

# Requirements Analysis and Specifications Document

Version 1.3

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# 1 Introduction

## 1.1 Purpose

This document represents the Requirement Analysis and Specification Document (RASD). The main goal of this document is to completely describe the system in terms of functional and non-functional requirements, to show the constraints and the limit of the software and simulate the typical use cases that will occur after the development. This document is intended to all developers and programmers who have to implement the requirements, to system analysts who want to integrate other systems with this one, and could be used as a contractual basis between the customer and the developer.

## 1.2 Actual System

The whole project is built on the assumption that no preexistent system exists. Every feature and component of the new system has to be built without modifying or reusing parts of any previous systems.

## 1.3 Scope of the project

The aim of this project is to develop MyTaxiService, a web/mobile application that makes easier and quicker taking taxis within the city's borders. Thanks to MyTaxiService, anyone can request or book a taxi and get realtime information about how long it will take to be picked up or about the taxi's current position and identification code. In addition to that, MyTaxiService provides an efficient way to allocate taxis by dividing the city in zones and using a queue based allocation system, in order to reduce the average waiting time and city's traffic.

## 1.4 Future Implementations

Further possible modifications/extensions are represented by adding to the described system the possibility of managing "Taxi Sharing". In this case users are allowed to "share" a taxi ride with others users going in the same direction.

## 1.5 Goals

1. Simplify and speed up the process of taking a taxi within the city's borders
  - (a) When a registered user has entered his taxi ride details and clicks or taps the "REQUEST TAXI" button, MyTaxiService will find the first available mtaxi that fits for the inserted ride details, and this mtaxi will pick up the registered user as soon as possible
  - (b) When a registered user has entered his booking details and clicks or taps the "BOOK TAXI" button, MyTaxiService will book a mtaxi that fits for the inserted booking details and for the indicated pick up time

2. Guarantee an efficient and fair management of taxi queues
  - (a) Guarantee a distribution of mtaxies in the city zones such that number of mtaxies in those zones is proportional to the average number of requests and to the zone sizes
  - (b) Guarantee short mtaxi availability times and short waiting times

## 1.6 Assumptions

1. MyTaxiService has been commissioned by the city's local government.
2. The local government provides each mtaxi with a device similar to a small navigator(MYT). This device is used to: see and accept ride/booking requests, see zone change orders, report accidents; it has a built-in gps module through which MyTaxiService can track the position of the mtaxi on which is mounted
3. Every MYT device is strictly associated to a Mtaxi driver, so that when MYT is turned on the mtaxi driver is automatically logged into MyTaxiService
4. Mtaxies can only serve ride/booking requests forwarded by MyTaxiService(B)
5. Mtaxies operate only within the city's borders
6. MyTaxiService does not offer any payments feature, so mtaxies driver can accept and manage payments the way they want

## 1.7 Terms and definitions

### **User**

A generic person not registered to MyTaxiService

### **Passenger**

A registered user that has requested a mtaxi ride/booking

### **Registered User**

A generic person that is registered to MyTaxiService

### **Administrator**

A supervisor of the mtaxies activities

### **Mtaxi**

A taxi that joined MyTaxiService

### **MyTaxiService(B)**

The back end of MyTaxiService, that is to say, those software components that manage the forwarding of ride/booking requests to mtaxi drivers, the search of available mtaxies compatible with the received ride/booking requests, the distribution of mtaxies in the different city's zones and other internal tasks not exposed to users or mtaxi drivers

**Ride**

A movement of people, through a taxi cab, from one location to another

**Ride request**

An electronic message sent by a registered user to MyTaxiService(B). This electronic message refers to the case in which the registered user wants to be picked up as soon as possible by a mtaxi

**Booking request**

An electronic message sent by a registered user to MyTaxiService(B). This electronic message refers to the case in which the registered user wants to be picked up by a mtaxi at a specific date and time

**Mtaxi booking, booking a ride**

If a registered user wants to be picked up by a mtaxi at specific date and time, he books a ride or a mtaxi

**MYT**

The device the local government provides to taxi drivers that have registered to MyTaxiService. This device integrates a client for MyTaxiService that is used by the mtaxi driver to see ride/booking requests and zone change orders, accept these requests and report accidents

**A mtaxi is available**

A mtaxi has finished serving a passenger and is ready for a new ride

**A mtaxi is unavailable**

A mtaxi is considered unavailable if and only if or is serving a passenger or has reported an accident or is stuck in the traffic (and this has been detected by MyTaxiService(B))

**Zone**

An area of the city about  $2km^2$  wide

**Credentials**

A combination of username and password, used by a registered user to access the MyTaxiService application

**Queue**

A data structure managed with a FIFO policy.

**Ride/booking request acceptance**

A mtaxi driver has accepted a ride/booking request if he has left in order to pick up the passenger associated with the request

**The city**

The city that is served by MyTaxiService and its taxies

### **Fair distribution of taxi zones**

A management of mtaxies in the city zones such that number of mtaxies in those zones is proportional to the average number of requests and to the zone sizes

**Bad Behavior/Behave Properly(Mtaxies)** An mtaxi doesn't behave properly: does not respect the work turn, does not accept a ride request within 10 mins and does not end a ride in the destination place or within a fixed time after he has reached the destination location

## 1.8 Acronyms

- **RASD:** Requirements Analysis and Specification Document
- **FIFO:** First In First Out
- **MITM:** Man In The Middle

## 1.9 Reference Documents

- Specification Document: MyTaxiService-AA2015-2016.pdf
- IEEE Std 830-1998 IEEE Recommended Practice for Software Requirements Specifications.
- IEEE Std 1016 tm -2009 Standard for Information Tecnology-System Design-Software Design Descriptions.

## 1.10 Main Actors

See Terms and Definitions section

- User
- Registered User
- Mtaxi driver
- Taxi driver
- MyTaxiService(B)
- Adimistrator

## 2 Requirements Specification

### 2.1 Functional requirements

The following table shows the only functionalities of MyTaxiService accessible by the different actors:

1. USER
  - (a) User registration
2. REGISTERED USER
  - (a) Login
  - (b) Remember me (see below for details)
3. LOGGED REGISTERED USER
  - (a) Logout
  - (b) Request a ride
  - (c) Book a ride
  - (d) View the status of a ride (requested or booked)
  - (e) Undo a ride booking (If possible)
4. TAXI DRIVER
  - (a) Taxi driver registration
5. MTAXI DRIVER
  - (a) Accept a ride request/booking
  - (b) Complete a ride
  - (c) View the details of ride request/booking
  - (d) Report an accident
6. ADMINISTRATOR
  - (a) View mtaxies reports of accidents and bad behaviors
  - (b) Reactivate accidented or suspended mtaxies
  - (c) Suspend a mtaxies from the service
7. A user can register to MyTaxiService only and only once
8. MyTaxiService has to be able to remember logged sessions so that when a registered user opens next time the MyTaxiService app or website, he has not to log in again (Remember me functionality)

9. MyTaxiService has to implement a user registration process that requires the user to insert: name, lastname, email, password
10. MyTaxiService has to implement a taxi driver registration process that requires the driver to insert personal data(name, lastname, address, ssn), vehicle data(brand and model, license plate number) and the work time table
11. During the user registration process, MyTaxiService has to be able to check the formal validity of the data inserted
12. During the taxi driver registration process, MyTaxiService has to be able to check the formal validity of the data inserted
13. MyTaxiService has to only accept user registrations with mail addresses not already used by other registered users
14. MyTaxiService has to only accept taxi driver registrations with ssn and license plate number not already used by other mtaxidriver
15. MyTaxiService has to only accept registrations whose data formal validity has been check successfully
16. Logged registered users can undo a reservation up to 10 minutes before the inserted picking up time
17. MyTaxiService has to allow multiple mtaxi bookings by the same logged registered user
18. MyTaxiService has not to allow multiple ride requests by the same logged registered user (a registered user can't make a new ride request until his last requested ride has been completed)
19. MyTaxiService can accept only ride requests that specify a starting location, an ending location and a number of passengers
20. MyTaxiService has to be able to access a list of every valid city's location
21. MyTaxiService has to be able to access realtime data about the city's traffic
22. MyTaxiService has to force a logged registered user to choose as starting/ending locations of a ride only valid city's locations
23. MyTaxiService has to force a logged registered user to chose among a list of only valid city's locations
24. MyTaxiService has to force a logged registered user, in the context of a booking request, to chose among a list of only valid hours, minutes, dates
25. MyTaxiService has to force a logged registered user not choose the same location as starting and ending location of a ride



