

# Textual Requirements specification for the Taxi Evolution

- Version 3.6 -

## 1 Introduction

The purpose of this document is to specify the requirements for the initial version of the Taxi Evolution project. The aim is to get a simple version of the system working to evaluate the system design and performance aspects.

This requirements specification is based on the specification provided by the Taxi company. Together with the company, several phases are defined for with the project should be divided into. The phases are:

1. Initial phase - This initial phase has the aim of evaluating architecture and functionality.
2. Basic system phase - When this phase is done, an operational system is available, with limited functionality. This system is put in real use to evaluate performance and function. User interfaces are an important part of this step.
3. Complete system phase - The last phase develops the rest of the system. At the end of the phase, the complete system is delivered.

From the original specification used in the contract bidding, a new requirement specification is developed. This document contains the first version of the new specification.

### 1.1 Explanation of the requirement specification

The requirements are mainly written in a feature style notation, using some state charts, context diagrams and other techniques to describe certain parts of the system. See, for example, Software Requirements - Styles and Techniques [Lauesen00].

## 1.2 Terminology

Word	Explanation
Antenna server	The computer server responsible for handling the communication between the different antennas (if several) and the central.
Car	Car in this context is the same as taxi, unless stated otherwise.
Central	The central is the location where the operators are situated. See operator.
Driver	A driver is a person driving the taxi.
Operator	An operator is the person sitting in the central, receiving orders from customers and directing traffic.
Order	An order is the information on the customer specifications for a taxi ride. That is, pick-up place, name of customer, special criteria, possibly drop-off point etc.
Radio link/communication	The name for the system enabling the communication between the taxis and the central. This incurs the radio traffic to and from the cars to the antennas, as well as the communication from the antenna server and the central.
Taxi	The vehicle transporting the customers.
Voice radio communication	All communication is done through a radio link. See radio link. With voice radio communication refers to voice communication channeled through the radio link.
Zone	A geographical area defined by the taxi company.

## 1.3 Structure of this document

This document is structured as follows: An overview of the system and some general data is described in section 2, General information. Section 3 defines the Functional requirements. The requirements are divided into different groups concerning different features. To get an overview you will have to read all the requirements for a specific group. Section 4 describes the non-functional requirements. Last is a list of references used in the text.

## 2 General information

The system has three basic modules, the taxis, the communication link and the central server. The database where to store information on the cars and the orders are stored in an independent system, not developed in this project. In addition, the user interface differs depending on which platform the different components are run. The user interface is therefore not a part of this specification. Figure 1 describes the interfaces for the Taxi Evolution system.

An arrow in figure 1 illustrates the user of an interface on another object. The database component is not developed in this project, nor is the accounting system. The requirements on the Taxi Evolution are that the information in the database is stored according to the ER-diagram in figure 2. This to facilitate the accounting system. In addition, the Central component must have an interface for the Accounting system, to allow the accounting

