC – Transport



In Figure 13 the Customer wants to use the bus service and thus the Bus Driver checks if there is still capacity for the Customer to board. If there is still capacity the Customer enters the bus. The Customer has either obtained a ticket before the ride or needs to buy a ticket from the Bus Driver. If the Customer has obtained the ticket before the ride the Bus Driver checks the Ticket and allows or denies access or asks the manager if the presented ticket is valid (process shown in Figure 15: As-Is – EPC – Ticket Information). If the Customer was denied access with a ticket obtained before the ride or needs to buy a ticket, the Customer must buy a ticket from the Bus Driver. The Bus Driver bills the Customer and the Customer pays or is denied access to the bus otherwise.

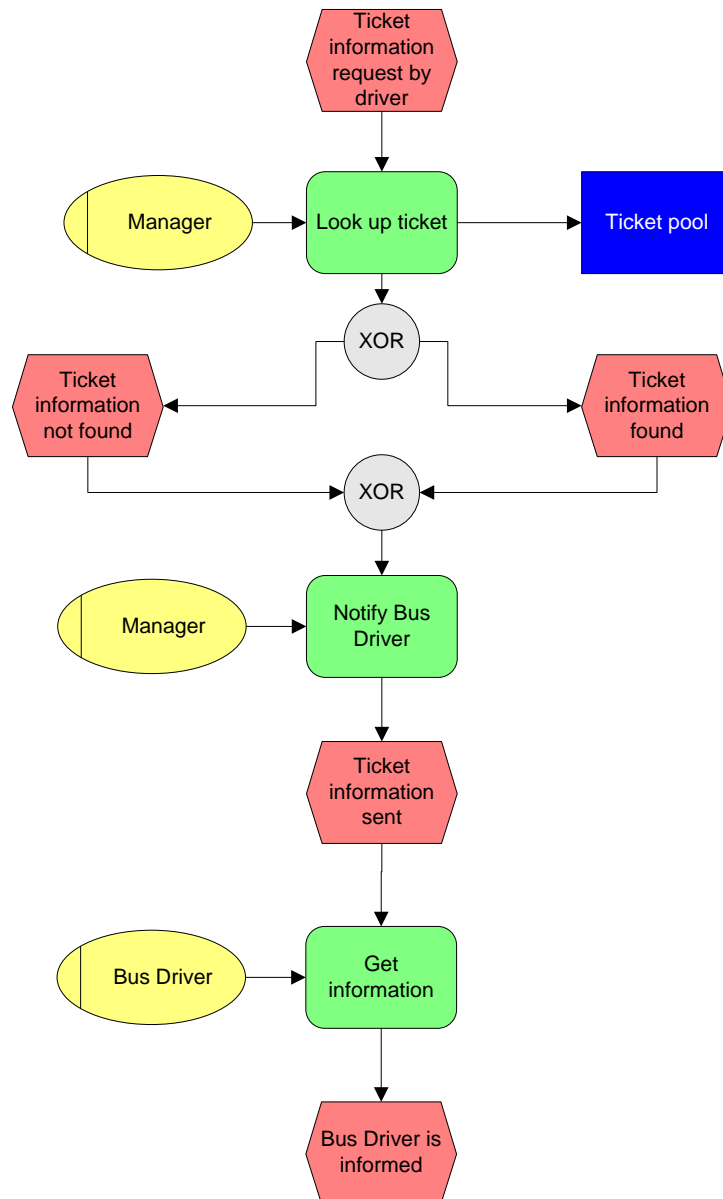
### 3.1.7. Manage Personnel



**Figure 14: As-Is – EPC – Manage Personnel**

In Figure 14 the Manager manages the personnel responsible for the management activities by maintaining a list of who is responsible for what.

### 3.1.8. Ticket Information



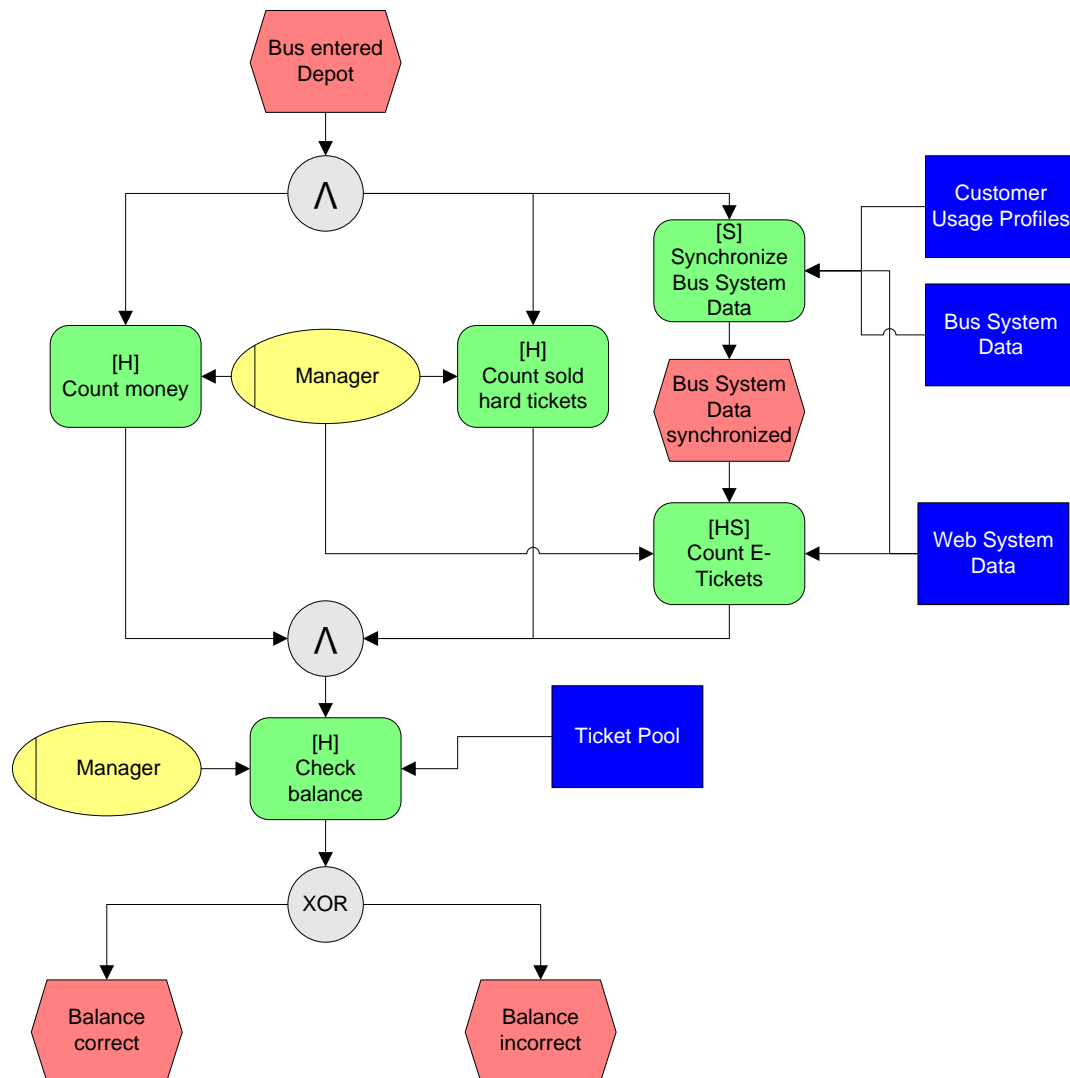
**Figure 15: As-Is – EPC – Ticket Information**

In

Figure 15 a Customer entered a bus and presented a ticket obtained before the ride to the Bus Driver, which the Bus Driver does not know. The Bus Driver asks the Manager if the presented Ticket is allowed on the bus and the Manager looks for the ticket in the Ticket Pool. If found the Manager can tell the Bus Driver to allow access. If not found the Manager has to come up with the decision whether or not to allow access.

## 3.2. To Be Situation

### 3.2.1. Accounting



**Figure 16: To-Be – EPC – Accounting**

In Figure 16 the bus is synchronized once it enters the bus depot and the Manager can in addition to the as-is situation also get the number of sold and used E-Tickets of a bus.

### 3.2.2. Bus Driver Instruction

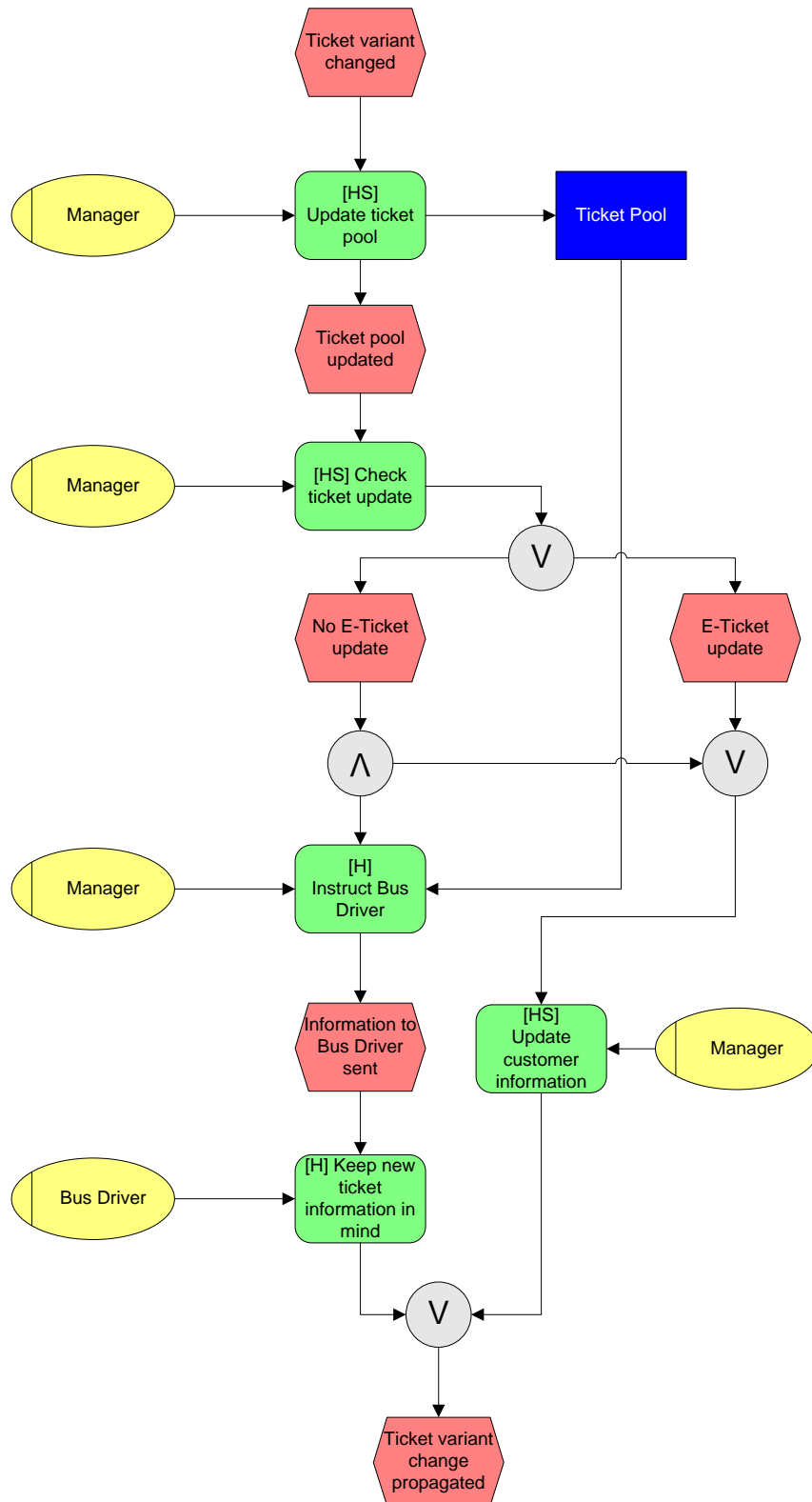


Figure 17: To-Be – EPC – Bus Driver Instruction

In Figure 17 the Manager can additionally to the as-is situation change one or more E-Ticket variants. The Manager task of informing the Bus Drivers is negligible for E-Tickets and the Customer Information is can be changed in the system for all Customers using the system.

### 3.2.3. Bus System Operation

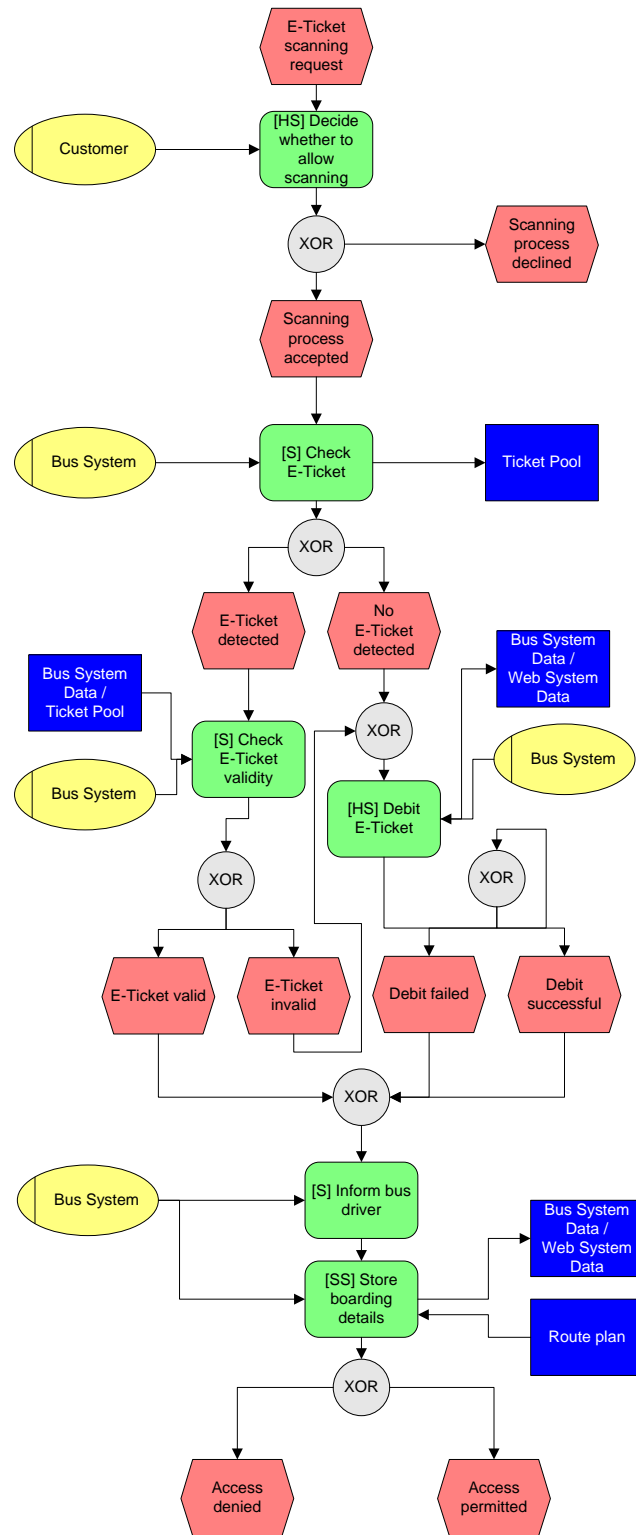


Figure 18: To-Be – EPC – Bus System Operation  
In

Figure 18 the Customer decides whether to allow scanning and a connection to the bus system from the mobile device or has a permanent option set to always allow the connection. The system checks whether the Customer has any E-Tickets on the mobile device. If so the system checks if one of them is valid on the bus. If there is no valid E-Ticket or no E-Ticket at all the Customer must buy an E-Ticket and the system informs the Bus Driver of the successful or failed payment of the E-Ticket.