26. MyTaxiService has to force a logged registered user not to make a booking request that is a copy, in terms of date and time, of a previous non completed booking request
27. MyTaxiService(B) has to be able to retrieve the position of each mtaxies using the gps system of their MYT devices
28. MyTaxiService(B) has to be able to logically divide the city in zones and associate sets of gps coordinates to these zones
29. MyTaxiService(B) has to be able to map a gps coordinate with a valid city's location
30. MyTaxiService(B) has to be able, using the mtaxies' gps coordinates and the city's public data, to understand the city's traffic situation zone by zone (High traffic, normal traffic, low traffic)
31. MyTaxiService has to be able using, the mtaxi GPS coordinates, to determine an estimated waiting time for the passenger served by the taxiS
32. MyTaxiService(B) has to be able, using the mtaxies' gps coordinates, to analyze their distribution among the different city's zones and understand if there's the need to change this distribution in relation to the average number of ride/booking requests per city's zone.
33. MyTaxiService(B) has to be able to send change zone orders to mtaxies
34. MyTaxiService(B) has to be able, using mtaxies' gps coordinates, to analyze the mtaxies' distribution among the different city's zone and build queues of available mtaxies for each zone
35. MyTaxiDriver(B) has to manage the forwarding of ride/booking requests using the queue based system discussed above: a ride/booking request is forwarded to the first mtaxi in the queue that corresponds to the city's zone of the requested ride's starting location
36. MyTaxiService(B) has to be able to manage a situation in which a mtaxi does not accept a ride/booking request within 10 mins. In this situation MyTaxiService has to find a new mtaxi to forward the request and to report this behavior to the mtaxi driver's supervisors
37. MyTaxiService app and website have to have the same functionalities
38. MyTaxiService(B) has to have access to the characteristics of each mtaxies (number of passengers, unique code)
39. MyTaxiService(B) has to use the mtaxi drivers' work timetable, in order to know when a mtaxi should start serving passengers, should take a lunch break or should finish all activities

40. MyTaxiService has to consider unavailable only mtaxies that or are serving a ride/-booking request or have reported an accident or are taking a break according to the work timetable, no other exceptions are allowed
41. MyTaxiService has to offer to mtaxi drivers the possibility of reporting an accident and therefore be considered unavailable
42. MyTaxiService has to be able to check if the location of a Mtaxi ,when its driver taps the "END RIDE" button, is the ending location of its current ride. If this check fails MyTaxiService has to report this behavior to the Mtaxi driver supervisor
43. MyTaxiService(B) has to be able to manage a situation in which a mtaxi that has arrived to the ending location of its current ride doesn't tap the "END RIDE" button within 10 mins. In this situation MyTaxiService has to report this behavior to the Mtaxi driver's supervisor.
44. MyTaxiService has to allow administrators to see reports about accidented mtaxies or mtaxies that have behaved in an improper way
45. MyTaxiService has to allow adminstrators to suspend mtaxies from the service
46. MyTaxiService has to allow adminstrators to reintegrate suspended mtaxies to the service
47. MyTaxiService has to allow administrators to keep a list of mtaxies that have not behaved properly

## 2.2 Non functional requirements

1. MyTaxiService has to guarantee that a mtaxi arrives at the start location of a ride within 10 mins
2. After a failure MyTaxiService has to be restarted within 1 hour
3. MyTaxiService must be available 24h/7d, with a down time of 1 hour per year
4. MyTaxiService has support a maximum of 1000 ride/booking requests per hour
5. Registered users have to be able to use properly all MyTaxiService's functionalities after a training time of at most 10 mins
6. All MyTaxiService's functionalities have to be reachable by a registered user with at most 3 clicks/taps from the after login screen of the web/mobile app

### 2.2.1 Security

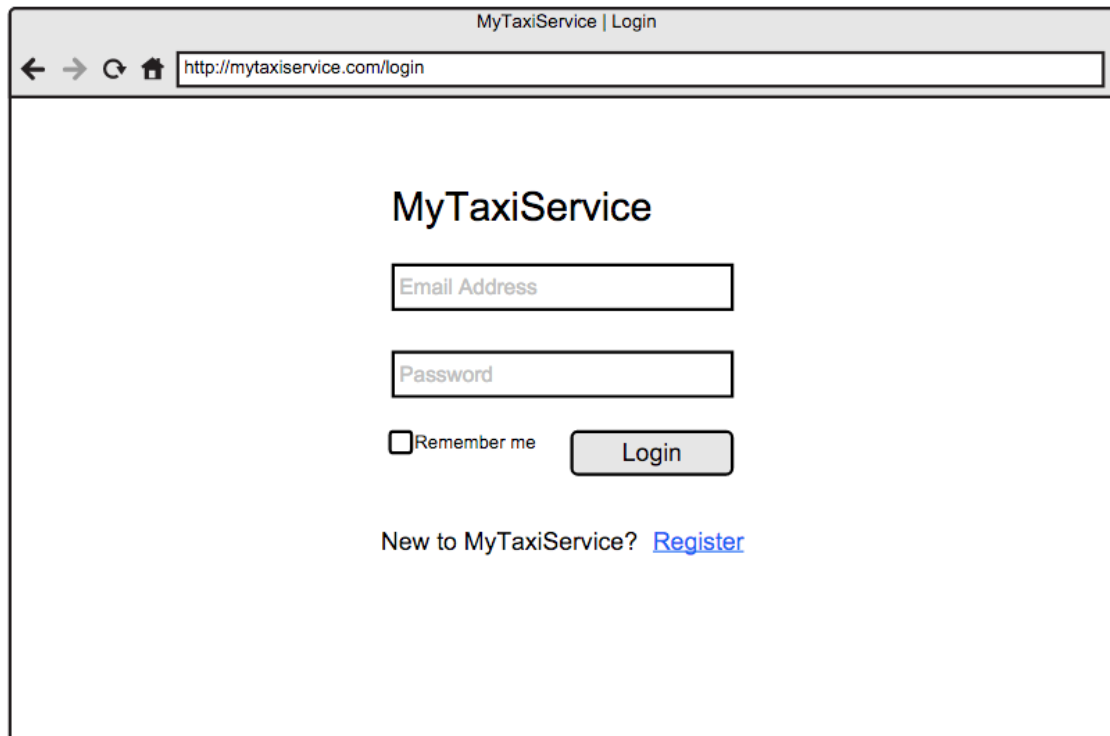
Among non functional requirements particular attention must be devoted to security aspects. During the login MyTaxiService has to prevent malicious users from phishing sensible data(password, username etc) by adopting suitable protection mechanisms(password encryption, encrypted communication protocols etc). From the server side MyTaxiService must guarantee that data access from remotes users is controlled and filtered such that no unauthorized access(SQL injection, MITM attack, etc) to sensible data is permitted.

### 2.2.2 Interfaces Requirements

In this section is shown a series of mockups that specify a set of requirements over the user interface.

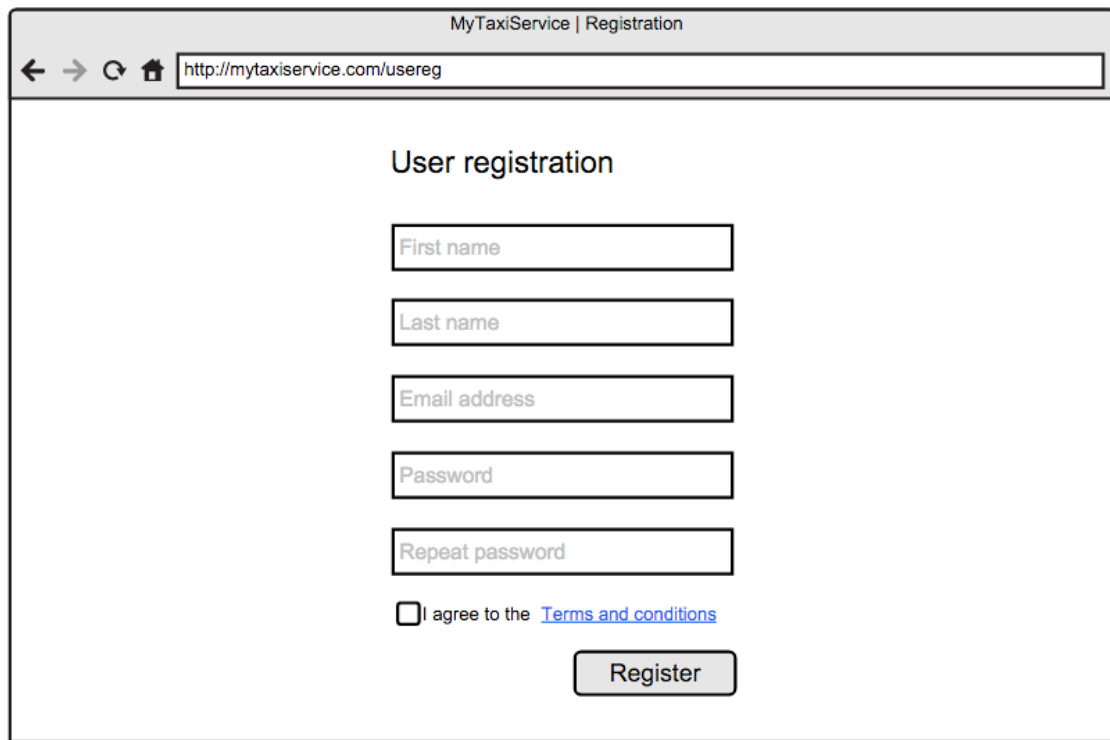
Each mockup is valid both for the website and mobile application version of MyTaxiService

This mockup shows the user login page



The mockup shows a web browser window with the title "MyTaxiService | Login". The address bar contains "http://mytaxiservice.com/login". The main content area features the "MyTaxiService" logo at the top. Below the logo are two input fields: "Email Address" and "Password". Under the "Email Address" field is a checkbox labeled "Remember me". To the right of the checkbox is a "Login" button. At the bottom, there is a link that says "New to MyTaxiService? [Register](#)".