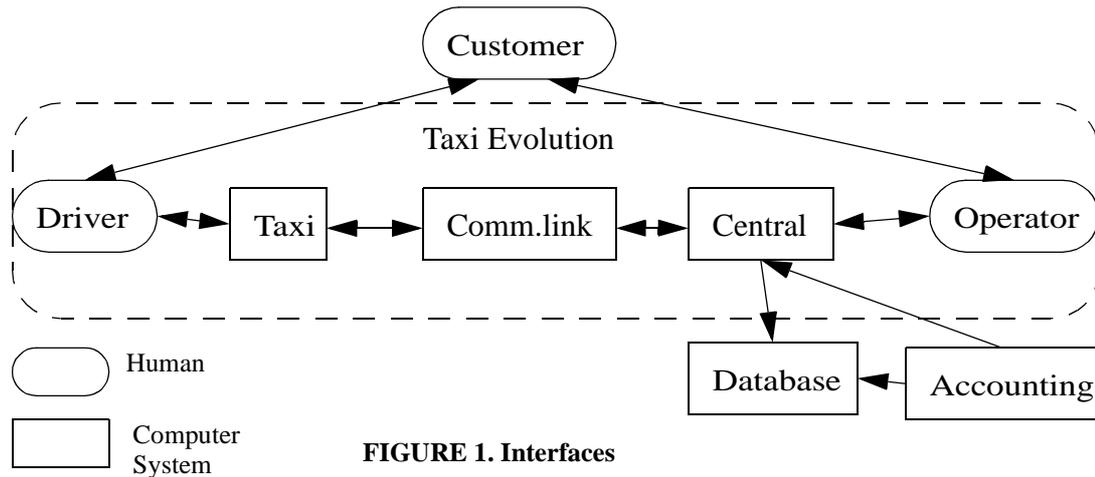


FIGURE 1. Interfaces

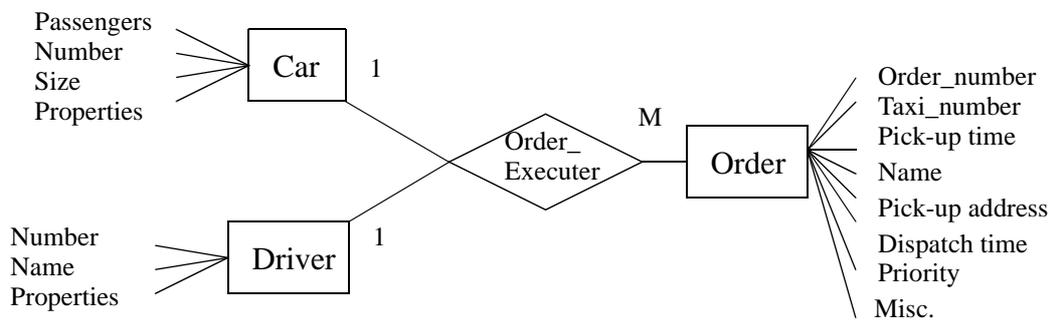


FIGURE 2. Database design

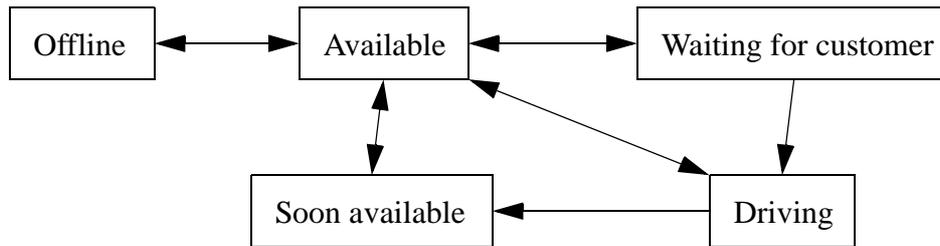
system to access certain data not stored in the database. As the accounting system has not yet been developed, it is left open how this interface should look.

The database is not used in the first version of the system. Instead, a simple component is implemented to simulate the presence of the database. The database is integrated to the system in the second step of the development. The details of the ER-diagram are explained in table 1.

From figure 1, two actors relevant to the system are defined:

- Driver - The driver actor is the taxi driver in the car.
- Operator - The operator actor is the person in the central.

The customer is not considered a part of the system and is thereby not considered as an actor.



**FIGURE 3. States of the taxi**

**TABLE 1. Database details**

Car		Driver		Order	
Property	Explanation	Property	Explanation	Property	Explanation
Passengers	The number of passengers the taxi can transport.	Number	The identification number of the driver.	Pick-up time	The time the customer wants to be picked up.
Number	The identification number of the taxi.	Name	The name of the driver.	Name	The name of the customer.
Size	The size of the car, i.e. how much load can it take. Ranges from very large to small.	Properties	Certain properties can be associated with a driver. These are specified here.	Pick-up address	The address where the pick-up should occur.
Properties	Other properties on the car, as allergy marked car.			Dispatch time	The time when the order should be dispatch. If -1, then manual. If 0, then the system should decide when to dispatch. If the time is greater than zero, then the order should be dispatch the specified time before pick-up time.
				Taxi	The taxi that should perform the order.
				Priority	Indicates how important an order is.
				Misc.	Other criteria on the order.

The taxis can be in one of the states described in figure 3. The driver actor is using the system in the taxi.

- Offline - When the taxi is not used at the moment. Not the same as not being in touch with the radio communication link.
- Available - The taxi is in use and is currently available to accept orders from the central or passing customer.
- Waiting for customer - The taxi has got an order and is currently waiting for the customer to arrive. This state is also used when driving to a customer location.
- Driving - The taxi has got a customer in the car and is currently transporting the customer to the desired location.
- Soon available - The taxi will be available in a certain amount of time and at some location. The time and location is controlled by the driver in the taxi. The taxi might have a customer or not.