### 3.2.4. Customer Information

*Comment:*  
All functions are  
conducted by the  
Customer if not  
marked otherwise

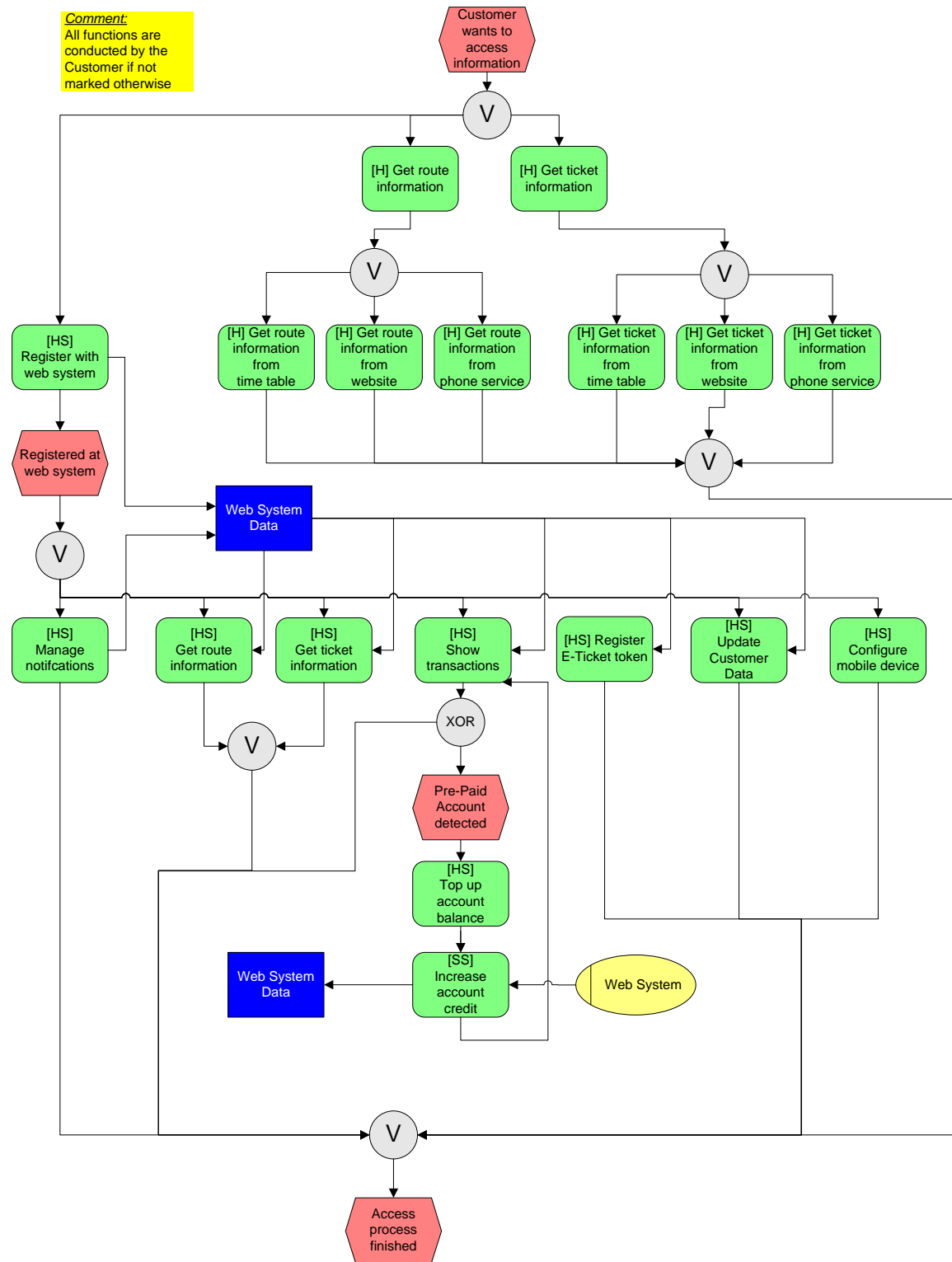
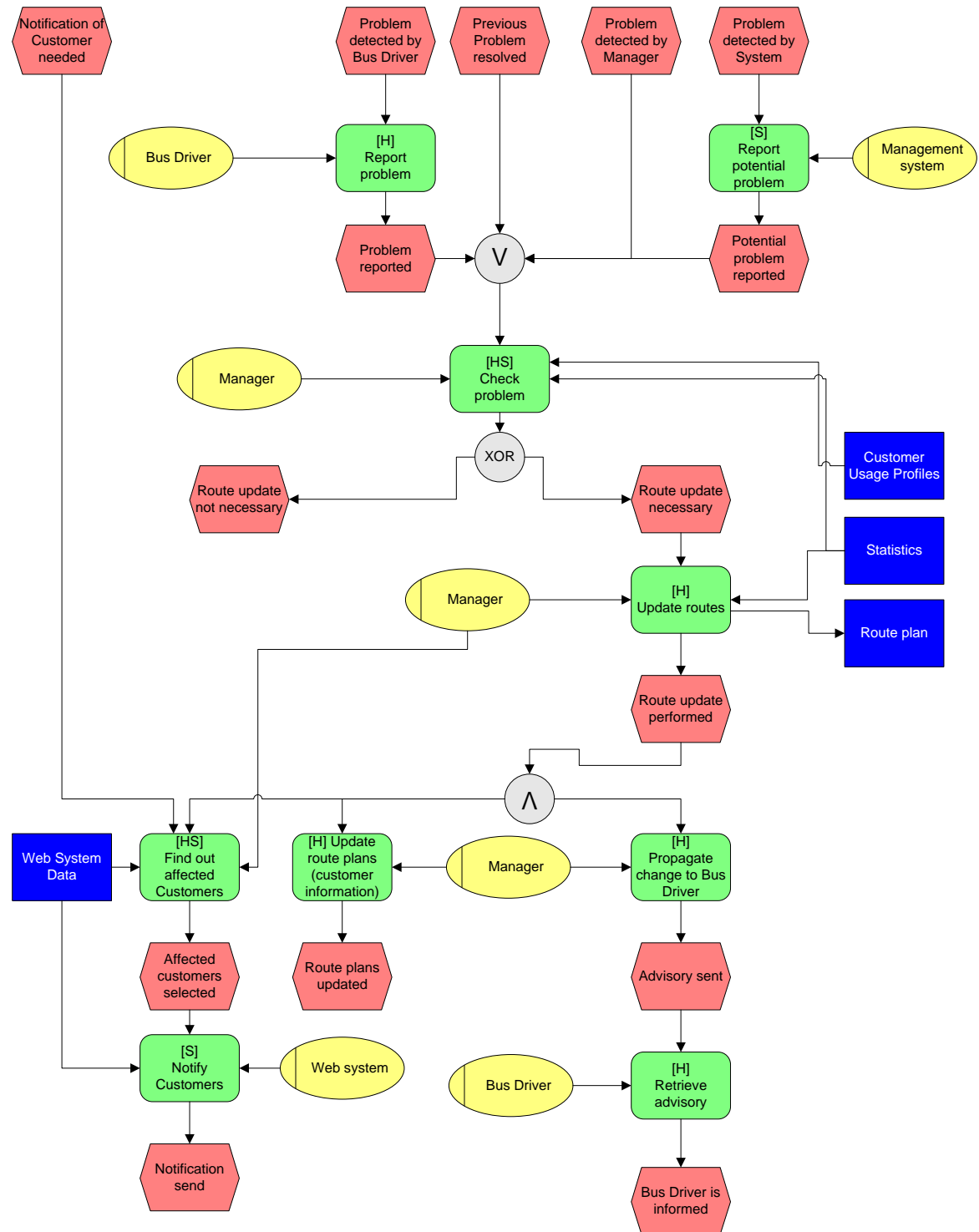


Figure 19: To-Be – EPC – Customer Information

In Figure 19 the Customer can additionally to the as-is situation register with / log in to the Web System and has the following options there:

1. Manage notifications: Manage routes and times when the Customer wants to be notified
2. Get route information: Get Information about current route status entered by the Manager
3. Get ticket information: Get Information about ticket types in Ticket Pool
4. Show transactions: Show transactions done in account, e.g. Buying of ticket, redeeming of token, top up of account
  - a. If the Customer has a pre-paid account then there is an option to top up the account balance. If chosen the Customer is taken to an external payment site where money can be charged to the Customer's account.
5. Register E-Ticket token: Register an E-Ticket token received with season ticket
6. Update Customer data: Change data such as username and password, address, etc.
7. Configure mobile device: Get information on how to setup the mobile device

### 3.2.5. Handle Route Problems



### Figure 20: To-Be – EPC – Handle Route Problems

In Figure 20 the Manager can additionally to the as-is situation also get a problem report from the system about a potential problem. The Manager can when checking a problem rely on real time data gathered from the bus as well as statistical data gathered from the usage of E-Tickets such as “How many passengers usually enter the bus at station X for the next bus to be there?” or “How many passengers are there usually in a bus on route Y on a Wednesday at 2 pm?”. Once the route(s) are updated the Manager can use the system to notify Customers. Therefore the Manager selects one or more Routes, inserts a message and the system automatically notifies all Customers which have a matching criteria for one selected Route. The notification might also be used by the Manager to propagate advertisement and other informations.

### 3.2.6. Transportation

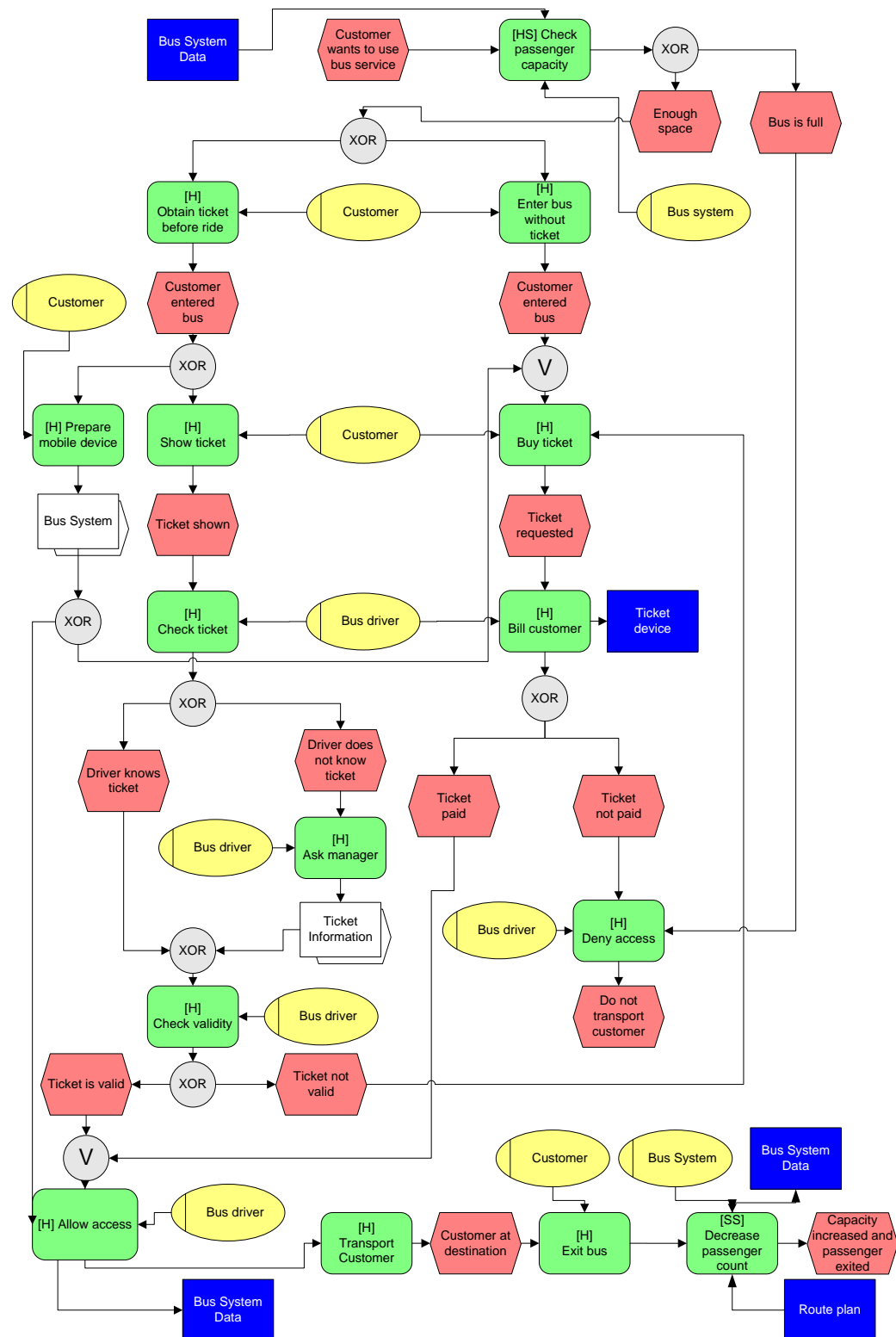
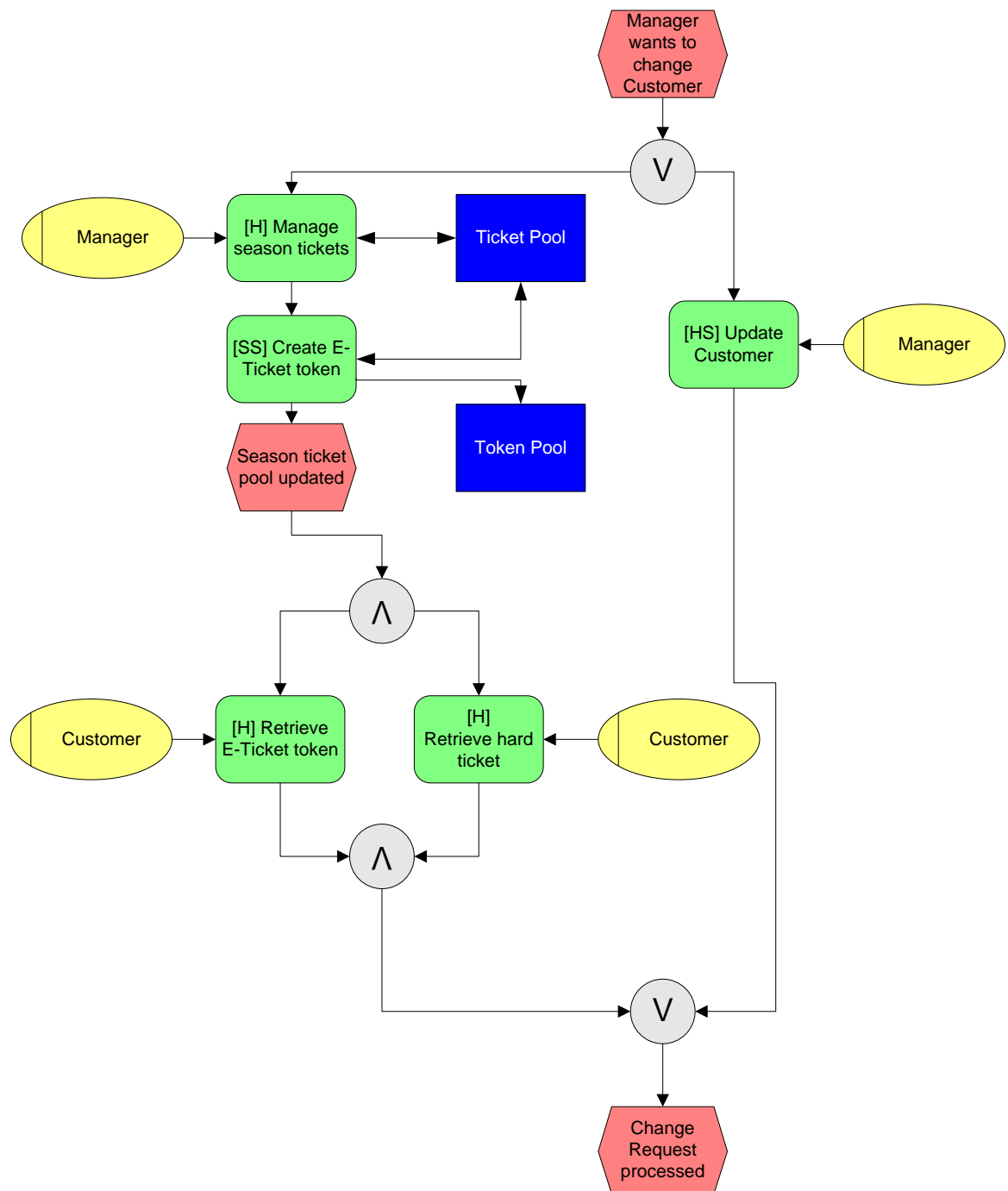


Figure 21: To-Be – EPC – Transportation

In Figure 21 the Customer additionally to the as-is situation also has the option to ride the bus using an E-Ticket. The Customer must be registered with the system to use this functionality (process shown in Figure 19: To-Be – EPC – Customer Information). The process when an E-Ticket is used is shown in Figure 18: To-Be – EPC – Bus System Operation.

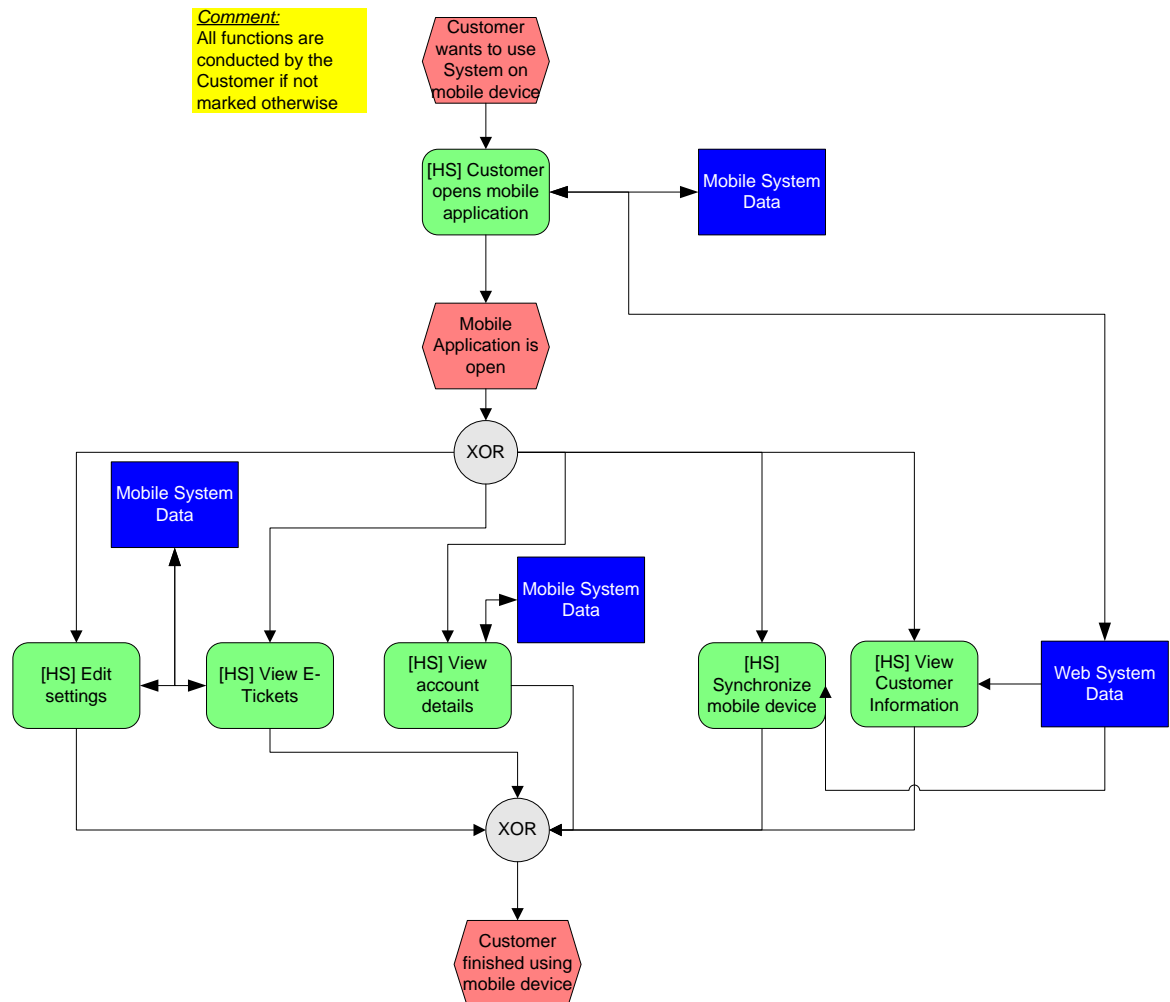
### 3.2.7. Ticket Management



### **Figure 22: To-Be – EPC – Ticket Management**

In Figure 22 the Manager additionally to the as-is-situation now creates an E-Ticket token for every season ticket, which is also delivered to the Customer. The Manager can also change the Customer's data in the system.