This mockup shows the user registration page



The mockup shows a web browser window with the title "MyTaxiService | Registration". The address bar contains the URL "http://mytaxiservice.com/usereg". The page content is titled "User registration" and features a vertical stack of five text input fields with placeholder text: "First name", "Last name", "Email address", "Password", and "Repeat password". Below these fields is a checkbox labeled "I agree to the" followed by a blue hyperlink "Terms and conditions". At the bottom right of the form is a grey "Register" button.

MyTaxiService | Registration

← → ↻ 🏠 http://mytaxiservice.com/usereg

### User registration

First name

Last name

Email address

Password

Repeat password

☐ I agree to the [Terms and conditions](#)

Register

This mockup shows the taxi driver registration page

MyTaxiService | Registration

← → ↺ 🏠 http://mytaxiservice.com/taxireg

### Mtaxi registration

Personal data

First name

Last name

Email address

Address

SSN

Taxi cab data

Brand

Model

License plate number

Worktime table

Turn start

Brand

Model

License plate number

Worktime table

Turn start

Hour 

10

 Min 

00

Turn end

Hour 

10

 Min 

00

Lunch start

Hour 

10

 Min 

00

Lunch end

Hour 

10

 Min 

00

☐ I agree to the [Terms and conditions](#)

Register

13

This mockup shows the ride request page

The mockup shows a web browser window with the title "MyTaxiService | Request". The address bar contains the URL "http://mytaxiservice.com/request". In the top right corner, there is a user profile icon labeled "User" and a "Logout" button. The main content area is titled "Request a taxi" and contains the following form elements:

- A dropdown menu for "Starting location".
- A dropdown menu for "Ending location".
- A spinner control for "1 Passenger".
- A "Confirm" button.