Note that these states are defined in the requirements for modelling the behavior of a taxi. These states need not be present in the actual implementation of the taxi of the central computer systems.

### **3 Functional requirements**

The functional requirements are divided into four sections. The three modules in figure 1 are developed by separate groups, each responsible for unit testing. All requirements for the taxi, central and communication link component are written in a feature style notation. In addition, a special part of the taxi component is the positioning system. This is dealt with separately since there are special requirements present on this component.

The functional requirements consist of four sections: Taxi (3.1), Central (3.2), Communication link (3.3) and Positioning system (3.4).

## 3.1 Taxi

### Driver

3.1.1 The taxi shall be able to be in different states, these states are:

Offline - the driver is logged out

Available - the driver is logged in and available for new customers.

Waiting for customer - the driver is logged in, has got an order and is currently waiting for the customer to arrive.

Driving a customer - the driver is logged in, and is currently driving a customer to a destination.

Soon available - the driver is logged in, and will be available in a certain amount of time on a certain location.

3.1.2 If a driver is not logged in to the system the operations are limited to login and start alarm.

3.1.3 The log in shall be confirmed by taxi number and driver number.

3.1.4 A driver can only log in if the car is in the state offline.

3.1.5 The system shall notify the driver whether a log in was successfully done or not.

3.1.6 When a driver is logging in, information about the position shall be sent to the central.

3.1.7 When a driver has logged in, the driver shall be in state available.

3.1.8 A driver shall be able to log out only if the driver already is logged in and is in state available.

3.1.9 The log out shall be confirmed by taxi number and driver number.

3.1.10 The system shall notify the driver whether a log out was successfully done or not.

3.1.11 When the driver knows the arrival time, the time and zone shall be sent to the system.

3.1.12 When a taxi switches states, the central shall be informed of it.

3.1.13 When a taxi switches to the state soon available, the system shall estimate how long it will take for the taxi to become available.

3.1.14 When the meter is turned on, the taxi shall be in the state driving a customer.

3.1.15 When the meter is turned off the taxi shall be in the state available.

3.1.16 When the meter is turned off the price of the fare shall be displayed and a receipt shall be printed.

### **Alarm**

3.1.17 When the alarm is turned on the central shall be notified immediately.

3.1.18 When the alarm is turned on, a voice channel shall be established immediately.

3.1.19 As long as the alarm is turned on, the taxi shall send its exact position to the central every 30 seconds.

3.1.20 The alarm shall work even if the driver is not logged in to the system.

3.1.21 It shall not be possible for the driver to reset the alarm.

### **Orders**

3.1.22 The driver shall be able to submit new orders to the system.

3.1.23 If there is not an available car for the submitted order, the order shall be rejected and a new order has to be submitted with different pick-up time.

3.1.24 The system shall notify the driver if an order from the driver was successfully sent to the system or not.

3.1.25 It shall only be possible to receive orders in the state available.

3.1.26 It shall be possible to submit orders in all states, except offline.

3.1.27 When a driver receives an order, the order can either be accepted or cancelled.

3.1.28 If an order is not accepted nor denied within a time-out limit, the order shall be automatically cancelled.

3.1.29 It shall be possible to cancel an accepted order.

## **Communication and Information**

- 3.1.30 It shall be possible to initiate voice communication from the taxi to the central.
- 3.1.31 The voice communication shall be made in a radio like manner.
- 3.1.32 When voice communication is initiated from the driver to the central, the call is put in a queue.
- 3.1.33 The voice communication shall be cancelled when either the driver or operator cancel the communication.
- 3.1.34 It shall be possible to receive text messages from the central.
- 3.1.35 The cars shall automatically send an acknowledgement when they receive a text message.
- 3.1.36 An graphical indicator shall indicate a received text message in the car.
- 3.1.37 An audio notification shall indicate a received text message in the car.
- 3.1.38 The message shall be marked read when the driver has read the text message.
- 3.1.39 Sending text messages shall not interfere with voice communication.
- 3.1.40 The driver shall be able to see how many cars there are in a specific zone.
- 3.1.41 The driver shall be able to see how many orders there are in a specific zone.
- 3.1.42 Information about each zone shall be sent to the taxi whenever there is an update i.e. there is a new order or there is a car leaving or entering a zone.