### 3.2.8. Mobile Device Usage



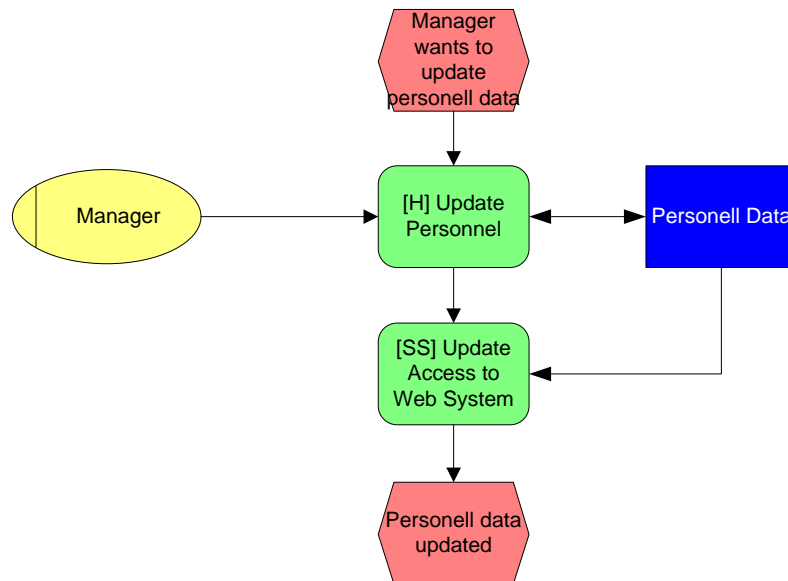
**Figure 23: To-Be – EPC – Mobile Device Usage**

In Figure 23 the Customer is presented with the system on the mobile device. The Customer must first log in to the system on the mobile device and then has the following options:

1. Edit settings: Change settings such as whether to always allow a connection establishment
2. View E-Tickets: View all E-Tickets on the mobile device
3. View account details: View details of account e.g. account type and balance
4. Synchronize mobile device: Synchronize with web system
5. View Customer Information: View Information from Manager about routes and tickets



### 3.2.9. Manage Personnel

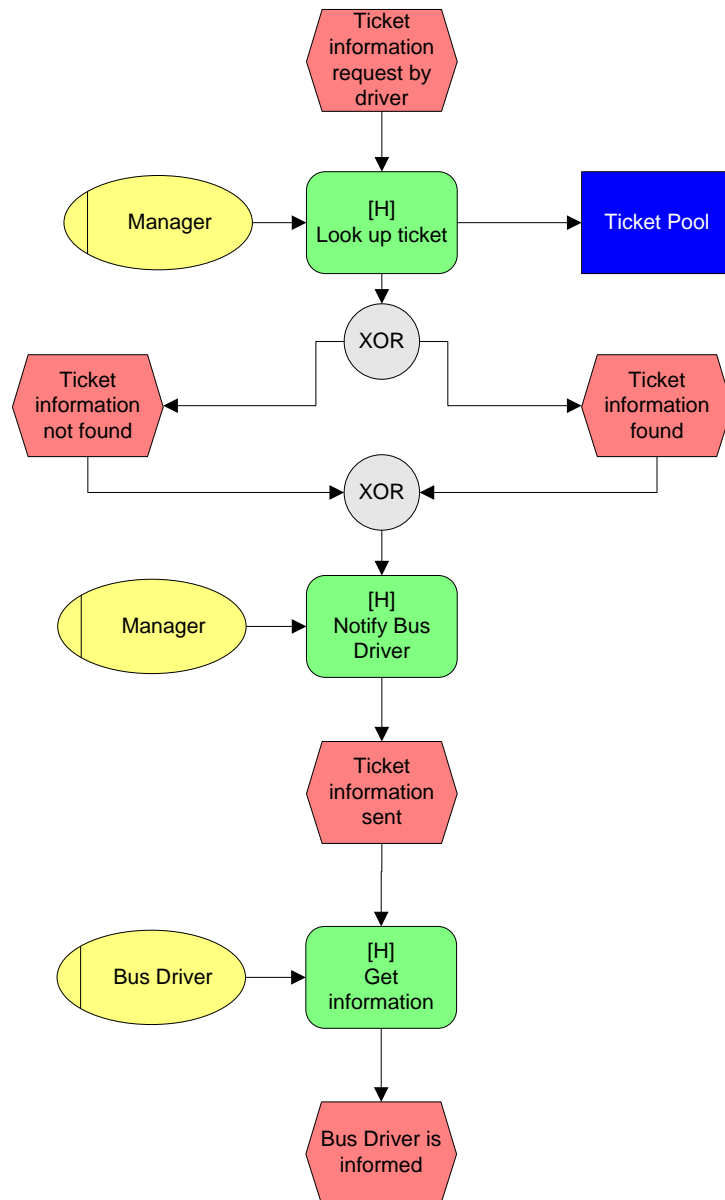


**Figure 24: To-Be – EPC – Manage Personnel**

In

Figure 24 the system receives the update to personnel from the personnel management system and updates the access to the web system so all Managers can log into the web system as Managers

### 3.2.10. Ticket Information



**Figure 25: To-Be – EPC – Ticket Information**

In Figure 25 the situation has not changed from the as-is situation. If there is a ticket unknown to the Bus Driver it must be a hard ticket and thus cannot be recognized by the bus system.

### 3.3. System Responsibility

To clarify which functions the system needs to provide, we classify each function of an EPC into one of these categories: Human, Human-System, System, System-System.

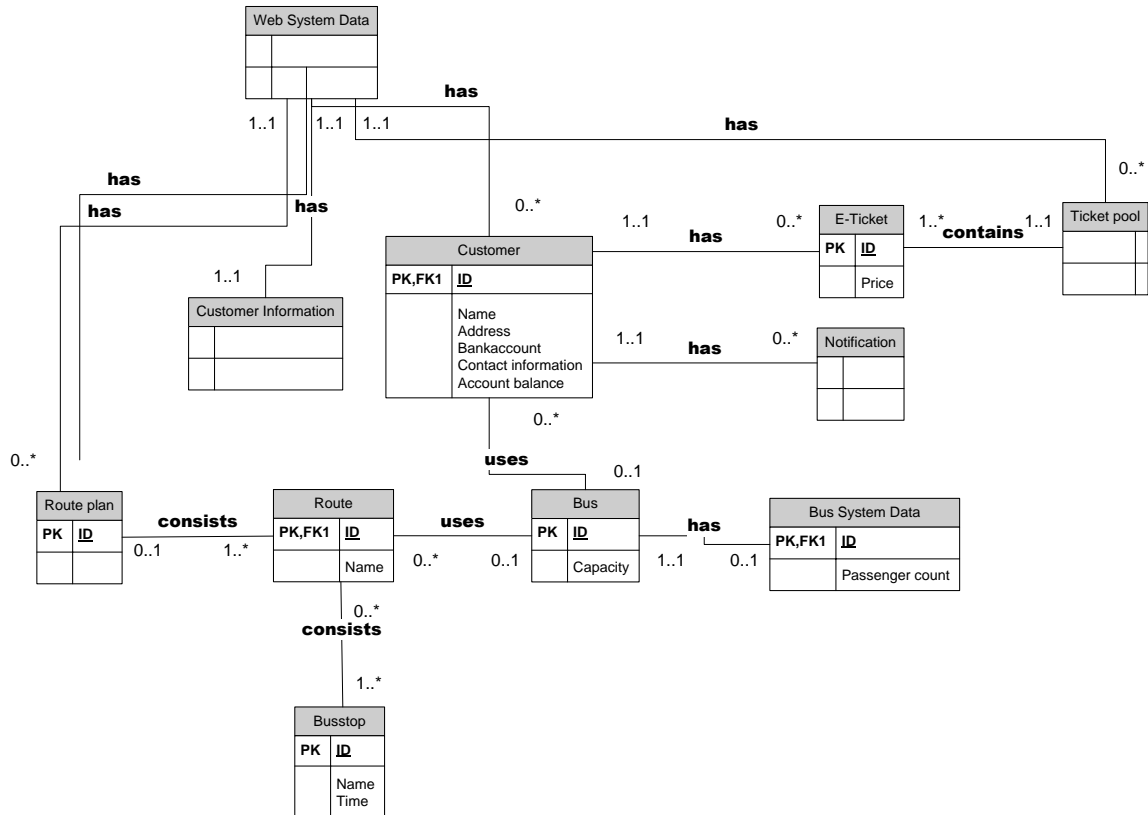
A Human function is a function, which is processed by a human without any interaction to the system. Human-System functions are the same, except that system interactions occur. Pure System functions relate to processes of the system, which do not need any interaction with the user. Additionally there are System-System functions. These functions describe a system procedure using other systems to provide the functionality.

	Name	Function	Human	Human-System	System	System-System
ToBe Accounting	F1	Count money	X			
	F2	Count sold hard tickets	X			
	F3	Synchronize Bus System Data			X	
	F4	Count E-Tickets		X		
	F5	Check balance	X			
BusDriverInstruct ion	F6	Update ticket pool		X		
	F7	Check ticket update		X		
	F8	Instruct Bus Driver	X			
	F9	Keep new ticket information in mind	X			
	F10	Update customer information		X		
ToBe BusSystem	F11	Decide whether to allow scanning		X		
	F12	Check E-Ticket			X	
	F13	Check E-Ticket validity			X	
	F14	Debit E-Ticket		X		
	F15	Inform Bus Driver			X	
	F15.1	Store boarding details				X
ToBe CustomerInformation	F16	Get route information	X			
	F17	Get route information from timetable	X			
	F18	Get route information from website	X			
	F19	Get route information from phone service	X			
	F20	Get ticket information	X			
	F21	Get ticket information from timetable	X			
	F22	Get ticket information from website	X			
	F23	Get ticket information from phone service	X			
	F24	Register with web system		X		
	F25	Manage notifications		X		
	F26	Get route information		X		

	F27	Get ticket information		X		
	F28	Show transactions		X		
	F29	Top up account balance		X		
	F30	Increase account credit				X
	F31	Register E-Ticket token		X		
	F32	Update Customer data		X		
	F33	Configure mobile device		X		
ToBe Route	F34	Report problem	X			
	F35	Check problem		X		
	F36	Report potential problem			X	
	F37	Update routes	X			
	F38	Propagate changes to Bus Driver	X			
	F39	Retrieve advisory	X			
	F40	Update route plans (customer information)	X			
	F41	Find out affected Customers		X		
	F42	Notify Customers			X	
ToBe Transport	F43	Check passenger capacity		X		
	F44	Enter Bus without ticket	X			
	F45	Buy ticket	X			
	F46	Bill Customer	X			
	F47	Obtain ticket before ride	X			
	F48	Show ticket	X			
	F49	Check ticket	X			
	F50	Ask manager	X			
	F51	Check validity	X			
	F52	Prepare mobile device	X			
	F53	Allow access	X			
	F54	Transport Customer	X			
	F55	Exit Bus	X			
	F56	Decrease passenger count				X
	F57	Deny access	X			
ToBeTicketMa nagement	F58	Manage season tickets	X			
	F59	Create E-Ticket token				X
	F60	Retrieve E-Ticket token	X			
	F61	Retrieve hard ticket	X			
	F62	Update Customer		X		
ToBe MobileDevice	F63	Customer opens mobile application		X		
	F64	Edit settings		X		
	F65	View E-Tickets		X		
	F66	View account details		X		
	F67	Synchronize mobile device		X		
	F68	View Customer Information		X		
ToBe Pers onnel	F69	Update personnel	X			
	F70	Update access to Web System				X
	F71	Look up ticket	X			

F72	Notify Bus Driver	X			
F73	Get information	X			

### 3.4. Contextual Data



**Figure 26: Contextual Data overview**

In Figure 26 the contextual data is depicted. In our system everything is either stored on the Bus System or the Web System. The Web System contains the route plan, Customer Information, the Ticket pool and Customers. A Customer can have one or more E-Tickets each having exactly one type out of the Ticket pool. Each Customer can be on board of either no bus or exactly one bus, which is either on no route (trips to the depot) or exactly one route in the route plan. Each Bus has a Bus System, which stores the current passenger count.

## 4. Interaction

Each use case describes one function from the EPC diagrams and the respective responsible roles. The mapping of functions to use case diagrams and system functions can be found in the **Appendix -> Traceability Matrix** section.

### 4.1. Use-Cases

#### 4.1.1. Accounting

ID	UC 1.1
Name	Count E-Tickets
Goal	Query database about used E-Tickets
Actor	Manager
Precondition	Bus System Data is synchronized
Description	<ol style="list-style-type: none"> <li>1. System checks if Manager is authenticated</li> <li>2. Manager selects menu entry "Access Statistics"</li> <li>3. System shows "Query Form"</li> <li>4. Manager puts relevant Bus Id and date into Query Form and confirms</li> <li>5. Go on with UC 1.2.1</li> <li>6. Manager reads relevant data</li> </ol>
Exception	1a1. System recognizes that Manager is not authenticated; Go on with UC 1.4.2 1a2. Go on with UC 1.1.2
(Business) Rules	
Quality Requirements	<i>Efficiency - Response Time/ Usage Time:</i> - Query must not take longer than 2sec - Overall Query Task must not take longer than 30sec <i>Usability - Suitability for the task:</i> - The system should only display relevant query data <i>Security - Privacy/Access+Authorization:</i> - The displayed data must not violate customer privacy - The data should only be visible to authorized users
Data	<i>Query Data</i> (bus_id, date)
System Functions	SF 1.1.1 User authentication and authorization SF 1.1.2 Query database SF 1.1.3 Display Message
Post-Conditions	Relevant information of E-Ticket is shown

<b>ID</b>	<b>UC 1.2</b>
<b>Name</b>	Query Bus Data
<b>Goal</b>	Query Bus Data in Web System Data
<b>Actor</b>	Manager
<b>Precondition</b>	Manager is authenticated with management client and <i>Query Data</i> is available
<b>Description</b>	1. System fetches relevant E-Ticket count and displays result in result list
<b>Exception</b>	<p>1a1. System recognizes that <i>Web System Data</i> is not current</p> <p>1a2. Manager selects the option to load the <i>Bus System Data</i></p> <p>1a2a1. Manager cancels</p> <p>1a2a2. System hides form</p> <p>1a3. System shows "Load Data From Bus Form"</p> <p>1a4. Manager clicks on "Synchronize Bus Data"</p> <p>1a5. System synchronize <i>Bus System Data</i> and stores data in <i>Web System Data</i> and hides form</p> <p>1a5a1. System cannot connect to <i>Bus System Data</i> and displays error Message</p>
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<p><i>Efficiency - Response- / Usage- / Transmission Time:</i></p> <ul style="list-style-type: none"> <li>- Query must not take longer than 2sec</li> <li>- Transmission must not take longer than 40sec</li> <li>- Overall Query Task must not take longer than 60sec</li> </ul> <p><i>Usability - Self-Descriptiveness:</i></p> <ul style="list-style-type: none"> <li>- The system should inform the user about the status of the transmission and query process</li> </ul> <p><i>Security - Confidentiality/Access+Authorization:</i></p> <ul style="list-style-type: none"> <li>- The query data must be encrypted</li> <li>- The query data should only be accessible to legitimate entities</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The query must fulfill the ACID properties</li> </ul>
<b>Data</b>	<p><i>Bus System Data;</i></p> <p><i>Web System Data;</i></p> <p><i>Query Data (bus_id)</i></p>
<b>System Functions</b>	SF 1.1.2 Query database

	SF 1.1.3 Display Message SF 1.2.1 Recognize data not up to date SF 1.2.2 Synchronize Bus System Data
<b>Post-Conditions</b>	<i>Bus System Data</i> of related bus id is stored in <i>Web System Data</i>

(UC 1.3 deprecated)