This mockup shows the booking request page

MyTaxiService

← → ↻ 🏠

http://mytaxiservice.com/book

👤 User

Logout

## Book a taxi

Starting location

▼

Ending location

▼

1 Passenger

▲ ▼

Date

4/22/2012

📅 ▼

Hour

12

▼

Min

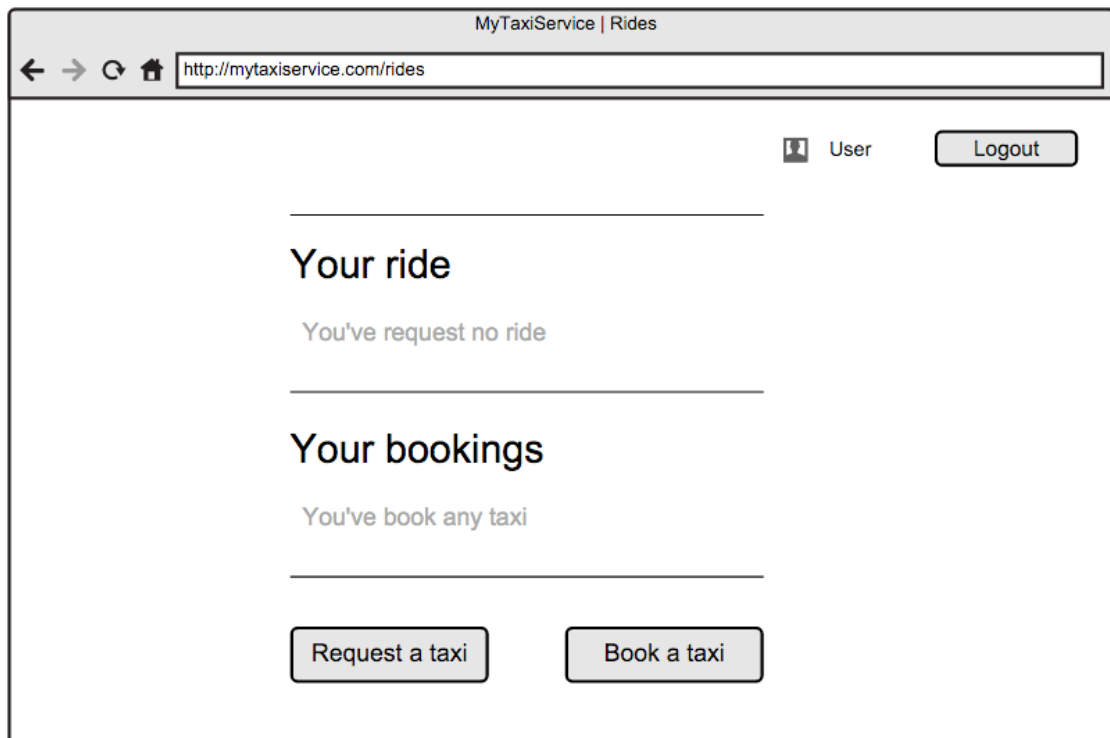
30

▼

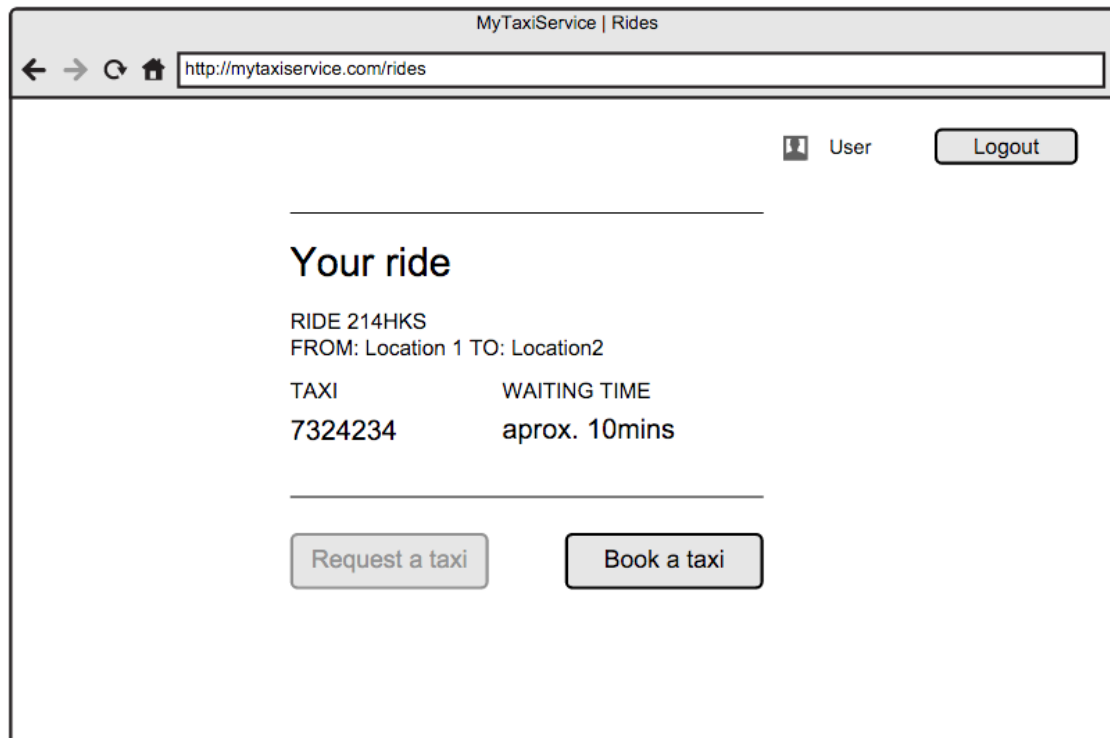
Confirm



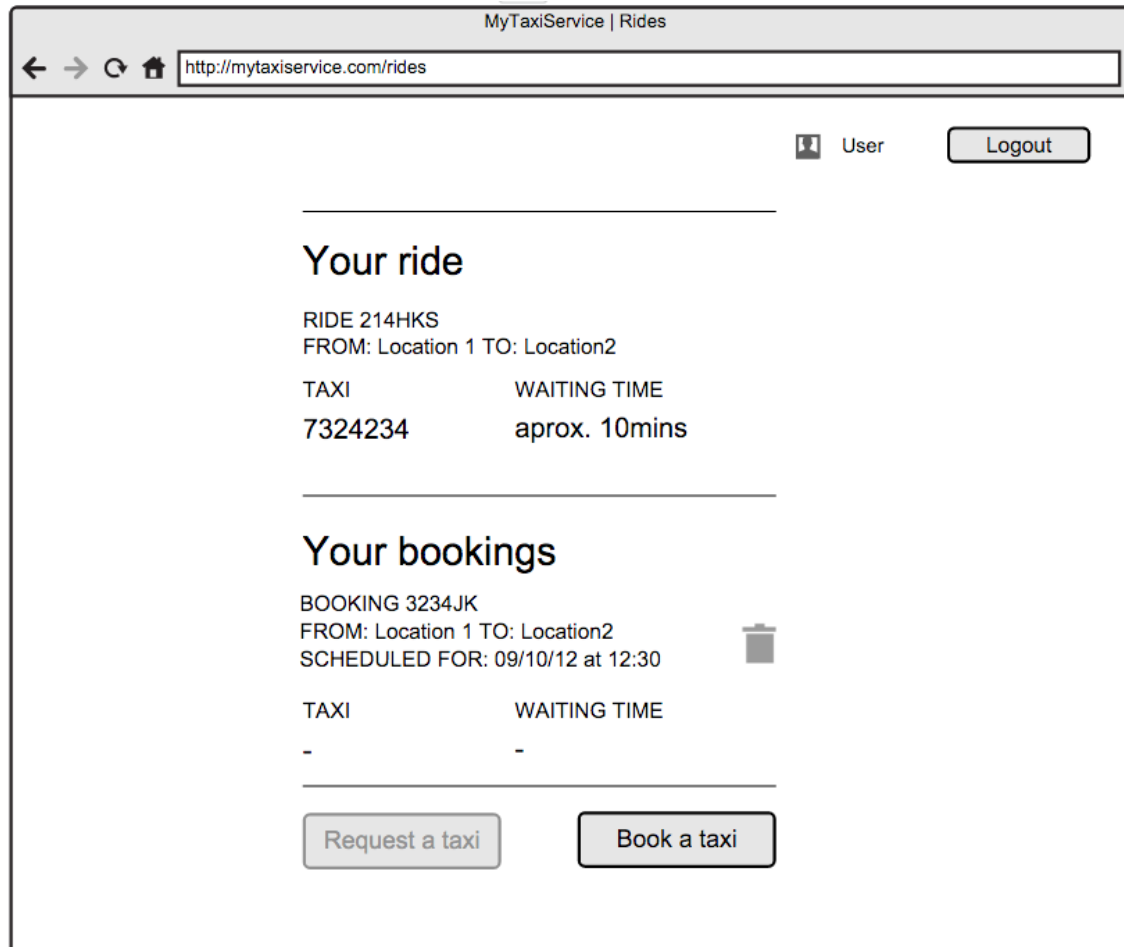
This mockup shows the home page with no booking/ride pending requests



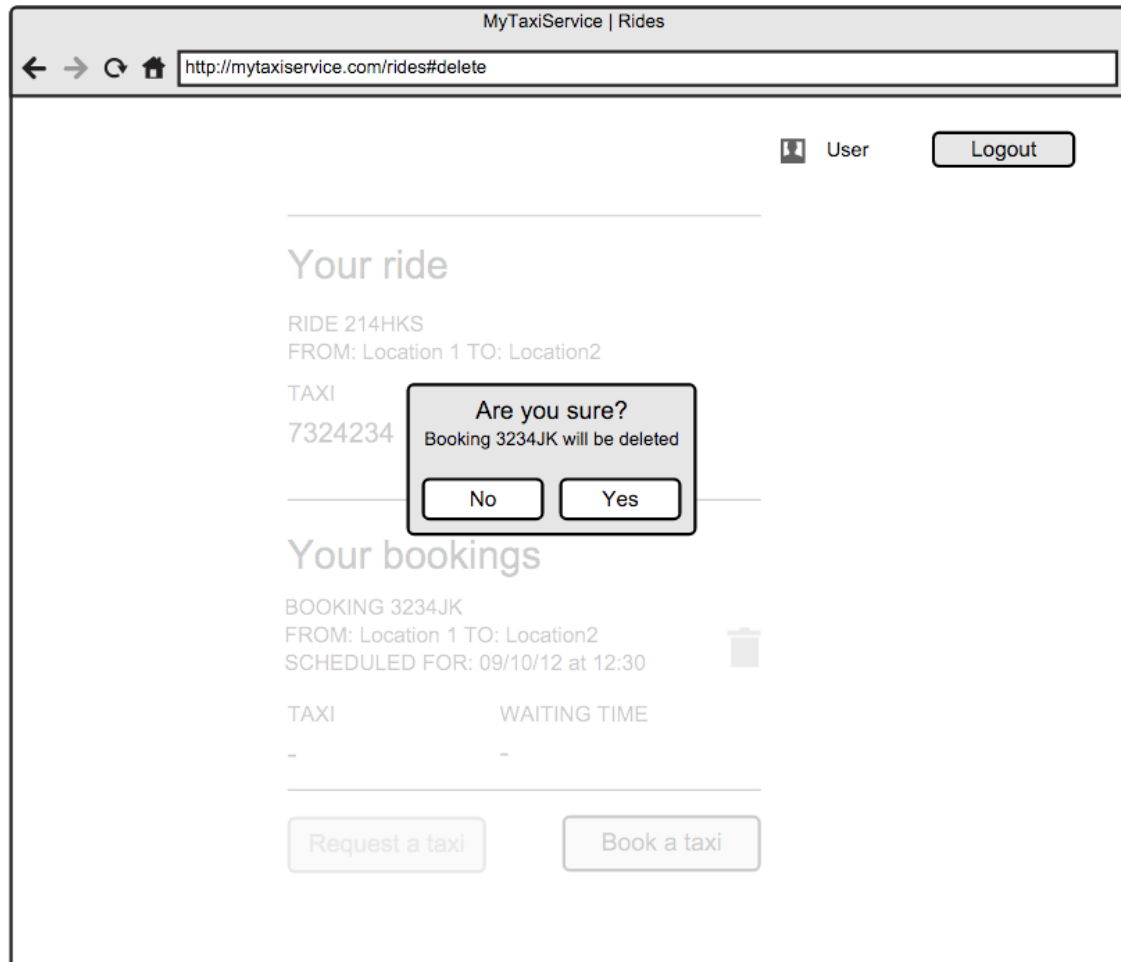
This mockup shows the home page with one pending requests