## **Properties**

- 3.1.43 Different drivers shall be able to have different properties, e.g. if they speak a certain language.
- 3.1.44 Different cars shall be able to have different properties, e.g. how many passengers that can be carried in the taxi, or if a car is allergy marked.
- 3.1.45 The operator shall be able to view the properties about a specific car.
- 3.1.46 The operator shall be able to view the properties about a specific driver.
- 3.1.47 The operator shall be able to view the properties of a set of cars.
- 3.1.48 The operator shall be able to view the properties of a set of drivers.
- 3.1.49 The drivers shall be able to view their own properties.

## 3.2 Central

The central component has two main functions:

- Serving as the interface for the operators.
- Storing information about available taxis. Typically, the positioning information is stored here.

For the former, feature style notation is used to define the requirements. The latter is dealt with in the requirements for the positioning system, as the function spans all the components.

### Operator

3.2.1 The operator shall be able to be in different states, these states are:

Offline - the operator is logged out

Online - the operator is logged in

3.2.2 If an operator is not logged in to the system the operations are limited to just login.

3.2.3 The log in shall be confirmed by user identification and password.

3.2.4 The system shall notify the operator if a log in was successfully done or not.

3.2.5 An operator shall be able to log out only if the operator already is logged in.

3.2.6 The system shall notify the operator if a log out was successfully done or not.

### Alarm

3.2.7 When the alarm is turned on the central shall be notified immediately.

3.2.8 When the alarm is turned on, a voice channel shall be established immediately.

3.2.9 As long as the alarm is turned on the exact position of the alarming car shall be sent to the central every 30 seconds.

3.2.10 The operator shall be able to reset the alarm.

## **Orders and dispatcher**

- 3.2.11 The operator shall be able to submit new orders to the system.
- 3.2.12 The system shall notify the operator if an order was successfully submitted to the system or not.
- 3.2.13 If there are one or several cars matching a certain order, the order shall be automatically dispatched to a car.
- 3.2.14 The operator shall be able to update already submitted orders.
- 3.2.15 The system shall be able to send orders for manual dispatch to the operator.
- 3.2.16 The system shall present an estimate of how long time it takes for a car to be available.
- 3.2.17 The system shall notify the operator when it is time to dispatch an submitted order.
- 3.2.18 If an order has the property dispatch time set to less than zero the order will be dispatched manually.
- 3.2.19 If an order has the property dispatch time set to zero the system will decide when the order will be dispatched.
- 3.2.20 If an order has the property dispatch time set to greater than zero the order will be dispatched the specified time before pick-up time.
- 3.2.21 If the order has the property taxi set to zero the system will decide to which car the order is dispatched to first.
- 3.2.22 If an order is manually dispatched to a driver and the order is denied, cancelled or ignored by the driver, the order will be returned to the operator for manual dispatch.

## **Communication and Information**

- 3.2.23 It shall be possible for the operator to initiate voice communication from the central to a specific car.
- 3.2.24 The voice communication shall be made in a radio like manner.
- 3.2.25 The voice communication shall be cancelled when either the driver or operator cancel the communication.
- 3.2.26 The operator shall be able to manually check available cars over a voice communication link.
- 3.2.27 It shall be possible to send text messages to one car.
- 3.2.28 It shall be possible to send text messages to a group of cars.
- 3.2.29 The text messages shall not interfere with the voice communication
- 3.2.30 The operator shall be able to see how many cars there are in a specific zone.
- 3.2.31 The operator shall be able to see how many orders there are in a specific zone.
- 3.2.32 Information about each zone shall be sent to the operator whenever the operator requests it.
- 3.2.33 When a driver is logged in, the system shall send overview information on all zones.

## **Properties**

- 3.2.34 Information about properties shall be stored until they are changed by an operator.
- 3.2.35 It shall be possible to update car properties.
- 3.2.36 It shall be possible to update driver properties.
- 3.2.37 The system shall acknowledge when the car properties are updated.
- 3.2.38 The system shall acknowledge when the driver properties are updated.

### 3.3 Communication Link

The requirements for the communication link are made up by mostly non-functional requirements. The link is primitive in the sense of context awareness, but handles issues like guaranteed delivery and fault recovery. The communication link has two main components: The transmission media and the communication server. The server is responsible for sending the information to the correct receiver. The media used depends on receiver and current conditions regarding the receiver. The basic function of the communication link is to transmit digitally coded information, in a point to point fashion or in a broadcast fashion.