<b>ID</b>	<b>UC 1.4</b>
<b>Name</b>	Authenticate with system
<b>Goal</b>	Authenticate successfully with the system
<b>Actor</b>	Manager
<b>Precondition</b>	
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Manager starts management client</li> <li>2. System shows login form</li> <li>3. Manager gives credentials</li> <li>4. System validates <i>User Credentials</i> and shows "Main Management Form"</li> </ol>
<b>Exception</b>	4a. System cannot validate credentials and shows access denied form
<b>(Business) Rules</b>	Manager needs to enter credentials
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 20sec <i>Usability - Self-Descriptiveness:</i> - The system should inform the user about the status of the login process <i>Security - Confidentiality/Access+Authorization:</i> - The system must only allow access for legitimate entities - The login process must be encrypted
<b>Data</b>	<i>User Credentials</i>
<b>System Functions</b>	SF 1.1.1 User authentication and authorization SF 1.1.3 Display Message
<b>Post-Conditions</b>	Manager is authenticated with system



### 4.1.2 Bus Driver Instruction

<b>ID</b>	<b>UC 2.1</b>
<b>Name</b>	Update ticket pool
<b>Goal</b>	Integrate changes of ticket types into ticket pool
<b>Actor</b>	Manager
<b>Precondition</b>	Manager is authenticated with system
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Manager selects menu entry "Manage E-Ticket Types"</li> <li>2. System shows "Manage E-Ticket Type Form"</li> <li>3. Manager updates ticket types</li> <li>4. System saves updates and closes form.</li> </ol>
<b>Exception</b>	4a1. System recognizes invalid data input and displays error message
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - Saving must not take longer than 2sec - Overall Task must not take longer than 30sec <i>Usability - Suitability for the task:</i> - The system should only display relevant data
<b>Data</b>	<i>E-Ticket Type</i>
<b>System Functions</b>	SF 1.1.1 User authentication and authorization SF 1.1.3 Display Message SF 2.1.1 Manage E-Ticket types
<b>Post-Conditions</b>	Change of <i>E-Ticket Type</i> is integrated into system

<b>ID</b>	<b>UC 2.2</b>
<b>Name</b>	Update customer information
<b>Goal</b>	Refresh information presented to Customer
<b>Actor</b>	Manager
<b>Precondition</b>	Manager is authenticated with system
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Manager selects menu entry "Manage Customer Information"</li> <li>2. System shows "Manage Customer Information Form"</li> <li>3. Manager updates information</li> <li>4. System saves updates and closes form</li> </ol>

<b>Exception</b>	4a1. System recognizes invalid data input and displays error message
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - Saving must not take longer than 2sec - Overall Task must not take longer than 30sec <i>Security - Access+Authorization:</i> - The data should only be changeable by authorized users
<b>Data</b>	<i>Customer Information</i>
<b>System Functions</b>	SF 1.1.1 User authentication and authorization SF 1.1.3 Display Message SF 2.2.1 Manage Customer Information
<b>Post-Conditions</b>	Changes of customer information are stored in the system

#### 4.1.3 Bus System Operation

<b>ID</b>	<b>UC 3.1</b>
<b>Name</b>	Communication confirmation
<b>Goal</b>	Have Customer's confirmation to go ahead with communication process
<b>Actor</b>	Customer
<b>Precondition</b>	Customer has mobile application installed and started
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer is at bus stop and bus approaches bus stop</li> <li>2. Mobile system detects presence of bus and checks if "Always allow connection" option in <i>Mobile System Settings</i> is set.</li> <li>3. Customer enters bus.</li> <li>4. Mobile system establishes connection with bus system.</li> </ol>
<b>Exception</b>	2a1. Mobile system does not have "Always allow connection" option set and shows "Confirm Connection Form" 2a2. Customer confirms 2a2a1. Customer does not confirm 2a2a2. Mobile system closes form and no connection is established

	2a3. Mobile system closes form; Go on with 3.1.3
<b>(Business) Rules</b>	Only allow communication with bus system in case the user has explicitly expressed confirmation via configuration or shows "Confirm Connection Form"
<b>Quality Requirements</b>	<i>Efficiency - Response Time/ Usage Time:</i> - Overall Task must not take longer than 20sec <i>Security - Privacy/Access+Authorization:</i> - The system is only allowed to auto-connect if user explicitly allowed it via respective settings - The settings must not be changeable by other entities than the respective user
<b>Data</b>	<i>Mobile System Settings</i>
<b>System Functions</b>	SF 3.1.1 Confirm connection establishment
<b>Post-Conditions</b>	Mobile device allowed to communicate with bus system

<b>ID</b>	<b>UC 3.2</b>
<b>Name</b>	Buy E-Ticket
<b>Goal</b>	Sell a valid <i>E-Ticket</i> to Customer and inform Bus Driver about ticketing process
<b>Actor</b>	Customer, Bus Driver
<b>Precondition</b>	Customer has mobile application installed, started and is inside the bus and bus system is connected to the mobile system
<b>Description</b>	<ol style="list-style-type: none"> <li>1. System displays "E-Ticket Type Selection Form" on mobile device display.</li> <li>2. Customer chooses an <i>E-Ticket Type</i>.</li> <li>3. System checks Customer account and debits E-Ticket cost and informs Bus Driver and Customer about successful E-Ticket sale and stores <i>Transaction</i> in <i>Bus System Data</i> and notifies Customer, if enabled, via notification service.</li> </ol>
<b>Exception</b>	3a1. System cannot debit E-Ticket cost and informs Bus Driver and Customer about failed E-Ticket sale and stores transaction in Bus System Data
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Transmission Time/ Usage Time:</i> - The transmission must not take longer than 5sec - Overall Task must not take longer than 20sec <i>Usability - Suitability for the task/Self-Descriptiveness:</i>

	<ul style="list-style-type: none"> <li>- The system should only display available tickets</li> <li>- The system must display all information important to the customer (prices, expiring time, usage time,...)</li> <li>- The system must inform the customer about the status of the purchasing/payment process</li> </ul> <p><i>Security - Confidentiality+Integrity:</i></p> <ul style="list-style-type: none"> <li>- The communication between bus and mobile system must be encrypted</li> <li>- The exchanged data must not be modifiable by third parties</li> </ul>
<b>Data</b>	<i>E-Ticket Type</i> list; <i>Mobile System Settings</i> ; <i>Transaction</i> ;
<b>System Functions</b>	SF 3.2.1 Perform E-Ticket payment SF 3.2.2 Inform Bus Driver SF 3.2.3 Inform Customer
<b>Post-Conditions</b>	Customer has valid E-Ticket

<b>ID</b>	<b>UC 3.3</b>
<b>Name</b>	Store Boarding Details
<b>Goal</b>	Associate the <i>Trip</i> related to the Customer with the Route specific data
<b>Actor</b>	System
<b>Precondition</b>	Customer has a valid E-Ticket and checking process was executed successfully
<b>Description</b>	1. System connects to the Route Planning System inside the Bus 2. Route Planning System retrieves the current <i>Bus</i> , <i>Bus to Route</i> , <i>Route</i> and <i>Bus Stop</i> data. 3. System associates information with the respective <i>Trip</i>
<b>Exception</b>	
<b>(Business) Rules</b>	A Trip needs to get always assigned with Bus Stop and Route information
<b>Quality Requirements</b>	<p><i>Security - Privacy:</i></p> <ul style="list-style-type: none"> <li>- The data must be stored in a way that it does not violate the customers' privacy</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The query must fulfill the ACID properties</li> </ul>

<b>Data</b>	<i>Bus to Route;</i> <i>Bus;</i> <i>Route;</i> <i>Bus Stop;</i> <i>Trip</i>
<b>System Functions</b>	SF 5.1.2 Retrieve Routes SF 3.3.1 Update Trip
<b>Post-Conditions</b>	Customer has valid E-Ticket

#### 4.1.4 Customer Information

<b>ID</b>	<b>UC 4.1</b>
<b>Name</b>	Authenticate with web system
<b>Goal</b>	Customer is authenticated with web system
<b>Actor</b>	Customer
<b>Precondition</b>	Customer is in web browser
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer opens website and selects login.</li> <li>2. System shows "Login Form"</li> <li>3. Customer enters user credentials and confirms</li> <li>4. System verifies user credentials, authenticates Customer and shows "Main Web Form"</li> </ol>
<b>Exception</b>	<p>3a1. Customer has no user credentials and needs to register first; go on with UC 4.2.1</p> <p>4a1. System cannot verify user credentials and displays a notification</p>
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<p><i>Efficiency - Usage Time:</i></p> <ul style="list-style-type: none"> <li>- Overall Task must not take longer than 20sec</li> </ul> <p><i>Usability - Self-Descriptiveness:</i></p> <ul style="list-style-type: none"> <li>- The system should inform the user about the status of the login process</li> </ul> <p><i>Security - Confidentiality/Access+Authorization:</i></p> <ul style="list-style-type: none"> <li>- The system must only allow access for legitimate entities</li> <li>- The login process must be encrypted</li> </ul>
<b>Data</b>	<i>User credentials;</i>
<b>System Functions</b>	SF 1.1.1 User authentication and authorization

	SF 1.1.3 Display Message
Post-Conditions	Customer has account in system and is authenticated
ID	UC 4.2
Name	Register new Customer
Goal	Register a new Customer in the system
Actor	Customer
Precondition	Customer has web browser started
Description	<ol style="list-style-type: none"> <li>1. Customer opens website and selects create account</li> <li>2. System shows "Create Account Form"</li> <li>3. Customer enters name, address, credentials and account type including payment details</li> <li>4. System creates account for Customer, logs customer in and shows "Main Web Form" with information about next steps.</li> </ol>
Exception	<p>4a1. System detects existing Customer account and notifies Customer</p> <p>4b1. System detects invalid data and notifies Customer</p>
(Business) Rules	Name, address and credentials must be entered at registration. There must not be two equal Customers. Customer must select either pre-paid or credit card as payment method and can enter account or credit card details.
Quality Requirements	<p><i>Efficiency - Usage Time:</i></p> <ul style="list-style-type: none"> <li>- Overall Task must not take longer than 60sec</li> </ul> <p><i>Usability - Suitability for the Task/Self-Descriptiveness:</i></p> <ul style="list-style-type: none"> <li>- The system should only request data that is absolutely necessary</li> <li>- The system should inform the user about the status of the account creation process and invalid inputs</li> </ul> <p><i>Security - Confidentiality/Privacy:</i></p> <ul style="list-style-type: none"> <li>- The system must store the customer data in a way that not interferes privacy and data usage policies</li> <li>- The account creation process must be encrypted</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The process must obey the ACID properties</li> </ul>
Data	<p>Customer</p> <p>Credit Card</p>

	<i>Web System Settings</i> <i>User credentials;</i>
<b>System Functions</b>	SF 1.1.3 Display Message SF 4.2.1 Create Customer account
<b>Post-Conditions</b>	Customer has account in system and is authenticated

<b>ID</b>	<b>UC 4.3</b>
<b>Name</b>	Manage Notifications
<b>Goal</b>	Customer wants to receive notifications based on Notification Rules.
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in and authenticated to Web System
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer selects manage notifications</li> <li>2. System shows "Manage Notification Form" with existing Notification Rules.</li> <li>3. Customer manages (add/edit/delete) Notification Rules</li> <li>4. System stores Notification Rules and informs Customer of success</li> </ol>
<b>Exception</b>	<p>4a1. System detects invalid data and displays a notification.</p> <p>4b1. System stores Notification Rules and informs Customer about the non-activation of the notification feature.</p>
<b>(Business) Rules</b>	Notification Rules are based on bus line numbers and timespans
<b>Quality Requirements</b>	<p><i>Efficiency - Usage Time:</i></p> <ul style="list-style-type: none"> <li>- Overall Task must not take longer than 30sec</li> </ul> <p><i>Security - Confidentiality/Privacy/Access+Authorization:</i></p> <ul style="list-style-type: none"> <li>- The system is not allowed to notify the customer without explicit allowance via these settings</li> <li>- The account creation process must be encrypted</li> <li>- The settings must only be modifiable by the respective customer</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The process must obey the ACID properties</li> </ul>
<b>Data</b>	Notification Rules
<b>System Functions</b>	SF 1.1.3 Display Message

	SF 4.3.1 Manage Notification Rules
<b>Post-Conditions</b>	Customer is notified when new information matches Notification Rules

<b>ID</b>	<b>UC 4.4</b>
<b>Name</b>	View information
<b>Goal</b>	Customer has information about current route problems and available (E)-Tickets
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in and authenticated to Web System
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer selects menu entry "Route and Ticket Information"</li> <li>2. System shows current route problems and available (E)-Ticket</li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 30sec <i>Usability - Suitability for the Task:</i> - The system should only display relevant data <i>Security - Access+Authorization:</i> - The data should only be available to authorized entities
<b>Data</b>	<i>Customer Information</i>
<b>System Functions</b>	SF 1.1.3 Display Message
<b>Post-Conditions</b>	Customer is informed about current route problems and available (E)-Tickets

<b>ID</b>	<b>UC 4.5</b>
<b>Name</b>	View transactions
<b>Goal</b>	Customer is informed about past money transactions
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in and authenticated to Web System
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer selects menu entry "View Transactions"</li> <li>2. System displays the "Transaction List" with the transactions of the Customer</li> </ol>



<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 30sec <i>Usability - Suitability for the Task:</i> - The system should only display relevant data <i>Security - Confidentiality/Privacy:</i> - The data should only be available to authorized entities - The data must only be accessible by the customer it belongs to
<b>Data</b>	<i>Transaction</i>
<b>System Functions</b>	SF 4.5.1 Display E-Ticket Transaction list
<b>Post-Conditions</b>	Customer is informed about current route problems and available (E)-Tickets

<b>ID</b>	<b>UC 4.6</b>
<b>Name</b>	Top up account balance
<b>Goal</b>	The account of the customer is recharged by the defined amount of money.
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in, authenticated to Web System, has a pre-paid account and is on the E-Ticket Transaction list
<b>Description</b>	1. Customer selects menu entry "Top up account" 2. System displays the "Recharge Form" 3. Customer enters amount of money to be added to account and confirms 4. Go on with UC 4.10.1 5. System detects successful transfer of payment; Go on with 4.5.2
<b>Exception</b>	5a1. Systems detects unsuccessful transfer of payment and notifies Customer
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Query Time / Usage Time:</i> - Overall Task must not take longer than 60sec <i>Usability - Self-Descriptiveness:</i> - The system should inform the user about the status of

	the recharge process and invalid inputs <i>Security - Confidentiality/Access+Authorization:</i> - The recharge process must be encrypted - The recharge process can only be invoked by authorized customers <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Data</b>	Recharge Transaction; Customer Account Information
<b>System Functions</b>	SF 1.1.3 Display Message SF 4.6.1 Recharge
<b>Post-Conditions</b>	Customer account is recharged with specified amount

<b>ID</b>	<b>UC 4.7</b>
<b>Name</b>	Update Customer data
<b>Goal</b>	Customer changes stored Customer account information
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in and authenticated to Web System
<b>Description</b>	1. Customer selects menu entry "Change My Data" 2. System shows "Change Customer Data Form" 3. Customer changes name/address/credentials, payment form including payment details and/or Notification and confirms 4. System updates Customer Account information.
<b>Exception</b>	4a1. System detects invalid data and notifies Customer
<b>(Business) Rules</b>	Customer must enter valid name and address. Customer must select either pre-paid or credit card as payment method or credit card details.
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 60sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only request data that is absolutely necessary - The system should inform the user about the status of the update process and invalid inputs <i>Security - Confidentiality/Privacy/Access+Authentication:</i> - The system must store the customer data in a way

	<p>that not interferes privacy and data usage policies</p> <ul style="list-style-type: none"> <li>- The update process must be encrypted</li> <li>- The update process can only be invoked by the respective authorized customer</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The process must obey the ACID properties</li> </ul>
<b>Data</b>	<p><i>Customer</i></p> <p><i>Credit Card</i></p> <p><i>Web System Settings</i></p> <p><i>User credentials;</i></p>
<b>System Functions</b>	<p>SF 1.1.3 Display Message</p> <p>SF 4.7.1 Update Customer account</p>
<b>Post-Conditions</b>	Updated Customer data is stored in the system

<b>ID</b>	<b>UC 4.8</b>
<b>Name</b>	Configure mobile device
<b>Goal</b>	Customer has mobile system installed and configured on mobile device
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in and authenticated to Web System
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer selects menu entry "Configure Mobile Devices"</li> <li>2. System shows "Send Installer Link To Phone Form" and sends Installer Link to mobile phone</li> <li>3. Customer downloads, installs and starts the mobile system on mobile phone</li> <li>4. Mobile system shows "Mobile Login Form"</li> <li>5. Customer enters user credentials and confirms</li> <li>6. Mobile system verifies the credentials and stores the credentials and shows "Change Mobile Settings Form" and synchronizes <i>Settings</i> and <i>E-Tickets</i> with mobile device.</li> <li>7. Customer selects whether to use the Automated Scanning and/or the Notification feature and/or Automatic Synchronization and confirms.</li> <li>8. System synchronizes <i>Settings</i> and <i>E-Tickets</i> with mobile device.</li> </ol>
<b>Exception</b>	3a1. Customer does not use form but types in mobile system installer link shown on form directly on mobile

	device; Go on with 4.8.4 7a1. System cannot verify user credentials and displays a notification
<b>(Business) Rules</b>	Synchronization is only allowed on one mobile device
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 300sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only send data really relevant to install the mobile system - The system should inform the user about the status of the SMS notification process <i>Security - Confidentiality/Access+Authorization:</i> - The notification function can only be invoked by authorized and legitimate customers - The mobile system login process must be encrypted - The synchronization process must be encrypted <i>Reliability - Recoverability:</i> - The system must offer a possibility to resend the SMS - The synchronization process must fulfill the ACID properties
<b>Data</b>	Customer Account information; User credentials;
<b>System Functions</b>	SF 1.1.1 User authentication and authorization SF 1.1.3 Display Message SF 4.8.1 Send Installer Link to mobile phone SF 4.8.2 Synchronize mobile device SF 4.8.3 Save mobile settings
<b>Post-Conditions</b>	Customer has mobile system installed, configured on mobile device and mobile device is ready to be used