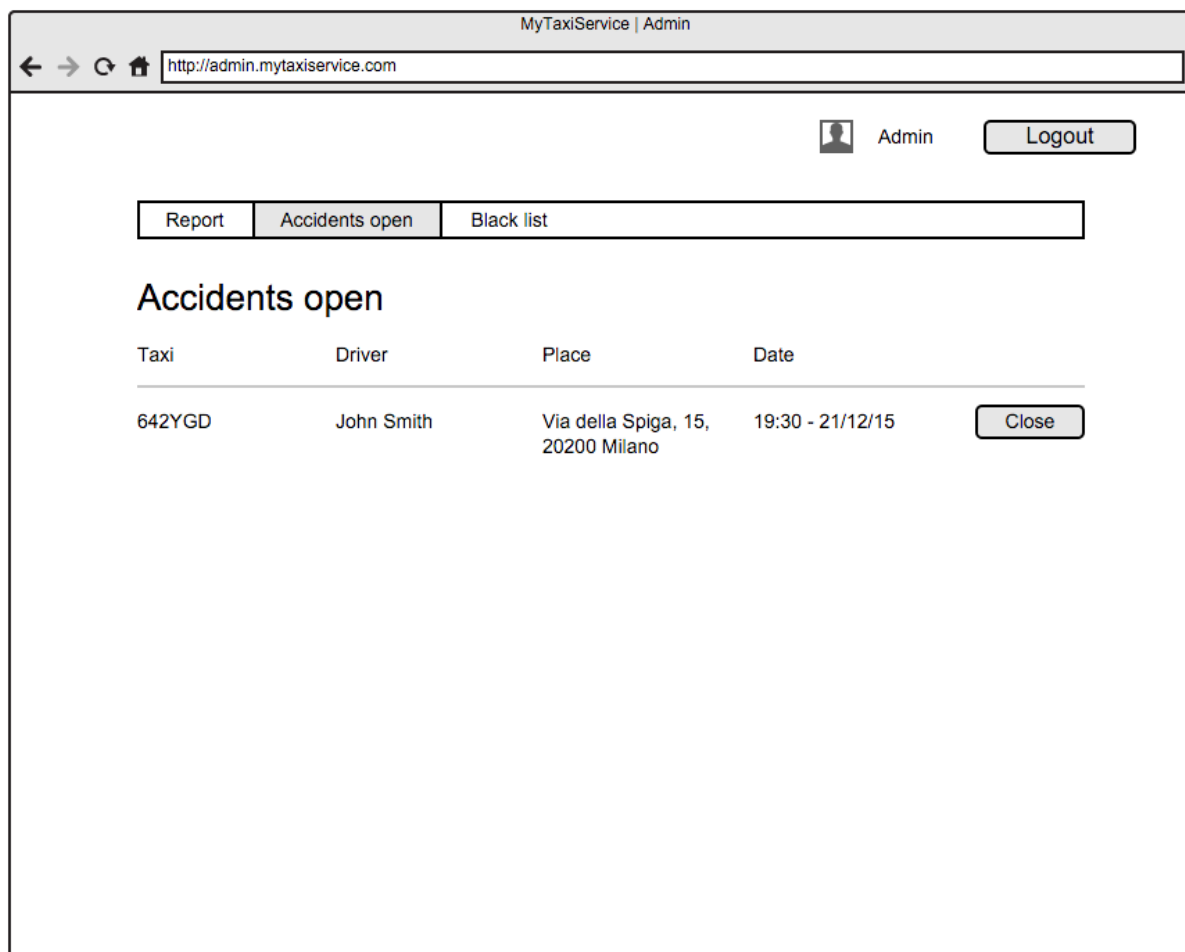
This mockup shows the home page with one pending ride and booking request



This mockup shows the deletion of a booking request by a registered user



This mockup shows the view accident reports page with one element



This mockup shows the dashboard page of the administrators

MyTaxiService | Admin

[←](#)
[→](#)
[↺](#)
[⌂](#)
<http://admin.mytaxiservice.com>

Admin
 Logout

Report

Accidents open

Black list

### Accidents

Taxi	Driver	Place	Date
642YGD	John Smith	Via della Spiga, 15, 20200 Milano	19:30 - 21/12/15

### Bad behaviour

#### Ride ending

Taxi	Driver	Delay	Place	Ending place	Date
642YGD	John Smith	-	Via della Spiga, 15, 20200 Milano	Via Rasputin, 4, 20200 Milano	19:30 - 21/12/15

Add to blacklist

#### Ride starting

Taxi	Driver	Delay	Place	Date
642YGD	John Smith	10'	Via della Spiga, 15, 20200 Milano	19:30 - 21/12/15
642YGD	John Smith		Via della Spiga, 15, 20200 Milano	19:30 - 21/12/15

### Bad behaviour

#### Ride ending

Taxi	Driver	Delay	Place	Ending place	Date
642YGD	John Smith	-	Via della Spiga, 15, 20200 Milano	Via Rasputin, 4, 20200 Milano	19:30 - 21/12/15

Add to blacklist

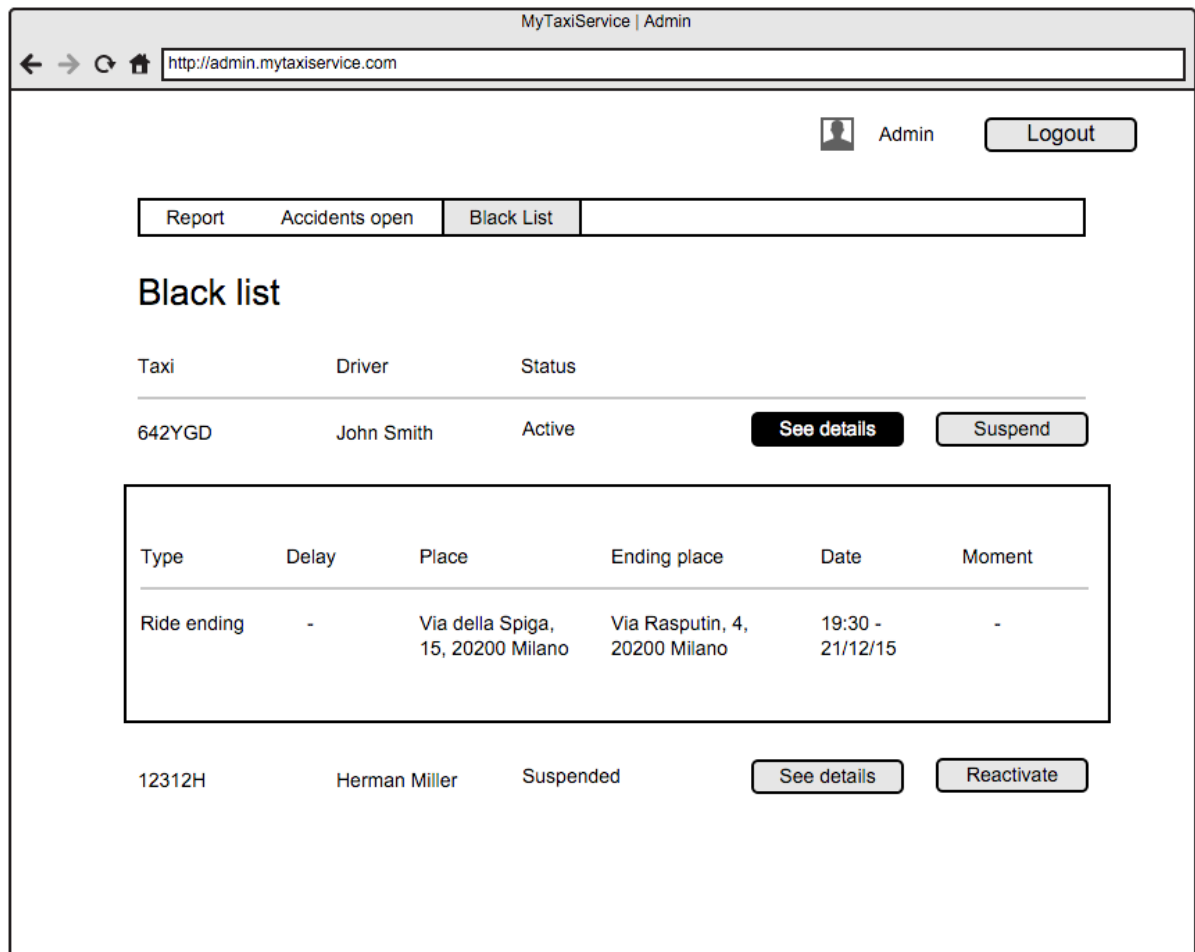
#### Ride starting

Taxi	Driver	Delay	Place	Date
642YGD	John Smith	10'	Via della Spiga, 15, 20200 Milano	19:30 - 21/12/15

#### Work turn

Taxi	Driver	Delay	Moment	Place	Date
642YGD	John Smith	10'	End lunch	Via della Spiga, 15, 20200 Milano	19:30 - 21/12/15

This mockup shows the black list administrators page with one element



### 2.3 Constraints

1. MyTaxiService requires Android 2.0 (or later) or IOS 6.0 (or later)
2. MyTaxiService requires a browser that supports Javascript, CSS, HTML
3. MyTaxiService requires an internet connection(3G or Wifi)

### 2.4 Domain Properties

1. Traffic information is reliable
2. GPS data are reliable
3. If a registered user requests a ride request then he will be present at the starting point when the mtaxi arrives

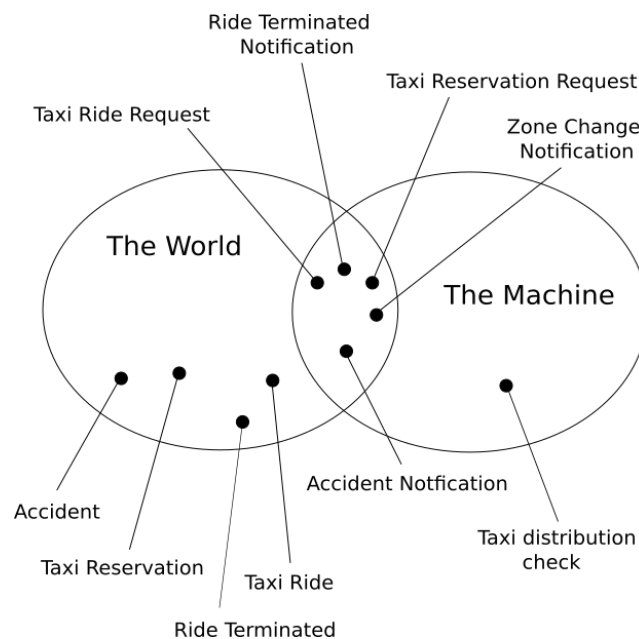
### 2.5 Jackson-Zave Model

In this section is included a possible formulation of the problem in term of the model proposed by Jackson and Zave.