#### Requirements:

- 3.3.1 The communication link interface shall accept text messages to send to a destination.
- 3.3.2 All coding of the messages shall be handled by the taxi system and central system.
- 3.3.3 The communication link shall be able to guarantee delivery and be able to recover from failures.
- 3.3.4 The communication between the taxi and the communication link shall be radio based using private antennas belonging to the taxi company.
- 3.3.5 The communication between the central and the communication link shall be done through a permanent network connection.
- 3.3.6 When a car is in one of the zones, it shall always be covered by at least one communication link.
- 3.3.7 The system shall be scalable, but must initially handle 150 cars.
- 3.3.8 It shall be possible to send messages from the communication link to groups of cars or single cars.
- 3.3.9 The communication link shall support both text information and speech information independently.

### 3.4 Positioning System

The positioning system is a part of the Taxi component. However, due to the specific requirements on the positioning, this is dealt with separately.

There are two modes for the positioning system:

1. Normal mode - The taxi has no customer in the car. The positioning system sends information to the central about the positioning only when changing zone.

2. Meter mode - When the meter is running, i.e. there is a customer in the taxi, the positioning system sends exact coordinate to the central every 30 seconds. This to be able to record the path a ride takes. This information is used in case of complaints.

The positioning information from a ride is stored in the central for the last 24 hours for all rides. The zone information that is sent in normal mode should not be stored.

To be able to fulfil the requirements in normal mode, a zone concept must be present in the positioning system. It should be possible to update the zones via the ordinary communication link.

### **Requirements:**

- 3.4.1 The positioning system should deliver a zone indicating the position of a car when the car is in the state Available.
- 3.4.2 The positioning information of a car in the state Available is only sent when there is an update. That is, when the information in the central is no longer accurate.
- 3.4.3 The positioning system should be able to send the exact positioning when the driver is driving a customer, i.e. the meter is running.
- 3.4.4 When the meter is running the position is sent every 30 seconds to the central.
- 3.4.5 The central system should send updates on the traffic overview as soon there is a change in a zone, either on available cars or on available orders.

## **4 Non-functional requirements**

The system has several requirements not relating to a certain function of the system. The list below deals with these issues.

### **4.1 Requirements**

- 4.1.1 Driver integrity - The position of the car should not be displayed exactly to users of the system, except for when driving a customer.
- 4.1.2 User identity - All users of the system, drivers or operators, shall have a unique identification number.
- 4.1.3 Usability - The system must be user-friendly. In the cars, special care must be taken to ensure that the interface is as non-intrusive as possible for the driver. Most functions should be possible to perform while driving and it is essential that the information is clear, the display clearly visible, and the sequences for different functions are short. In the cen-

tral, it is important that the operators can easily enter new orders into the system and also view the traffic overview to be able to manually dispatch cars.

4.1.4 Robust - The different systems should not affect one another. The system has three main functional aspects: Ordering system, radio communication and positioning system. The systems must operate separately and a failure in one of the system should not affect the other systems. Typically, if the ordering system is down, it should then be possible to use the radio communication to manually dispatch and make orders.

4.1.5 Consistent - The system should work in a consistent way even if a car is out of range from the central. This typically happens when a car is driving customers outside the regular area.

4.1.6 Legal - The system must comply with all laws and regulations applicable to a taxi organization.

4.1.7 GPS - GPS is used as positioning system. The positioning should be handled automatically without the driver having to interfere with the system.

4.1.8 Uptime - The system in the taxis must have a total uptime of at least 99% of the operational time, i.e. be working 99% of the time. The equivalent requirements for the central system are an uptime of at least 99.9% of the operational time.

4.1.9 Response time - All communications over the radio link, not being a voice communication, should be negotiated in less than 5 seconds in 99% of all transfers. There must never be more than 1 second delay in the voice communication.

4.1.10 Quality - The voice communication shall use a sample frequency of 8000 Hz and 8 bits for coding each sample. (This is the equivalent specification for the voice quality in the GSM system.) This will generate traffic of 64 kbps.

4.1.11 Capacity - All non-voice communication should be handled by the system, independent on load and number of taxis. The system should also be able to handle up to 5 parallel voice channels at a time, besides the ordinary non-voice traffic.

4.1.12 Maintenance - The number of cars, centrals and antennas in the system should be changeable. That is, the number should be easily changed if the conditions change.