<b>ID</b>	<b>UC 4.9</b>
<b>Name</b>	Register E-Ticket token
<b>Goal</b>	Register an E-Ticket token to use a season ticket with the mobile system
<b>Actor</b>	Customer
<b>Precondition</b>	Customer logged in and authenticated to Web System and Customer has received a E-Ticket token
<b>Description</b>	1. Customer selects menu entry "Register E-Ticket Token"

	2. System shows "Register E-Ticket Token Form" 3. Customer enters token received 4. System verifies token and stores relevant ticket information and displays a confirmation message. 5. Customer opens mobile system application and clicks on synchronize. 6. System synchronizes mobile device.
<b>Exception</b>	4a1. System does not recognize token and displays error message
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 60sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only request data that is absolutely necessary to register the token - The system should inform the user about the status of the token registration process and invalid inputs <i>Security - Confidentiality/Access+Authorization:</i> - The token must be generated in a way that makes it extremely difficult to reproduce via e.g. brute forcing - The account creation process must be encrypted <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Data</b>	E-Ticket Token; Customer Account Data;
<b>System Functions</b>	SF 1.1.3 Display Message SF 4.8.2 Synchronize mobile device SF 4.9.1 Register E-Ticket token
<b>Post-Conditions</b>	Customer has registered a season ticket with mobile system

<b>ID</b>	<b>UC 4.10</b>
<b>Name</b>	External payment request
<b>Goal</b>	Make a successful payment request to an external service/system
<b>Actor</b>	External payment service
<b>Precondition</b>	The system invoked a request to debit a specified amount of money by the use of an external service/system

<b>Description</b>	<ol style="list-style-type: none"> <li>1. System calls external service.</li> <li>2. External service takes over responsibility for payment process and responds successful transfer to system</li> <li>3. System stores successful payment process in Pre-Pay Transaction</li> </ol>
<b>Exception</b>	<p>2a1. External service takes over responsibility for payment process and responds failed transfer to system</p> <p>2a2. System stores failed payment process in Pre-Pay Transaction</p>
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<p><i>Efficiency - Usage Time:</i></p> <ul style="list-style-type: none"> <li>- Overall Task must not take longer than 30sec</li> </ul> <p><i>Security - Confidentiality/Privacy/Access+Authorization:</i></p> <ul style="list-style-type: none"> <li>- The external payment process must be encrypted</li> <li>- The external payment process must not be accessible by unauthorized entities</li> <li>- The exchanged data must not violate the customers' privacy</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The synchronization process must fulfill the ACID properties</li> </ul>
<b>Data</b>	Pre-Pay Transaction
<b>System Functions</b>	SF 4.6.1 Recharge
<b>Post-Conditions</b>	Customer account is recharged with specified amount

#### 4.1.5 Handle Route Problems

<b>ID</b>	<b>UC 5.1</b>
<b>Name</b>	Check Problem
<b>Goal</b>	Decide if a route update is necessary.
<b>Actor</b>	Manager
<b>Precondition</b>	Problem report from Bus Driver, Manager or System available or previous problem is resolved.
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Manager selects menu entry "Show Bus Utilization"</li> <li>2. System shows " Show Bus Utilization Form"</li> <li>3. Manager puts relevant date into form</li> </ol>

	4. System shows "Graphical Bus Utilization Form" 5. Manager decides to update one or more routes; go on with UC 5.2.3
<b>Exception</b>	3a1. System recognizes invalid data input and displays error message 5a1. Manager decides not to update a route
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 30sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only display data really relevant to come up with an update decision - The system should explicitly highlight congested routes <i>Reliability - Recoverability:</i> - The synchronization must obey the ACID properties
<b>Data</b>	<i>Route Plan; User Profiles; Bus System Data; Utilization Query Data (MISSING DATA Date, Time)</i>
<b>System Functions</b>	SF 1.2.2 Synchronize Bus System Data SF 5.1.1 Calculate utilization information SF 5.1.2 Retrieve Routes
<b>Post-Conditions</b>	Route update is necessary.

<b>ID</b>	<b>UC 5.3</b>
<b>Name</b>	Notify affected Customers
<b>Goal</b>	Send advertisements, route changes, etc. only to affected Customers
<b>Actor</b>	Manager
<b>Precondition</b>	Manager is authenticated with system.
<b>Description</b>	1. Manager selects menu entry "Notify Customers" 2. System shows "Notify Affected Customers Form" 3. Manager adds Customers based on a <i>Route</i> or manually 4. System selects Customers having one or more matching <i>Notification Rule</i> selected according to the selected <i>Routes</i> 5. Manager enters message and confirms 6. System notifies Customers selected "Notify Affected Customers Form"

Exception	2a1. Manager does not confirm 2a2. System closes "Notify Affected Customers Form"
(Business) Rules	
Quality Requirements	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 60sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only send data really relevant to the customer - The system should only display directly affected customers - The system should inform the manager about the status of the notification process <i>Security - Privacy/Access+Authorization:</i> - The notification function can only be invoked by authorized and legitimate managers - The system should only notify/display customers that explicitly allowed notifications <i>Reliability - Recoverability:</i> - The system must offer a possibility to resend the notification
Data	<i>Notification Rule;</i> <i>Customer</i>
System Functions	SF 5.3.1 Retrieve affected Customers SF 5.3.2 Notify Customers SF 5.1.2 Retrieve Routes
Post-Conditions	Affected Customers are notified

#### 4.1.6 Transportation

ID	UC 6.1
Name	Check passenger capacity
Goal	Get current boarded E-Ticket holder count
Actor	Bus Driver
Precondition	Bus Driver on duty
Description	1. Bus Driver looks on system console 2. System console displays current boarded E-Ticket holder count
Exception	
(Business) Rules	



<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 10sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only display the effective passenger count in a way that it is easy to see even in stressful situations <i>Security - Privacy:</i> - The system should only display an anonymous passenger count, not any specific personal data
<b>Data</b>	E-Ticket Passengers
<b>System Functions</b>	SF 6.1.1 Get E-Ticket passenger count
<b>Post-Conditions</b>	Bus Driver is informed about current boarded E-Ticket holder count

<b>ID</b>	<b>UC 6.2</b>
<b>Name</b>	Decrease passenger count
<b>Goal</b>	Get the current Route information and associate it as exit information to the Trip of the Customer
<b>Actor</b>	System
<b>Precondition</b>	Customer has exited the bus
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system recognizes that the Customer has exited the bus and connects to the Route Planning System</li> <li>2. Route Planning System retrieves the current <i>Bus</i>, <i>Bus to Route</i>, <i>Route</i> and <i>Bus Stop</i> data.</li> <li>3. System associates information with the respective <i>Trip</i></li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Security - Privacy:</i> - The system should only display an anonymous passenger count, not any specific personal data
<b>Data</b>	<i>Bus to Route;</i> <i>Bus;</i> <i>Route;</i> <i>Bus Stop;</i> <i>Trip</i>
<b>System Functions</b>	SF 5.1.2 Retrieve Routes

	SF 3.3.1 Update Trip
<b>Post-Conditions</b>	The update to the <i>Trip</i> was made

#### 4.1.7 Ticket Management

<b>ID</b>	<b>UC 7.1</b>
<b>Name</b>	Create E-Ticket Token
<b>Goal</b>	Store a unique Token for each freshly created season ticket
<b>Actor</b>	Season Ticket System
<b>Precondition</b>	A new season ticket has been created in the Season Ticket System
<b>Description</b>	<ol style="list-style-type: none"> <li>1. System notices that new Season Ticket has been created and requests respective data from the Season Ticket System</li> <li>2. Season Ticket System transfers requested data to the System</li> <li>3. System creates a new unique Token, stores the Token and transfers Token to Season Ticket System</li> </ol>
<b>Exception</b>	<p>2a1. Season Ticket System cannot transfer requested data</p> <p>2a2. Go on with 7.1.2</p>
<b>(Business) Rules</b>	For every new Season Ticket there must be a unique Token
<b>Quality Requirements</b>	<p><i>Efficiency - Usage Time:</i></p> <ul style="list-style-type: none"> <li>- Overall Task must not take longer than 2sec</li> </ul> <p><i>Security - Confidentiality:</i></p> <ul style="list-style-type: none"> <li>- The token must be generated in a way that makes it extremely difficult to reproduce via e.g. brute forcing</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The process must obey the ACID properties</li> </ul>
<b>Data</b>	<p>Season Ticket Data</p> <p>Token</p>
<b>System Functions</b>	SF 7.1.1 Token creation
<b>Post-Conditions</b>	Bus Driver is informed about current boarded E-Ticket holder count

<b>ID</b>	<b>UC 7.2</b>
<b>Name</b>	Update Customer
<b>Goal</b>	Retrieve and modify data of a Customer
<b>Actor</b>	Manager
<b>Precondition</b>	Manager is authenticated with system
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Manager clicks on "Manage Customer" menu entry.</li> <li>2. System shows "Select Customer Form".</li> <li>3. Manager selects a Customer.</li> <li>4. System displays <i>Customer</i>, related <i>Credit Card</i>, related <i>Settings</i> and related <i>Transactions</i> in "Manage Customer Form"</li> <li>5. Manager makes modifications on <i>Customer</i> and <i>Transactions</i> and confirms</li> <li>6. System stores modifications</li> </ol>
<b>Exception</b>	6a1. System recognizes invalid data input and displays an error message
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<p><i>Efficiency - Usage Time:</i></p> <ul style="list-style-type: none"> <li>- Overall Task must not take longer than 60sec</li> </ul> <p><i>Usability - Suitability for the Task:</i></p> <ul style="list-style-type: none"> <li>- The system should only display data that is relevant to the manager</li> </ul> <p><i>Security - Privacy/Access+Authorization:</i></p> <ul style="list-style-type: none"> <li>- The customers personal data must not be accessible to illegitimate entities</li> <li>- The manager should only have access to the customers' personal data that is absolutely necessary to perform the respective task</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The process must obey the ACID properties</li> </ul>
<b>Data</b>	<i>Customer</i> <i>Transaction</i> <i>Credit Card</i> <i>Web System Settings</i>
<b>System Functions</b>	SF 1.1.3 Display Message SF 7.2.1 Manage Customer
<b>Post-Conditions</b>	Bus Driver is informed about current boarded E-Ticket holder count

### 4.1.8 Mobile Device Usage

<b>ID</b>	<b>UC 8.1</b>
<b>Name</b>	Customer opens mobile application
<b>Goal</b>	Load application and settings on mobile device
<b>Actor</b>	Customer
<b>Precondition</b>	
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer starts the mobile system on the mobile device</li> <li>2. System synchronizes <i>Settings</i> and <i>E-Ticket</i> with web system and shows "Main Mobile Form"</li> </ol>
<b>Exception</b>	2a1. The system detects that "Automatic synchronization" option is not set in <i>Mobile System Settings</i> and shows "Main Mobile Form"
<b>(Business) Rules</b>	Only perform automatic synchronization if option is checked
<b>Quality Requirements</b>	<i>Security - Privacy:</i> - The automated synchronization process should only be invoked if the customer explicitly allowed it <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Data</b>	<i>Mobile System Settings</i> <i>E-Ticket</i>
<b>System Functions</b>	SF 4.8.2 Synchronize mobile device
<b>Post-Conditions</b>	Bus Driver is informed about current boarded E-Ticket holder count

<b>ID</b>	<b>UC 8.2</b>
<b>Name</b>	Edit settings
<b>Goal</b>	Edit the settings on the mobile device
<b>Actor</b>	Customer
<b>Precondition</b>	Mobile system is loaded and opened
<b>Description</b>	<ol style="list-style-type: none"> <li>1. Customer clicks on "Change settings".</li> <li>2. System shows "Change Mobile Settings Form".</li> <li>3. Customer edits "<i>Mobile Settings</i>" and confirms.</li> <li>4. System stores <i>Mobile Settings</i> in <i>Mobile System Data</i> and asks the user if a synchronization should be made</li> </ol>

	5. Customer confirms the synchronization 6. System synchronizes the mobile device and closes form and displays "Main Mobile Form"
Exception	5a1. Customer does not confirm the synchronization 5a2. System closes form
(Business) Rules	
Quality Requirements	<i>Efficiency - Usage Time/Query Time:</i> - The synchronization must not take longer than 10sec - Overall Task must not take longer than 60sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only display data that is absolutely necessary in order to change details and settings - The system should inform the user about the status of the update/synchronization process and invalid inputs <i>Security - Confidentiality/Privacy:</i> - The system must store the customer data in a way that not interferes privacy and data usage policies - The update process must be encrypted <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
Data	<i>Mobile System Settings</i>
System Functions	SF 4.8.2 Synchronize mobile device SF 4.8.3 Save mobile settings
Post-Conditions	Updated settings are stored on mobile device

ID	UC 8.3
Name	View E-Tickets
Goal	Display all E-Tickets, which are stored on mobile device
Actor	Customer
Precondition	Mobile system is loaded and opened
Description	1. Customer clicks on "Show E-Tickets". 2. System shows "E-Ticket List" with all <i>E-Tickets</i> stored on mobile device.
Exception	
(Business) Rules	
Quality Requirements	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 20sec

	<i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only display data that is absolutely necessary to see which tickets are available
Data	<i>E-Ticket</i>
System Functions	SF 8.3.1 Get stored E-Tickets
Post-Conditions	<i>E-Ticket list</i> is displayed

ID	UC 8.4
Name	View account details
Goal	Get information about current credit and account type
Actor	Customer
Precondition	Mobile system is loaded and opened
Description	1. Customer clicks on "View account details". 2. System shows account details.
Exception	
(Business) Rules	
Quality Requirements	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 20sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only display data that is absolutely necessary to see the relevant account details
Data	<i>Customer</i>
System Functions	SF 8.4.1 Get account information
Post-Conditions	The account information is displayed

ID	UC 8.5
Name	Synchronize mobile device
Goal	Synchronize the mobile system with the web system
Actor	Customer
Precondition	Mobile system is loaded and opened
Description	1. Customer clicks on "Synchronize". 2. System synchronizes <i>Settings</i> and <i>E-Ticket</i> with web system
Exception	
(Business) Rules	

<b>Quality Requirements</b>	<i>Efficiency - Usage Time/Query Time:</i> - The synchronization must not take longer than 10sec - Overall Task must not take longer than 20sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should inform the user about the status of the update/synchronization process <i>Security - Confidentiality/Privacy:</i> - The synchronization process must be encrypted <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Data</b>	<i>Mobile System Settings</i> <i>E-Ticket</i>
<b>System Functions</b>	SF 4.8.2 Synchronize mobile device
<b>Post-Conditions</b>	The mobile device is synchronized

<b>ID</b>	<b>UC 8.6</b>
<b>Name</b>	View Customer Information
<b>Goal</b>	Display Customer Information on mobile device
<b>Actor</b>	Customer
<b>Precondition</b>	Mobile system is loaded and opened
<b>Description</b>	1. Customer clicks on "View Route and Ticket Information". 2. System loads the <i>Customer Information</i> from the <i>Web System Data</i> and loads notification messages received by the mobile phone
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time/Query Time:</i> - The data retrieval must not take longer than 10sec - Overall Task must not take longer than 20sec <i>Usability - Suitability for the Task/Self-Descriptiveness:</i> - The system should only display data that is absolutely necessary to see potential problems for the customer
<b>Data</b>	<i>Customer Information</i>
<b>System Functions</b>	SF 8.6.1 Get customer information
<b>Post-Conditions</b>	Customer Information is displayed

**4.1.9 Manage Personnel**

<b>ID</b>	<b>UC 9.1</b>
<b>Name</b>	Update access to Web System
<b>Goal</b>	Information about Manager is retrieved from the external personnel management system
<b>Actor</b>	Personnel management system
<b>Precondition</b>	An update to the personnel management system was performed
<b>Description</b>	<ol style="list-style-type: none"><li>1. System fetches the information (user credentials) about Managers</li><li>2. System integrates the <i>User</i> data with the Managers</li></ol>
<b>Exception</b>	
<b>(Business) Rules</b>	Every Manager in personnel management system is also a Manager in web system
<b>Quality Requirements</b>	<i>Efficiency - Query Time / Usage Time:</i> <ul style="list-style-type: none"><li>- Overall Task must not take longer than 60sec</li><li>- The personnel query must not take longer than 40sec</li></ul> <i>Security - Confidentiality/Access+Authorization:</i> <ul style="list-style-type: none"><li>- The data exchange must be encrypted</li><li>- The personnel data must not be accessible by unauthorized and illegitimate entities</li></ul> <i>Reliability - Recoverability:</i> <ul style="list-style-type: none"><li>- The process must obey the ACID properties</li></ul>
<b>Data</b>	<i>Manager</i>
<b>System Functions</b>	SF 9.1.1 Integrate Manager
<b>Post-Conditions</b>	Managers of the personnel management system are integrated into the web system



## 4.2. System Functions

### 4.2.1. Accounting

<b>ID</b>	<b>SF 1.1.1</b>
<b>Name</b>	User authentication and authorization
<b>Input Data</b>	<i>User Credentials</i>
<b>Precondition</b>	<i>User data is available in Web System Data</i>
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system checks if the <i>User Credentials</i> match with the <i>User Credentials</i> of a <i>User</i> in the database.</li> <li>2. The system stores successful <i>User Authentication</i> attempt for the respective user.</li> </ol>
<b>Exception</b>	2a1. The system cannot find the matching user entry 2a.2. The system cannot create the <i>User Authentication</i>
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - Overall Task must not take longer than 20sec <i>Usability - Self-Descriptiveness:</i> - The system should inform the user about the status of the login process <i>Security - Confidentiality/Access+Authorization:</i> - The system must only allow access for legitimate entities - The login process must be encrypted
<b>Output Data</b>	<i>User Authentication</i>
<b>Post-Conditions</b>	The user credentials are checked and the respective <i>User Data</i> is retrieved

<b>ID</b>	<b>SF 1.1.2</b>
<b>Name</b>	Query Database
<b>Input Data</b>	<i>Query Data</i>
<b>Precondition</b>	Manager Authentication is available
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system prepares a database query for the provided <i>Query Data</i>.</li> <li>2. The system queries the database.</li> <li>3. The system processes the response and presents the results.</li> </ol>
<b>Exception</b>	

<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Response Time/ Usage Time:</i> - Query must not take longer than 2sec <i>Usability - Suitability for the task:</i> - The system should only display relevant query data <i>Security - Privacy/Access+Authorization:</i> - The displayed data must not violate customer privacy - The data should only be visible to authorized users
<b>Output Data</b>	<i>Query Data</i> result
<b>Post-Conditions</b>	<i>Query Data</i> result is shown

<b>ID</b>	<b>SF 1.1.3</b>
<b>Name</b>	Display Message
<b>Input Data</b>	Message
<b>Precondition</b>	
<b>Description</b>	1. The system shows the <i>Message</i> to the user.
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	
<b>Output Data</b>	
<b>Post-Conditions</b>	The <i>Message</i> is shown

<b>ID</b>	<b>SF 1.2.1</b>
<b>Name</b>	Recognize data not up to date
<b>Input Data</b>	<i>Query Data</i>
<b>Precondition</b>	Manager Authentication is available and a query request has been made
<b>Description</b>	1. The system checks whether the <i>Query Data</i> includes the current date. 2. The system checks whether the stored data is up to date by looking at the last <i>Synchronization</i> . 3. The system returns that the data is not up to date.
<b>Exception</b>	1a1. The query data does not affect the current date. 1a2. The system returns that the data is up to date. 2a1. The stored data is up to date.