In the 'Machine' circle are included the main events that can only be observed by the system.

In the 'World' circle are included the main events that can only be observed in the external environment.

Finally in the intersection of the two circles('Shared Phenomena') are inserted the events that are observed(controlled) by the environment and controlled(observed) by the system.





### 3 Scenarios, Use Case and UML diagrams

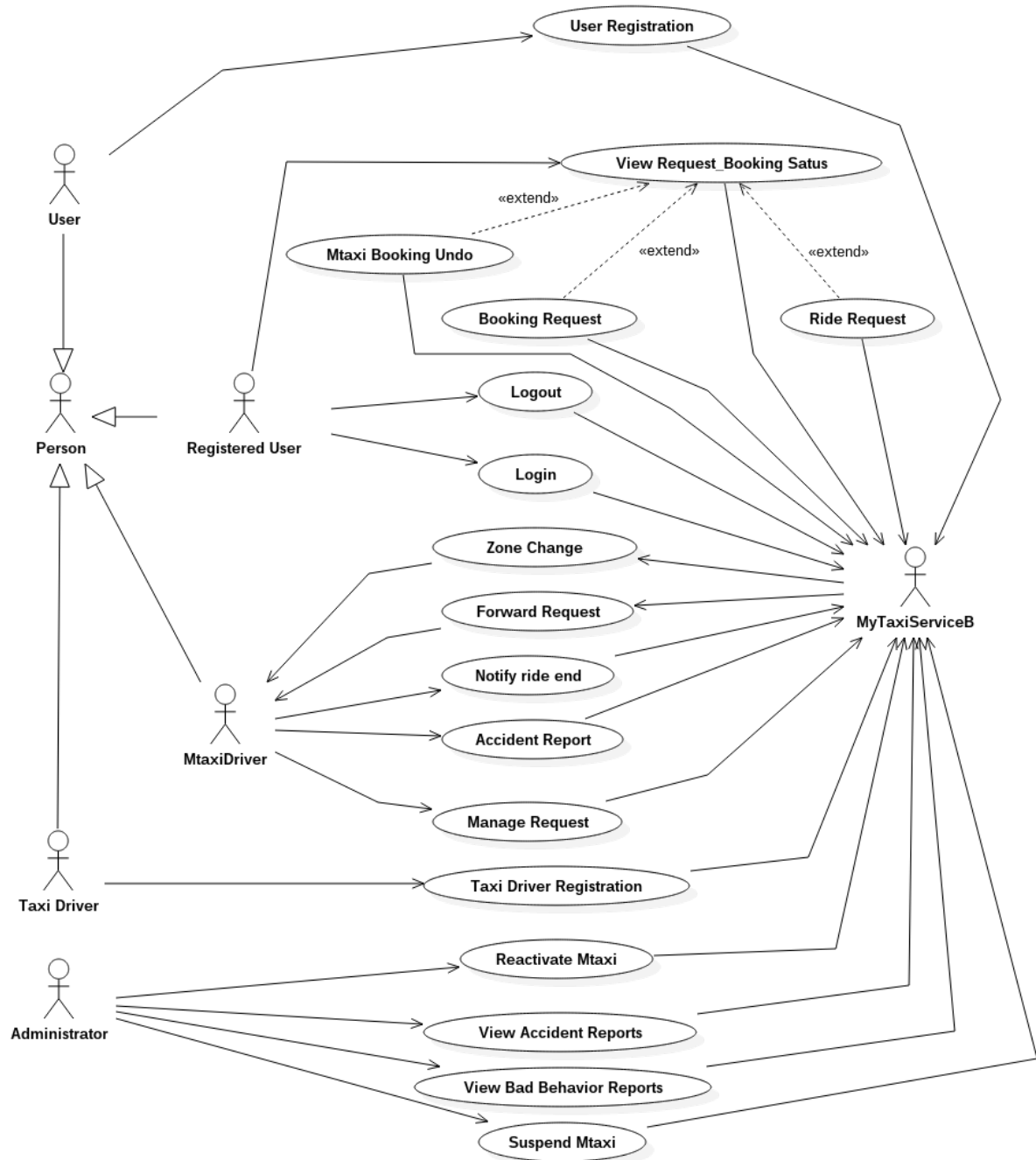
#### 3.1 Scenarios

1. Bob is a product manager with a very busy schedule. At 11.00 he has a meeting with a group of clients to discuss about the features of a new product. This meeting is located in a another part of the city. For his shifts Bob usually takes taxies, and, in order to speed up this process, he started using MyTaxiService. It's 10:30 and Bob decides to take a taxi via MyTaxiService. He opens the app, the app remembers his credentials and logs him in. Bob inserts the address of the meeting and of his current location, choses one passenger and taps the "REQUEST TAXI" button. MyTaxiService then alerts him that is finding a mtaxi. Near Bob's location, a mtaxi has finished serving a passenger, so MyTaxiService(B) signals to it Bob's request. Charlene, the driver of the mtaxi, despite the fact that it's still work time, she wants to take a coffee and so ignores the request. After 5 mins MyTaxiService(B) tries to find a new mtaxi for Bob: Albert's mtaxi is available and MyTaxiService(B) forwards Bob's request to it. Albert receives the request and alerts MyTaxiService(B) that he's going to take care of the ride. MyTaxiService alerts Bob that his taxi will arrive in 3 mins. The Taxi arrives, and in 10 mins Bob reaches the meeting place. MyTaxiService(B) signals the behavior of Charlene to her supervisors, and, after a few weeks, Charlene receives a warning and a fine of 200 euro
2. It's Friday, 10 a.m, Paris, Ann, a young american tourist, has to take a flight at 12 a.m to return to New York City. Ann has carefully planned the return trip, infact yesterday she made a taxi booking via MyTaxiService web site for 9:45 a.m , but the mtaxi has not arrived yet. So she take her smartphone opens the MyTaxiService application, enters her credentials and after a successful login she discovers that her mtaxi is stuck in a terrible traffic jam and that MyTaxiService is trying to find a new mtaxi. "I'll miss my flight!" she thinks, and starts to wait with the heart full of hope
3. Dave, an experienced taxi driver of the city, has received, through MyTaxiService, a request for a ride from a passenger. "It's not too much far from where i am now", he thinks, "It'll be easy", and notifies MyTaxiService that he'll take care of the request. He starts driving toward the passenger's position, but suddenly , while he's crossing a very busy crossroad, a reckless driver coming from the left crosses at high speed the crossroad and hits with violence Dave's taxi cab. Luckily nobody gets hurt, but Dave's taxi cab has been seriously damaged. Dave cannot fulfill the passenger's request so he takes his smartphone, opens the MyTaxiService app, and taps the "REPORT ACCIDENT" button, he accesses a screen where he inserts the accident details and taps the "SUBMIT" button. MyTaxiService(B) receives the Dave's report and after some computations selects and notifies another driver to fulfill the passenger request.