	2a2. The system returns that the data is up to date.
(Business) Rules	
Quality Requirements	
Output Data	Yes/No
Post-Conditions	The stored data was checked if it is up to date

ID	SF 1.2.2
Name	Synchronize Bus System Data
Input Data	<i>Bus System Data, Web System Data</i>
Precondition	Data connection to bus available
Description	<ol style="list-style-type: none"> <li>1. The system retrieves the <i>Bus System Data</i>.</li> <li>2. The system integrates the <i>Bus System Data</i> into the <i>Web System Data</i>.</li> <li>3. The system integrates the <i>Web System Data</i> into the <i>Bus System Data</i>.</li> <li>4. The system stores synchronization information in <i>Synchronization</i>.</li> <li>5. The system creates and updates <i>Profiles</i> and <i>Notification Rules</i></li> </ol>
Exception	
(Business) Rules	
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - Transmission must not take longer than 40sec
Output Data	
Post-Conditions	The <i>Bus System Data</i> and <i>Web System Data</i> are synchronized.

#### 4.2.2. Bus Driver Instruction

ID	SF 2.1.1
Name	Manage E-Ticket Types
Input Data	<i>E-Ticket Type</i>
Precondition	Manager <i>Authentication</i> exists
Description	<ol style="list-style-type: none"> <li>1. The system checks whether the input <i>E-Ticket Type</i> is valid</li> <li>2. The system checks if the selected <i>E-Ticket Type</i> already exists in <i>Web System Data</i>.</li> </ol>

	3. The system adds the new <i>E-Ticket Type</i> to the <i>Web System Data</i>
Exception	<p>1a1. The system recognizes that the input <i>E-Ticket Type</i> is not valid</p> <p>1a2. The system returns an error</p> <p>2a1. The system deactivates the selected <i>E-Ticket Type</i></p> <p>2b1. The system updates the selected <i>E-Ticket Type</i> with the new ticket data</p>
(Business) Rules	No duplicate <i>E-Ticket Type</i> are allowed
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - Saving must not take longer than 2sec
Output Data	
Post-Conditions	Update to the <i>E-Ticket Type</i> is made

ID	SF 2.2.1
Name	Manage Customer Information
Input Data	<i>Customer Information</i>
Precondition	Manager <i>Authentication</i> exists
Description	<p>1. The system checks whether the input <i>Customer Information</i> is valid</p> <p>2. The system checks if the selected <i>Customer Information</i> already exists in <i>Web System Data</i>.</p> <p>3. The system adds the new <i>Customer Information</i> to the <i>Web System Data</i></p>
Exception	<p>1a1. The system recognizes that the input <i>Customer Information</i> is not valid</p> <p>1a2. The system returns an error</p> <p>2a1. The system deactivates the selected <i>Customer Information</i></p> <p>2b1. The system updates the selected <i>Customer Information</i> with the new ticket data</p>
(Business) Rules	
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - Saving must not take longer than 2sec
Output Data	
Post-Conditions	Update to the <i>Customer Information</i> is made

### 4.2.3. Bus System Operation

ID	SF 3.1.1
Name	Confirm connection establishment
Input Data	<i>Mobile System Settings</i>
Precondition	
Description	<ol style="list-style-type: none"> <li>1. The system checks if "Always allow connection" option in <i>Mobile System Settings</i> is set.</li> <li>2. The system confirms the connection establishment.</li> </ol>
Exception	2a1. The system disallows the connection establishment.
(Business) Rules	The system must not confirm connection establishment if option is not set.
Quality Requirements	<i>Security - Privacy/Access+Authorization:</i> - The system is only allowed to auto-connect if user explicitly allowed it via respective settings
Output Data	Yes/No
Post-Conditions	The connection establishment was confirmed

ID	SF 3.2.1
Name	Perform E-Ticket Payment
Input Data	<i>E-Ticket Type, Customer</i>
Precondition	
Description	<ol style="list-style-type: none"> <li>1. The system checks if <i>Customer's</i> credit is sufficient to pay for selected <i>E-Ticket Type</i>.</li> <li>2. The system debits the account.</li> <li>3. The system creates the <i>E-Ticket</i>.</li> <li>4. The system stores a <i>Transaction</i> in the <i>Bus System Data</i>.</li> <li>5. The system stores a <i>Trip</i> in the <i>Bus System Data</i>.</li> </ol>
Exception	1a1. The system recognizes insufficient credit of <i>Customer</i> . 1a2. The system stores a <i>Transaction</i> in the <i>Bus System Data</i>
(Business) Rules	The credit of the <i>Customer</i> must be positive to be sufficient.
Quality Requirements	<i>Efficiency - Transmission Time/ Usage Time:</i> - The transmission must not take longer than 5sec

	<i>Usability - Suitability for the task/Self-Descriptiveness:</i> <ul style="list-style-type: none"> <li>- The system should only display available tickets</li> <li>- The system must display all information important to the customer (prices, expiring time, usage time,...)</li> <li>- The system must inform the customer about the status of the purchasing/payment process</li> </ul>
Output Data	<i>E-Ticket</i>
Post-Conditions	The Customer has a valid E-Ticket.

ID	SF 3.2.2
Name	Inform Bus Driver
Input Data	
Precondition	A ticket payment or checking process has finished.
Description	<ol style="list-style-type: none"> <li>1. The system recognizes a successful payment or checking process.</li> <li>2. The system signals that Customer is allowed to enter bus.</li> </ol>
Exception	1a1. The system recognizes a failed payment or checking process. 1a2. The system signals that the Customer is not allowed to enter bus.
(Business) Rules	The <i>Customer</i> must not enter bus without previous allowance by the system or the Bus Driver.
Quality Requirements	
Output Data	
Post-Conditions	The Customer is allowed to enter the bus.

ID	SF 3.2.3
Name	Inform Customer
Input Data	<i>Mobile System Settings</i>
Precondition	A ticket payment process has finished successfully.
Description	<ol style="list-style-type: none"> <li>1. The system recognizes that the "SMS Payment Notification" option is set.</li> <li>2. The system sends SMS to Customer.</li> </ol>
Exception	1a1. The system recognizes that the "SMS Payment Notification" option is not set.

(Business) Rules	The <i>Customer</i> must always be informed about payment process if option is set.
Quality Requirements	
Output Data	
Post-Conditions	The Customer is informed about payment process.

ID	SF 3.2.4
Name	Check E-Ticket
Input Data	
Precondition	The connection establishment was confirmed.
Description	1. The system recognizes that Customer has at least one <i>E-Ticket</i> .
Exception	1a1. The system recognizes that Customer has no <i>E-Ticket</i> .
(Business) Rules	
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - Checking must not take longer than 2sec - The transmission must not take longer than 5sec
Output Data	Yes / No
Post-Conditions	The Customer has at least one <i>E-Ticket</i> .

ID	SF 3.2.5
Name	Check E-Ticket validity
Input Data	<i>E-Ticket</i>
Precondition	The Customer has at least one <i>E-Ticket</i> .
Description	1. The system searches for one valid <i>E-Ticket</i> belonging to the Customer. 2. The system recognizes a valid <i>E-Ticket</i> . 3. The system stores a <i>Trip</i> in the <i>Bus System Data</i> .
Exception	1a1. The system does not find a valid <i>E-Ticket</i> .
(Business) Rules	
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function must not take longer than 2sec
Output Data	
Post-Conditions	The Customer has a valid <i>E-Ticket</i> and <i>Trip</i> is logged.

<b>ID</b>	<b>SF 3.3.1</b>
<b>Name</b>	Update Trip
<b>Input Data</b>	<i>Route, Bus to Route, Bus Stop, Bus, Trip</i>
<b>Precondition</b>	The <i>Trip</i> already exists in the data
<b>Description</b>	1. The system saves the information of <i>Route, Bus to Route, Bus Stop and Bus</i> into the <i>Trip</i> as start information.
<b>Exception</b>	1a1. The system recognizes that the <i>Trip</i> has already information about the start and saves the <i>Route, Bus to Route, Bus Stop and Bus</i> into <i>Trip</i> as end information
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	
<b>Output Data</b>	
<b>Post-Conditions</b>	The <i>Trip</i> was updated.

#### 4.2.4. Customer Information

<b>ID</b>	<b>SF 4.2.1</b>
<b>Name</b>	Create Customer account
<b>Input Data</b>	<i>Customer, Credit Card, Settings, User</i>
<b>Precondition</b>	
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system validates new <i>Customer, Credit Card</i> and <i>Settings</i> data.</li> <li>2. The system stores <i>Customer, Credit Card</i> and <i>Settings</i> data.</li> <li>3. The system stores successful <i>User Authentication</i> attempt for the respective user.</li> </ol>
<b>Exception</b>	<p>1a1. The system recognizes that the new <i>Customer</i> already exists.</p> <p>1b1. The system recognizes that the new <i>Customer</i> is invalid.</p>
<b>(Business) Rules</b>	<i>Credit Card</i> must not necessarily be inserted.
<b>Quality Requirements</b>	<p><i>Efficiency - Response- / Usage- / Transmission Time:</i></p> <ul style="list-style-type: none"> <li>- This system function must not take longer than 2sec</li> </ul> <p><i>Security - Confidentiality/Privacy:</i></p> <ul style="list-style-type: none"> <li>- The system must store the customer data in a way</li> </ul>



	that not interferes privacy and data usage policies - The account creation process must be encrypted <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Output Data</b>	<i>User Authentication</i>
<b>Post-Conditions</b>	A new Customer is registered and authorized with the system.

<b>ID</b>	<b>SF 4.3.1</b>
<b>Name</b>	Manage Notification Rules
<b>Input Data</b>	<i>Notification Rule</i>
<b>Precondition</b>	<i>User Authentication</i> is available in system.
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system checks whether the input <i>Notification Rule</i> is valid</li> <li>2. The system checks if the selected <i>Notification Rule</i> already exists in <i>Web System Data</i>.</li> <li>3. The system adds the new <i>Notification Rule</i> to the <i>Web System Data</i></li> <li>4. The system checks if "Receive Notification Option" is set and returns the result</li> </ol>
<b>Exception</b>	<p>1a1. The system recognizes that the input <i>Notification Rule</i> is not valid</p> <p>1a2. The system returns an error</p> <p>2a1. The system deletes the selected <i>Notification Rule</i></p> <p>2b1. The system updates the selected <i>Notification Rule</i></p>
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function must not take longer than 2sec <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Output Data</b>	Yes / No
<b>Post-Conditions</b>	Changes to <i>Notification Rule</i> have been executed.

<b>ID</b>	<b>SF 4.5.1</b>
<b>Name</b>	Display E-Ticket Transaction list
<b>Input Data</b>	<i>Transaction</i>
<b>Precondition</b>	<i>User Authentication</i> is available in system.

<b>Description</b>	1. The system displays list of stored <i>Transaction</i> .
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function must not take longer than 2sec
<b>Output Data</b>	
<b>Post-Conditions</b>	All stored Transactions have been displayed.

<b>ID</b>	<b>SF 4.6.1</b>
<b>Name</b>	Recharge
<b>Input Data</b>	<i>Transaction</i>
<b>Precondition</b>	<i>User Authentication</i> is available in system.
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system validates the amount of the <i>Transaction</i>.</li> <li>2. The system invokes the external payment service</li> <li>3. The system gets success response from external payment service</li> <li>4. The system stores successful payment in <i>Transaction</i>.</li> </ol>
<b>Exception</b>	1a1. The system recognizes invalid amount 1a2. The system returns an error 3a1. The system gets an failed response from external payment system 3a2. The system returns an error
<b>(Business) Rules</b>	The amount must be positive.
<b>Quality Requirements</b>	<i>Security - Confidentiality/Access+Authorization:</i> - The recharge process must be encrypted - The recharge process can only be invoked by authorized customers <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Output Data</b>	
<b>Post-Conditions</b>	The <i>Recharge Transaction</i> was executed successfully.

<b>ID</b>	<b>SF 4.7.1</b>
<b>Name</b>	Update Customer account
<b>Input Data</b>	<i>Customer, Credit Card, Settings, User</i>

<b>Precondition</b>	<i>User Authentication</i> is available in system.
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system checks that <i>User Authentication</i> fits to the to be updated <i>Customer</i>, <i>Credit Card</i> and <i>Settings</i> data.</li> <li>2. The system validates to be updated <i>Customer</i>, <i>Credit Card</i> and <i>Settings</i> data.</li> <li>3. The system updates <i>Customer</i>, <i>Credit Card</i> and <i>Settings</i> data.</li> </ol>
<b>Exception</b>	<p>1a1. The system recognizes that <i>User Authentication</i> does not fit to the to be updated <i>Customer</i>, <i>Credit Card</i> and <i>Settings</i> data.</p> <p>1a2. The system returns an error.</p> <p>2a1. The system recognizes that the to be updated <i>Customer</i> is invalid.</p>
<b>(Business) Rules</b>	Customer is only allowed to change his own settings.
<b>Quality Requirements</b>	<p><i>Efficiency - Response- / Usage- / Transmission Time:</i></p> <ul style="list-style-type: none"> <li>- This system function must not take longer than 2sec</li> </ul> <p><i>Security</i></p> <ul style="list-style-type: none"> <li>-</li> </ul> <p><i>Confidentiality/Privacy/Access+Authentication:</i></p> <ul style="list-style-type: none"> <li>- The system must store the customer data in a way that not interferes privacy and data usage policies</li> <li>- The update process must be encrypted</li> <li>- The update process can only be invoked by the respective authorized customer</li> </ul> <p><i>Reliability - Recoverability:</i></p> <ul style="list-style-type: none"> <li>- The process must obey the ACID properties</li> </ul>
<b>Output Data</b>	
<b>Post-Conditions</b>	The Customer Data was updated successfully.

<b>ID</b>	<b>SF 4.8.1</b>
<b>Name</b>	Send Installer Link to mobile phone
<b>Input Data</b>	<i>Customer</i>
<b>Precondition</b>	<i>User Authentication</i> is available in system.
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system sends Installer Link to mobile phone</li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	The sending can be done via e.g. SMS, QR code or email.
<b>Quality</b>	<i>Security - Confidentiality/Access+Authorization:</i>

<b>Requirements</b>	<ul style="list-style-type: none"> <li>- The notification function can only be invoked by authorized and legitimate customers</li> </ul> <i>Reliability - Recoverability:</i> <ul style="list-style-type: none"> <li>- The system must offer a possibility to resend the sms</li> </ul>
<b>Output Data</b>	
<b>Post-Conditions</b>	The Customer has information how to install the mobile system.

<b>ID</b>	<b>SF 4.8.2</b>
<b>Name</b>	Synchronize mobile device
<b>Input Data</b>	<i>Customer, Settings, E-Ticket</i>
<b>Precondition</b>	<i>User Authentication</i> is available in system.
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system integrates data from the <i>Web System Data</i> into the <i>Mobile System Data</i></li> <li>2. The system integrates data from the <i>Mobile System Data</i> into the <i>Web System Data</i></li> <li>3. The system stores the synchronization information in <i>Mobile Synchronization</i> in <i>Web System Data</i></li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	If there is a conflict while synchronizing, the newer version of the <i>Settings</i> must be integrated. Only Season <i>E-Tickets</i> must be synchronized.
<b>Quality Requirements</b>	<i>Security - Confidentiality/Access+Authorization:</i> <ul style="list-style-type: none"> <li>- The mobile system login process must be encrypted</li> <li>- The synchronization process must be encrypted</li> </ul> <i>Reliability - Recoverability:</i> <ul style="list-style-type: none"> <li>- The synchronization process must fulfill the ACID properties</li> </ul>
<b>Output Data</b>	
<b>Post-Conditions</b>	The <i>Web System Data</i> and the <i>Mobile System Data</i> are synchronized and information about the synchronization process is stored.

<b>ID</b>	<b>SF 4.8.3</b>
<b>Name</b>	Save mobile settings
<b>Input Data</b>	<i>Mobile System Settings</i>
<b>Precondition</b>	

Description	1. The system saves the <i>Mobile System Settings</i> in <i>Mobile System Data</i>
Exception	
(Business) Rules	
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function must not take longer than 2sec
Output Data	
Post-Conditions	The <i>Mobile System Settings</i> are stored in <i>Mobile System Data</i>

ID	SF 4.9.1
Name	Register E-Ticket token
Input Data	<i>E-Ticket Token</i>
Precondition	<i>User Authentication</i> is available in system.
Description	1. The system verifies the <i>E-Ticket Token</i> 2. The system creates a new <i>E-Ticket</i> for the season ticket 3. The system stores new <i>E-Ticket</i> 4. The system invalidates the <i>E-Ticket Token</i>
Exception	1a1. The system recognizes that the verification failed. 1a2. The system returns an error.
(Business) Rules	An <i>E-Ticket Token</i> must not be used more than once.
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function must not take longer than 2sec <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
Output Data	<i>E-Ticket</i>
Post-Conditions	A new E-Ticket for the season ticket exists.

#### 4.2.5. Handle Route Problems

ID	SF 5.1.1
Name	Calculate utilization information
Input Data	<i>Query Data, Profile</i>
Precondition	<i>Manager Authentication</i> is available in system.
Description	1. The system checks if data is up to date for <i>Query</i>

	<i>Data</i> (SF 1.2.1) 2. The system queries the database (SF 1.1.2) 3. The system loads the Customer Profiles. 4. The system accumulates the Profiles and the Query and calculates utilization and stores it into <i>Utilization Data</i>
Exception	1a1. The system recognizes that data is not up to date 1a2. The system synchronizes affected busses (SF 1.2.2) 1a3. Go on with SF 5.1.1.2
(Business) Rules	If data is queried for current situation, a synchronization with all busses is necessary.
Quality Requirements	
Output Data	<i>Utilization Data</i>
Post-Conditions	Utilization information is calculated.

ID	SF 5.1.2
Name	Retrieve Routes
Input Data	
Precondition	<i>Manager Authentication</i> is available in system.
Description	1. The system connects to the Route Planning System 2. The system retrieves all <i>Route</i> , <i>Bus Stop</i> , <i>Bus to Route</i> and <i>Bus</i> data.
Exception	
(Business) Rules	
Quality Requirements	<i>Reliability - Recoverability:</i> - The system function must obey the ACID properties
Output Data	<i>Route</i> <i>Bus Stop</i> <i>Bus to Route</i> <i>Bus</i>
Post-Conditions	Information from the Route Planning System is loaded into the system

ID	SF 5.3.1
Name	Retrieve affected Customers

<b>Input Data</b>	<i>Customer, Notification Rule, Route</i>
<b>Precondition</b>	<i>Manager Authentication</i> is available in system.
<b>Description</b>	1. The system retrieves all <i>Customer(s)</i> having at least one <i>Notification Rule</i> matching the updated route
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function must not take longer than 2sec
<b>Output Data</b>	
<b>Post-Conditions</b>	All affected Customers are retrieved.

<b>ID</b>	<b>SF 5.3.2</b>
<b>Name</b>	Notify Customers
<b>Input Data</b>	<i>Customer</i>
<b>Precondition</b>	<i>Manager Authentication</i> is available in system.
<b>Description</b>	1. The system notifies all <i>Customer(s)</i> from input data.
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Security - Privacy/Access+Authorization:</i> - The notification function can only be invoked by authorized and legitimate managers - The system should only notify/display customers that explicitly allowed notifications <i>Reliability - Recoverability:</i> - The system must offer a possibility to resend the notification
<b>Output Data</b>	
<b>Post-Conditions</b>	All customers from input data are notified.

<b>ID</b>	<b>SF 5.3.3</b>
<b>Name</b>	Detect potential problem
<b>Input Data</b>	<i>Web System Data</i>
<b>Precondition</b>	The data storage was synchronized between <i>Bus System Data</i> and <i>Web System Data</i>
<b>Description</b>	1. The system analyzes the <i>Web System Data</i> for potential inconsistencies and problems

	2. The system reports problems via Email to the Manager
Exception	2a1. The system did not detect any problems.
(Business) Rules	Inconsistencies and problems may be defined by rules and patterns
Quality Requirements	<i>Efficiency - Response- / Usage- / Transmission Time:</i> - This system function should not use more than 10 % of system resources
Output Data	
Post-Conditions	Potential Problems are reported to the Manager

#### 4.2.6. Transportation

ID	SF 6.1.1
Name	Get E-Ticket passenger count
Input Data	<i>Trip</i>
Precondition	Bus System is loaded
Description	1. The system calculates the passenger count by looking at the <i>Trips</i> 2. The system displays the passenger count
Exception	
(Business) Rules	
Quality Requirements	<i>Security - Privacy:</i> - The system should only display an anonymous passenger count, not any specific personal data
Output Data	
Post-Conditions	The E-Ticket count is displayed

#### 4.2.7. Ticket Management

ID	SF 7.1.1
Name	Token Creation
Input Data	<i>Season Ticket Data</i>
Precondition	
Description	1. System creates a unique <i>Token</i> based on the <i>Season Ticket Data</i> 2. The system stores the <i>Token</i> in <i>Web System Data</i> 3. System creates a new unique <i>Token</i> and stores the



	Token
Exception	
(Business) Rules	
Quality Requirements	<i>Efficiency - Usage Time:</i> - System function must not take longer than 2sec <i>Security - Confidentiality:</i> - The token must be generated in a way that makes it extremely difficult to reproduce via e.g. brute forcing <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
Output Data	Token
Post-Conditions	A unique <i>Token</i> is created and stored

ID	SF 7.2.1
Name	Manage Customer
Input Data	<i>Customer, Credit Card, Transaction</i>
Precondition	A <i>User Authentication</i> for the Manager exists
Description	1. The system verifies the changes on <i>Customer, Credit Card, Transaction</i> 2. The system updates changes on <i>Customer, Credit Card, Transaction</i> 3. The system stores the changes
Exception	1a1. System recognizes invalid changes 1a2. System returns an error
(Business) Rules	
Quality Requirements	<i>Efficiency - Usage Time:</i> - System function must not take longer than 2sec <i>Security - Privacy/Access+Authorization:</i> - The customers personal data must not be accessible to illegitimate entities - The manager should only have access to the customers' personal data that is absolutely necessary to perform the respective task <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
Output Data	
Post-Conditions	<i>Customer, Credit Card, Transaction</i> is updated

**4.2.8. Mobile Device Usage**

<b>ID</b>	<b>SF 8.3.1</b>
<b>Name</b>	Get stored E-Tickets
<b>Input Data</b>	
<b>Precondition</b>	
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system fetches stored <i>E-Tickets</i> from <i>Mobile System Data</i></li> <li>2. The system returns the <i>E-Tickets</i></li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - System function must not take longer than 2sec
<b>Output Data</b>	<i>E-Ticket</i>
<b>Post-Conditions</b>	E-Tickets were retrieved

<b>ID</b>	<b>SF 8.4.1</b>
<b>Name</b>	Get account information
<b>Input Data</b>	
<b>Precondition</b>	
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system loads <i>Customer</i> from the <i>Mobile System Data</i></li> <li>2. The system calculates the credit and the account type</li> <li>3. The system returns the credit and the account type</li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - System function must not take longer than 2sec
<b>Output Data</b>	<i>Customer</i>
<b>Post-Conditions</b>	Information about the account is retrieved

<b>ID</b>	<b>SF 8.6.1</b>
<b>Name</b>	Get customer information

<b>Input Data</b>	
<b>Precondition</b>	
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system loads <i>Customer Information</i> from the <i>Web System Data</i></li> <li>2. The system returns the <i>Customer Information</i></li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Usage Time:</i> - System function must not take longer than 2sec
<b>Output Data</b>	<i>Customer Information</i>
<b>Post-Conditions</b>	The customer information is returned

#### 4.2.9. Manage Personnel

<b>ID</b>	<b>SF 9.1.1</b>
<b>Name</b>	Integrate Manager
<b>Input Data</b>	
<b>Precondition</b>	A connection to the personnel management system exists
<b>Description</b>	<ol style="list-style-type: none"> <li>1. The system fetches Manager from personnel management system</li> <li>2. The system retrieves the user credentials from the Manager list.</li> <li>3. The system integrates the Manager into the <i>User</i> database of the <i>Web System Data</i></li> </ol>
<b>Exception</b>	
<b>(Business) Rules</b>	
<b>Quality Requirements</b>	<i>Efficiency - Query Time / Usage Time:</i> - System function must not take longer than 40sec <i>Security - Confidentiality/Access+Authorization:</i> - The data exchange must be encrypted - The personnel data must not be accessible by unauthorized and illegitimate entities <i>Reliability - Recoverability:</i> - The process must obey the ACID properties
<b>Output Data</b>	<i>Manager</i>
<b>Post-Conditions</b>	All Manager are integrated into the <i>Web System Data</i>



### 4.3. Interaction Data

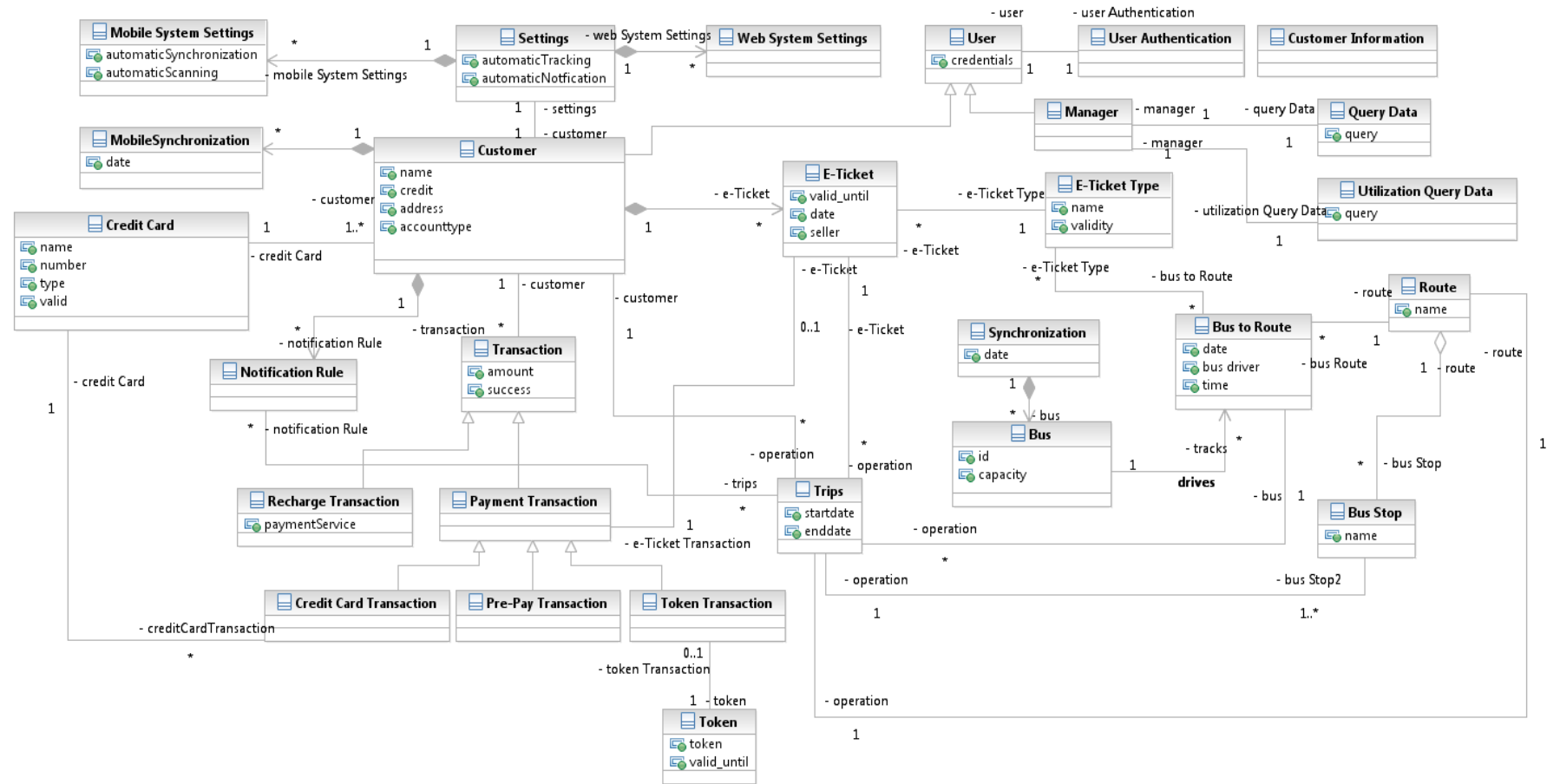


Figure 27: Interaction Data

#### 4.4. UI-Structure

One of the main design goals of our system is the attempt to make the graphical user interfaces of the sub systems as intuitively and efficiently usable as possible. Therefore quality goals regarding usability and user experience are highly important for the overall system and will be addressed in the architecture of the subsystems and the design of the corresponding user interfaces.

In the following an overview of the most important usability quality requirements is given along with a description how they are addressed in the GUI design:

1. **Suitability for the task:**

To enable an efficient and intuitive usage of the graphical user interfaces the system should only provide data and information that are really necessary to perform the specific task it should support the user with. Therefore *information overload* as well as *lack of information* should be avoided wherever possible. To cope with this requirement, our user interfaces are designed in a way that minimizes unnecessary and potentially distracting information overload by using a task-oriented menu and dialogues structure.

2. **Self-Descriptiveness:**

In many scenarios where our subsystems are used to perform and support specific tasks like e.g. buying a ticket the time needed to operate a part of the system via the graphical user interface has to be very low. To address this crucial requirement the elements of the graphical user interfaces of our system have to be *self-explanatory* and intuitively understandable to avoid a waste of time due to problems in understanding the meaning of an element. Therefore the GUIs of our subsystems use comprehensible and self-describing icon language as well as adequate feedback methods for invoked actions.

3. **Controllability:**

If the menu structure and navigation of an graphical user interface is too complex and obscure, the user can easily get lost and frustrated resulting in a bad user experience and delayed reaction times. To avoid these problems our user interface design focuses on establishing a clear and easily *understandable*, *traceable* menu structure and *navigation support* which supports the user to perform the tasks in a convenient way.

#### 4. Conformity with the user expectations

One of the biggest threats to usability are graphical user interfaces and elements that do not behave like the user expects them to behave. Examples for this are GUIs that do not obey common style guides and design guidelines or GUIs that use inconsistent element icons, actions or descriptions. To avoid this problem our user interface design focuses on providing a high *consistency* of GUI elements during the application flow.