4. Ann, a young female student from Texas, is visiting Italy with his boyfriend Bob. It's Friday morning, they are walking on the streets of Milan and they're thinking about visiting the Expo on Saturday. Ann proposes to use a taxi to reach Expo's location and Bob agrees. Ann is a very cautious person so she thinks it's better to book a taxi, for this reason she searches on Google "taxi milano book" and discovers MyTaxiService. She downloads the app on her Iphone; she opens the app, which displays a login screen with a registration button, and taps that button being so redirected to a registration screen; she inserts her mail address, choses and confirm a password, accepts the legal terms of the app and taps the confirm button; after that Ann is ready to use the app. In order to book a taxi for Saturday for the Expo, Ann accesses the booking section of the app, taps the "ADD BOOKING" button and in the add booking screen inserts the Expo's location by selecting the right item in a dropdown menu, inserts the time and location of the picking , choses two passengers and taps the big "BOOK TAXI" button, MyTaxiService responds by alerting Ann that her booking has been processed successfully. Ann is happy about the fact that everything has proceeded without problems. Bob instead is not so happy because he thinks that the Milan's transportation system is perfect to reach Expo and its far way cheaper than taking a taxi. Bob and Ann have a brief discussion about this and, at the end, Ann agrees with Bob. Given that, Ann tries to undo the booking: she opens the app, she logs in, she accesses the booking section and there she sees her booking for Saturday, she taps the bin icon to delete the booking, she confirms her intention to do that and everything is done.
5. It's Thursday, 14:00 and George, a young mtaxi driver, is driving in the city's center. He noticed many of his colleagues waiting for requests in their cabs. Meanwhile MyTaxiService(B), by making some analysis on the mtaxies' gps data, realizes that there are too many mtaxies in the city's center in relation with the number of ride requests for that zone. The system also indentifies some zones of the city where the concentration of mtaxies is too low. According to a policy based on some statistical data MyTaxiService(B) decides to move 10 mtaxies, including the George's one, from the city's center to the city's zones mentioned above. As a consequence of, George receives by MyTaxiService a notification that alerts him to move to zone C (one of the city's zones with low concentration of mtaxies). George start driving towards zone C and continues his work.

## 3.2 Use cases of the application

### 3.2.1 General use case diagram



1. A registered user makes a ride request

**Use case name:** Ride request

**Actors:** A registered user, MyTaxiService(B)

**Pre-cons:** The registered user has logged into MyTaxiService.

**Post-cons:** MyTaxiService(B) receives the ride request and tries to find an available mtaxi to fulfill it.

**Entry Cnd:** A registered user wants to be picked up by a mtaxi as soon as possible in a given place.

**Exit Cnd:** The registered user is acknowledged that MyTaxiService(B) has received successfully the ride request

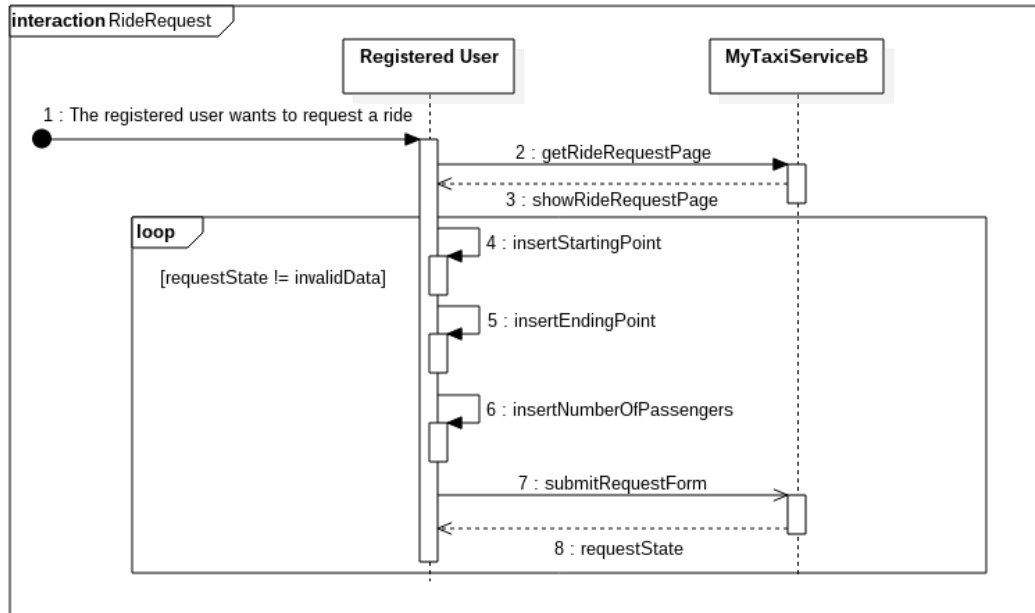
**Exceptions**

- (a) Connection lost(for the mobile app): the registered user is immediately notified of the event and asked to try again later
- (b) Invalid input: the registered user is asked to reenter the information

**Flow of events**

- (a) The registered user taps/clicks the "REQUEST TAXI" button
- (b) The registered user is redirected to a screen dedicated to the insertion of the requested ride's details
- (c) The registered user fills out a form for the ride request inserting the ride's starting and ending location (chosen from a list of every valid city's location) and the number of passengers
- (d) The registered user submits to MyTaxiService(B) the form by clicking/-tapping the "CONFIRM REQUEST" button

## Sequence diagram



## 2. A registered user makes a booking request

**Use case name:** Booking request

**Actors:** A registered user, MyTaxiService(B)

**Pre-cons:** The registered user has logged into MyTaxiService.

**Post-cons:** MyTaxiService(B) receives the booking request and registers it; 10 mins before the chosen picking up time, MyTaxiService(B) will try to find an available taxi to fulfill the request

**Entry Cnd:** A registered user wants to book a mtaxi in order to be picked up at a specific date and time

**Exit Cnd:** The registered user is acknowledged that MyTaxiService(B) has received successfully the ride request

### Exceptions

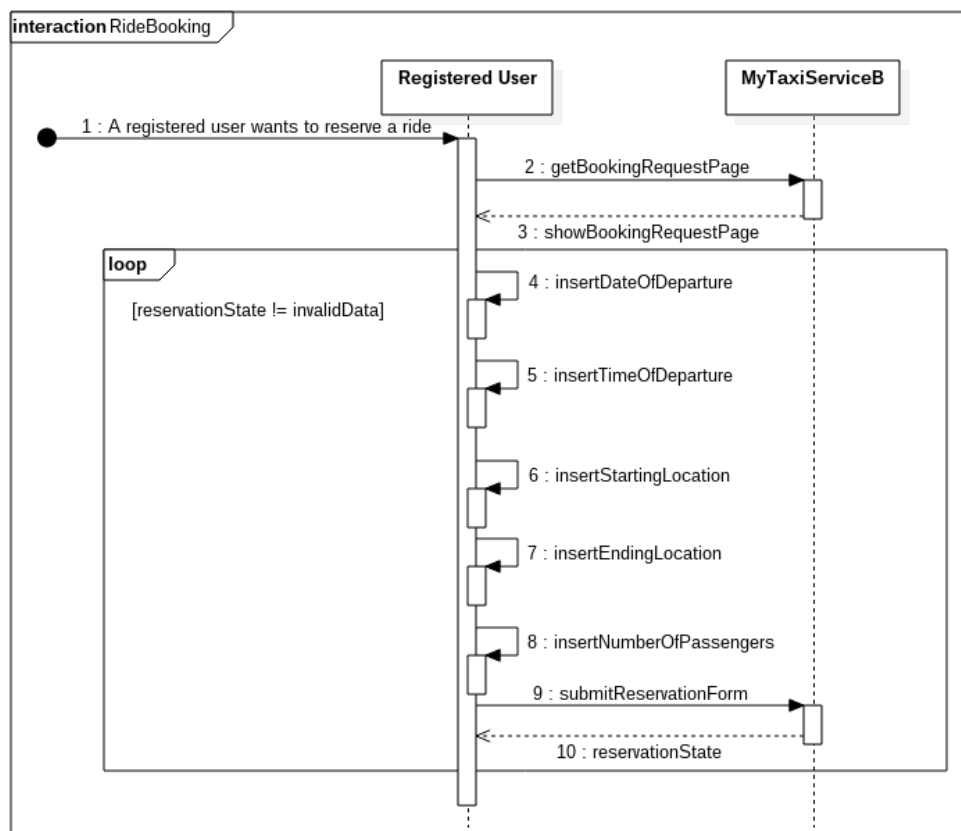
- (a) Connection lost(for the mobile app): the registered user is immediately notified of the event and asked to try again later
- (b) Invalid input: the registered user is asked to reenter the information

### Flow of events

- (a) The registered user taps/clicks the "BOOK TAXI" button on the booking/request ride page of the app/website

- (b) The registered user is redirected to a screen dedicated to the insertion of the requested booking details
- (c) The registered user fills out a form for the booking request, inserting the ride's starting and ending location, the number of passengers, the date and the time(chosen from a list of every valid dates and times) for which be picked up.
- (d) The registered user submits to MyTaxiService(B) the form by clicking/-tapping the "CONFIRM BOOKING" button

Sequence diagram



- 3. MyTaxiService(B) forwards a received ride request to a mtaxi driver

**Use case name:** Forward request

**Actors:** A mtaxi driver, MyTaxiService(B)

**Pre-cons:** The mtaxi driver has informed MyTaxiService(B) that he has finished serving a passenger and so is ready for a new ride

**Post-cons:** The mtaxi driver knows that a registered user has requested a ride with the specified details and is ready to fulfill it