##### 4.4.1. Bus Driver UI

Bus Driver UI

<p><b>Purpose:</b> Show number of boarded Customers and pictures of entering Customers</p> <p><b>Data:</b> -</p> <p><b>Function:</b>                      Display passenger count                      Display Customer photo</p>
---

**Figure 28: UI Structure – Bus Driver UI**

## 4.4.2. Manager UI

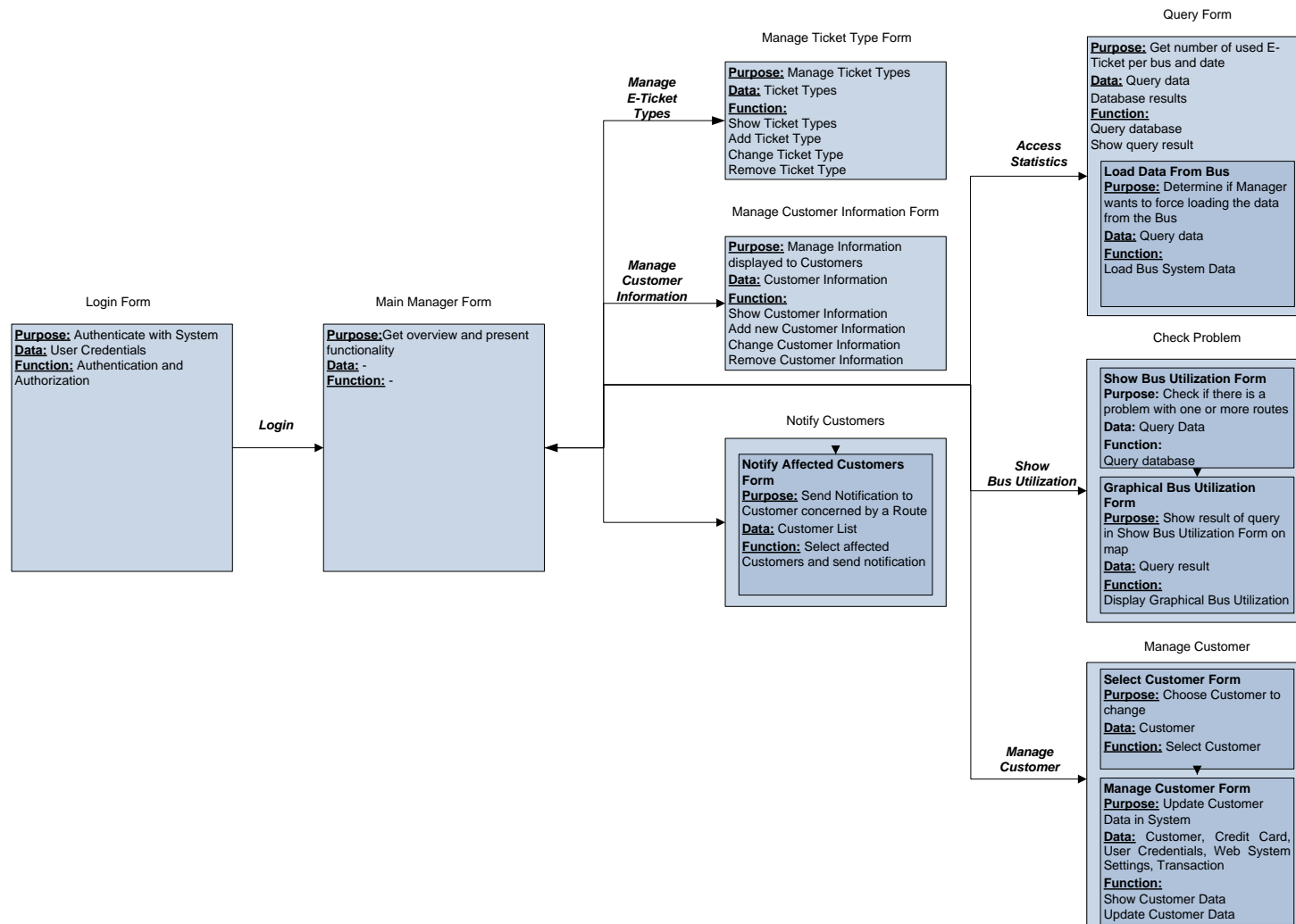


Figure 29: UI Structure – Manager UI



### 4.4.3. Customer Web UI

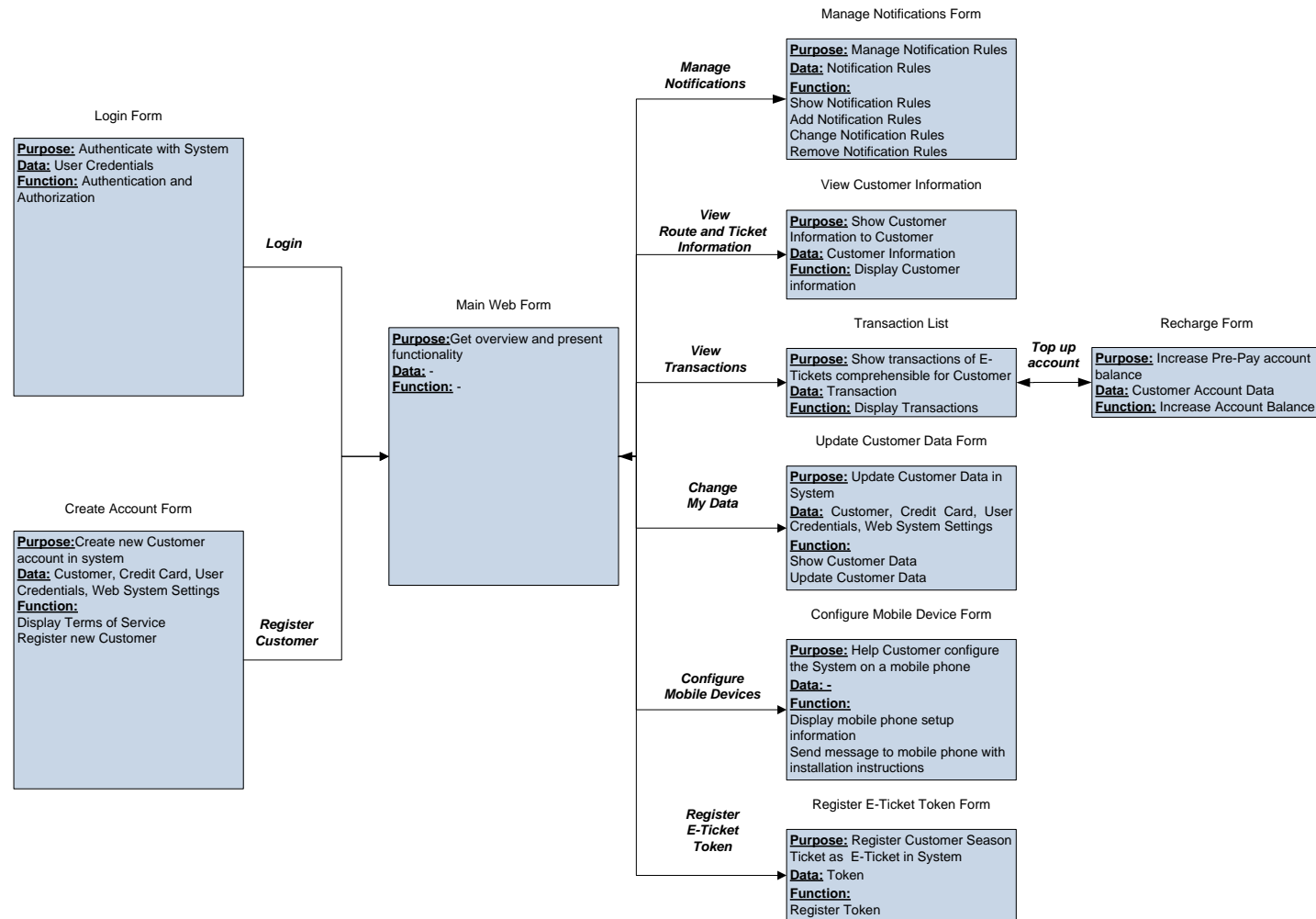


Figure 30: UI Structure – Customer Web UI

#### 4.4.4. Customer Mobile Device UI

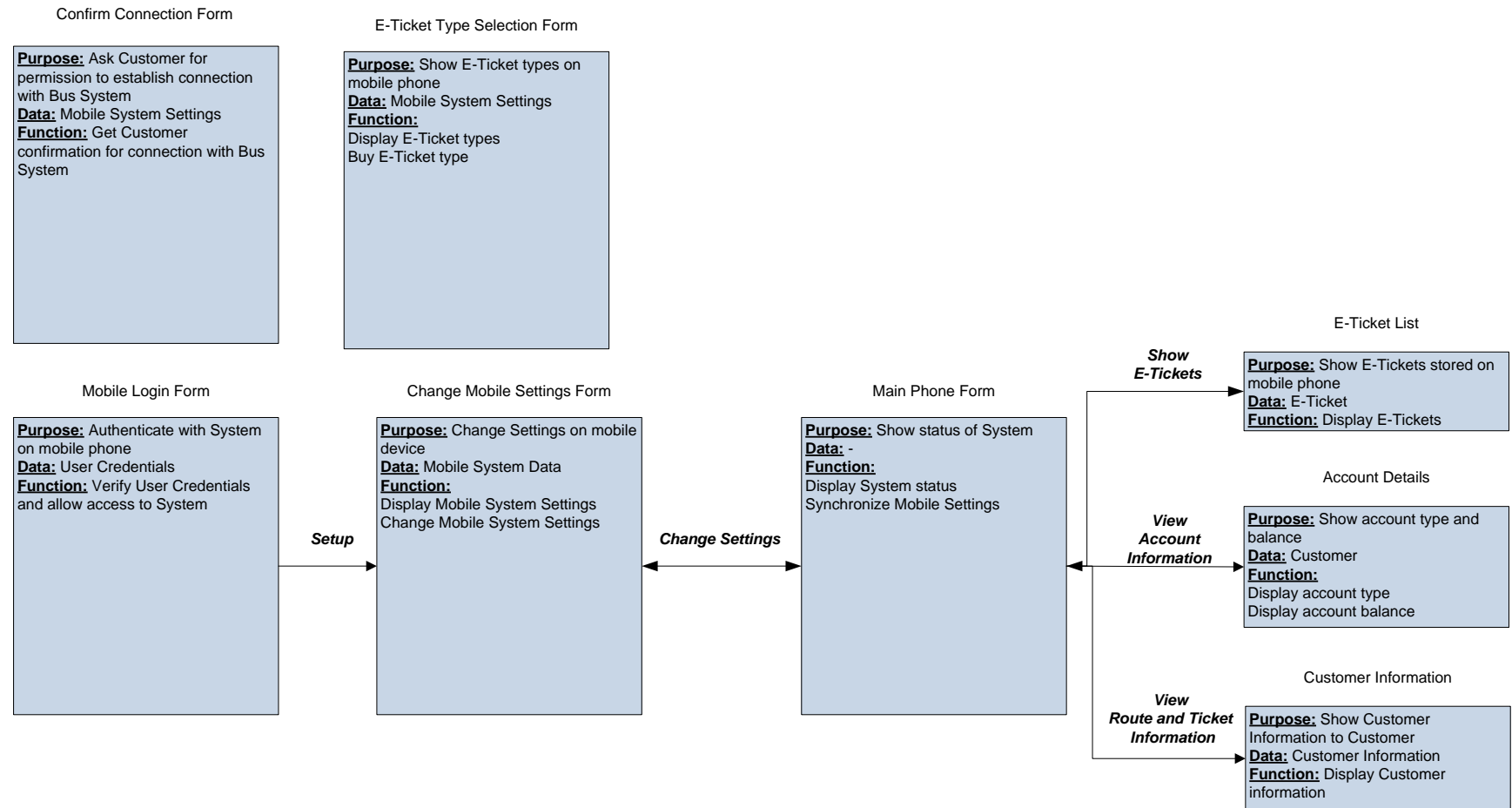


Figure 31: UI Structure – Customer Mobile Device UI

## 5. Appendix

### 5.1. Traceability

#### 5.1.1. As-Is Task EPC Matrix

Goals			TaskID	Task	EPC
QG 1.1	FG 1.1		T 1.1	Instruct Bus Driver	Bus Driver Instruction
			T 1.2	Manage ticket pool	Bus Driver Instruction
QG 1.1, QG 1.2, QC 1.4	FG 1.2		T 1.3	Update routes	Route
			T 1.4	Access statistics	Route
			T 1.5	Advice Bus Driver	Route
			T 1.10	Manage personnel responsibilities	Personnel
QG 1.1, QG 1.3, QG 1.4	FG 1.3		T 1.6	Manage season tickets	Ticket Management
			T 1.7	Manage Bus Driver accounting	Ticket Management
QG 1.3	FG 1.4		T 1.8	Propagate information to Customer	Route, Bus Driver Instruction
			T 1.9	Manage Customer accounts	Ticket Management
QG 2.1	QG 2.1.1, QG 2.1.2	FG 2.1	T 2.1	Report problem	Route
			T 2.2	Retrieve advisory	Route
QG 2.1, QC 2.2	QG 2.1.1, QG 2.1.2	FG 2.2	T 2.3	Check passenger capacity	Transport
			T 2.4	Use devices	Transport
QG 2.2, QG 2.3	FG 2.3		T 2.5	Check ticket	Transport
			T 2.6	Bill customer	Transport
QG 3.1, QG 3.2, QG 3.3, QG 3.4	FG 3.1		T 3.1	Query information	Customer information
QG 3.2, QG 3.3	FG 3.2		T 3.2	Buy ticket	Transport, Ticket Management, Customer Information

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			T 3.3	Pay ticket	Transport
QG 3.2, QG 3.3, QG 3.4	FG 3.3		T 3.4	Enter bus	Transport

### 5.1.2. To-Be Task EPC Matrix

Goals			TaskID	Task	EPC
QG 1.1	FG 1.1		T 1.1	Instruct Bus Driver	Bus Driver Instruction
			T 1.2	Manage ticket pool	Bus Driver Instruction
QG 1.1, QG 1.2, QC 1.4	FG 1.2		T 1.3	Update routes	Route
			T 1.4	Access statistics	Route
			T 1.5	Advice Bus Driver	Route
			T 1.10	Manage personnel responsibilities	Personnel
QG 1.1, QG 1.3, QG 1.4	FG 1.3		T 1.6	Manage season tickets	Ticket Management
			T 1.7	Manage Bus Driver accounting	Ticket Management
QG 1.3	FG 1.4		T 1.8	Propagate information to Customer	Route, Bus Driver Instruction
			T 1.9	Manage Customer accounts	Ticket Management
QG 2.1	QG 2.1.1, QG 2.1.2	FG 2.1	T 2.1	Report problem	Route
			T 2.2	Retrieve advisory	Route
QG 2.1, QC 2.2	QG 2.1.1, QG 2.1.2	FG 2.2	T 2.3	Check passenger capacity	Transport
			T 2.4	Use devices	Transport
QG 2.2, QG 2.3	FG 2.3		T 2.5	Check ticket	Transport
			T 2.6	Bill customer	Transport
QG 3.1, QG 3.2, QG 3.3, QG 3.4	FG 3.1		T 3.1	Query information	Customer information, Mobile Device
QG 3.2, QG 3.3	FG 3.2		T 3.2	Buy ticket	Transport, Ticket Management, Customer Information, Bus System Operation
			T 3.3	Pay ticket	Transport, Bus System Operation
QG 3.2, QG 3.3, QG 3.4	FG 3.3		T 3.4	Enter bus	Transport, Bus System Operation

### 5.1.3. EPC Use Case Matrix

EPC	Function	Use Case ID	Use Case Name	Function ID	Function Name
Accounting	Count E-Tickets	UC 1.1	Count E-Tickets	SF 1.1.1	User authentication and authorization
				SF 1.1.2	Query database
				SF 1.1.3	Display Message
		UC 1.2	Query Bus Data	SF 1.1.2	Query database
				SF 1.1.3	Display Message
				SF 1.2.1	Recognize data not up to date
	Count E-Tickets	UC 1.4	Authenticate with system	SF 1.2.2	Synchronize Bus System Data
				SF 1.1.1	User authentication and authorization
Bus Driver Instruction	Update ticket pool	UC 2.1	Update ticket pool	SF 1.1.1	User authorization
	Check ticket update			SF 1.1.3	Display Message
	Update customer information	UC 2.2	Update customer information	SF 2.1.1	Manage ticket types
				SF 1.1.1	User authorization
				SF 1.1.3	Display Message
				SF 2.2.1	Manage customer information
Bus System	Decide whether to allow scanning	UC 3.1	Communication confirmation	SF 3.1.1	Confirm connection establishment
	Debit E-Ticket	UC 3.2	Buy E-Ticket	SF 3.2.1	Perform E-Ticket payment
				SF 3.2.2	Inform Bus Driver
				SF 3.2.3	Inform Customer
	Store boarding details	UC 3.3	Store boarding details	SF 5.1.2	Retrieve Routes
				SF 3.3.1	Update Trip
Customer Information	Register with Web System	UC 4.1	Authenticate with Web System	SF 1.1.1	User authentication and authorization
				SF 1.1.3	Display Message
		UC 4.2	Register new Customer	SF 1.1.3	Display Message
				SF 4.2.1	Create Customer account

	Manage notifications	UC 4.3	Manage notifications	SF 1.1.3	Display Message
				SF 4.3.1	Manage Notification Rules
	Get route information	UC 4.4	View information	SF 1.1.3	Display Message
	Get ticket information				
	Show transactions	UC 4.5	View transactions	SF 4.5.1	Display E-Ticket Transaction list
	Top up account balance	UC 4.6	Top up account balance	SF 1.1.3	Display Message
				SF 4.6.1	Recharge
	Update Customer data	UC 4.7	Update Customer data	SF 1.1.3	Display Message
				SF 4.7.1	Update Customer account
	Configure mobile device	UC 4.8	Configure mobile device	SF 1.1.1	User authentication and authorization
				SF 1.1.3	Display Message
				SF 4.8.1	Send Installer Link to mobile phone
				SF 4.8.2	Synchronize mobile device
				SF 4.8.3	Save mobile settings
	Register E-Ticket token	UC 4.9	Register E-Ticket token	SF 1.1.3	Display Message
				SF 4.8.2	Synchronize mobile device
				SF 4.9.1	Register E-Ticket token
	Increase E-Ticket credit	UC 4.10	External payment request	SF 4.6.1	Recharge
Route	Check Problem	UC 5.1	Check Problem	SF 1.2.2	Synchronize Bus System Data
				SF 5.1.1	Calculate utilization information
				SF 5.1.2	Retrieve Routes
	Find out affected Customers	UC 5.3	Notify affected Customers	SF 5.1.2	Retrieve Routes
				SF 5.3.1	Retrieve affected customers
Transportation	Check passenger capacity	UC 6.1	Check passenger capacity	SF 6.1.1	Get E-Ticket passenger count
Ticket Management	Create E-Ticket token	UC 7.1	Create E-Ticket Token	SF 7.1.1	Token creation
	Update Customer	UC 7.2	Update Customer	SF 1.1.3	Display Message
				SF 7.2.1	Manage Customer

Mobile Device Usage	Customer opens mobile application	UC 8.1	Customer opens mobile application	SF 4.8.2	Synchronize mobile device
	Edit settings	UC 8.2	Edit settings	SF 4.8.2	Synchronize mobile device
				SF 4.8.3	Save mobile settings
	View E-Tickets	UC 8.3	View E-Tickets	SF 8.3.1	Get stored E-Tickets
	View account details	UC 8.4	View account details	SF 8.4.1	Get account information
	Synchronize mobile device	UC 8.5	Synchronize mobile device	SF 4.8.2	Synchronize mobile device
	View Customer Information	UC 8.6	View Customer Information	SF 8.6.1	Get customer information
Personnel	Update access to Web System	UC 9.1	Update access to Web System	SF 9.1.1	Integrate Manager