**Entry Cnd:** MyTaxiService(B) has received a ride request from a logged registered user

**Exit Cnd:** MyTaxiService(B) is acknowledged that the mtaxi driver has received successfully the ride request

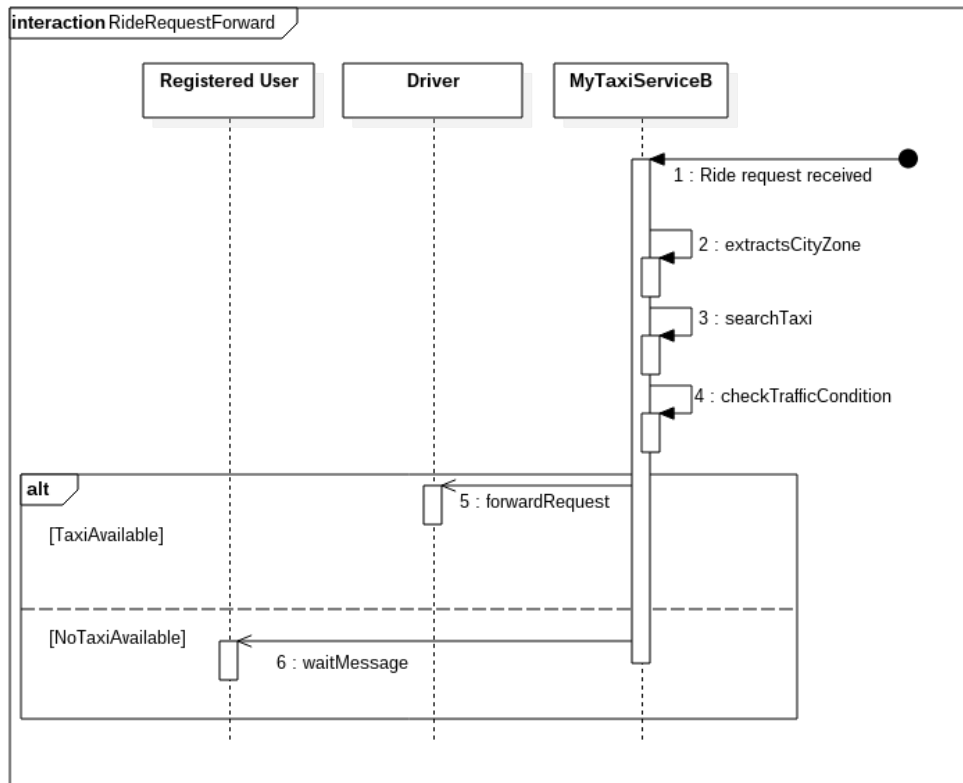
**Exceptions**

- (a) No mtaxi is available for the city's zone relative to the ride request: MyTaxiService(B) tries to find a mtaxi that fits the ride request details (in terms of number of passengers) and that is located in the city's zones adjacent to the one above mentioned
- (b) No mtaxi available: MyTaxiService(B) notifies the registered user who made the request, that no mtaxi is available and that he should try again later

**Flow of Events**

- (a) MyTaxiService(B) extracts the city zone relative to the starting location of the ride request
- (b) MyTaxiService(B) selects a mtaxi that suits the ride requests details (in terms of number of passengers) from the queue of available mtaxies for the city zone above mentioned
- (c) MyTaxiService(B) checks if the traffic conditions in the zone where the selected mtaxi is located are acceptable (they allow the mtaxi to reach the registered user to pick up within 10 minutes)
- (d) MyTaxiService(B) forwards the ride request to the driver of the selected mtaxi

## Sequence diagram



4. A mtaxi driver informs MyTaxiService(B) that he has finished serving a passenger

**Use case name:** Notify ride end

**Actors:** A mtaxi driver, MyTaxiService(B)

**Pre-cons:** The mtaxi current location is the ending location of his last ride

**Post-cons:** MyTaxiService(B) considers the mtaxi available

**Entry Cnd:** The mtaxi driver has finished serving a passenger

**Exit Cnd:** The mtaxi driver is acknowledged that MyTaxiService(B) has received successfully his notification

### Exceptions

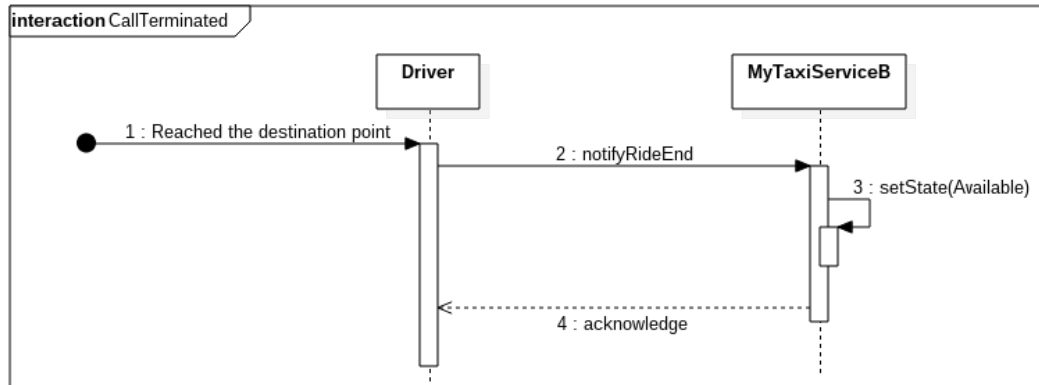
- (a) Connection Lost: the mtaxi driver is immediately notified of the event and is asked to try again later

### Flow of Events

- (a) The mtaxi driver taps the "END RIDE" button on the screen of his MYT and so notifies MyTaxiService(B) that he has ended serving a passenger and is now available for other ride/booking requests



## Sequence diagram



5. A mtaxi driver manages a ride request from MyTaxiService(B)

**Use case name :** Manage request

**Actors :** A mtaxi driver, MyTaxiService(B)

**Pre cons :** The mtaxi has to be available

**Post cons :** The mtaxi driver has started driving to the starting location of the requested ride

**Entry Cnd :** MyTaxiService(B) has forwarded successfully a ride request to the mtaxi driver

**Exit Cnd :** The mtaxi driver is acknowledged that MyTaxiService(B) has received successfully his notification of ride acceptance.

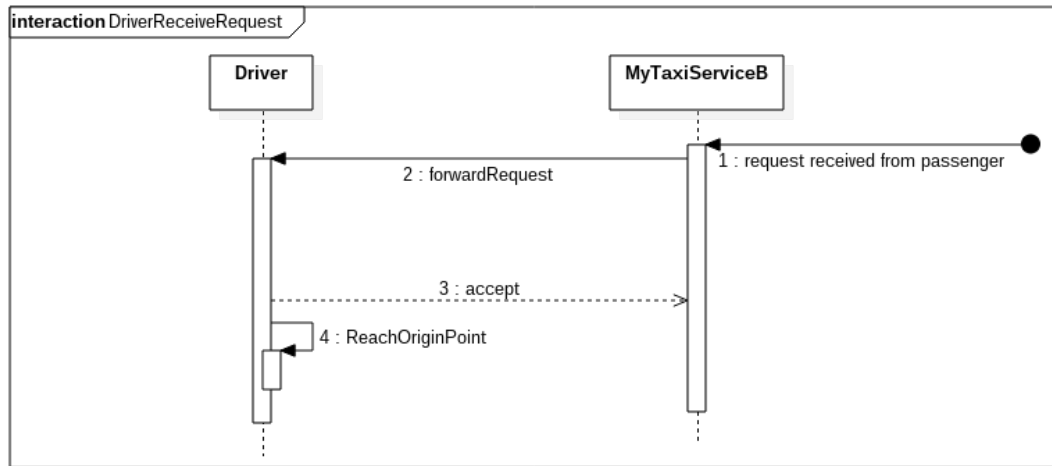
### Exceptions

- (a) If MyTaxiService(B) does not receive the acceptance of the ride request by the mtaxi driver within 2 mins, it selects another mtaxi to fulfill the request, and signals to the supervisors of the mtaxi driver in discussion his behavior

### Flow of Events

- (a) The mtaxi driver taps the "ACCEPT REQUEST" button on the screen of his MYT, and so notifies MyTaxiService(B) that he's going to take immediately care of the request

## Sequence diagram



6. A registered user logs into MyTaxiService

**Use case name:** Login

**Actors:** A registered user, MyTaxiService(B)

**Pre Cnd:** The registered user is not logged into MyTaxiService. The registered user has access to MyTaxiService app or website

**Post Cnd:** The registered user has access to all the functionalities of MyTaxiService reserved to registered users(see functional reqs)

**Entry Cnd:** The registered user wants to access the functionalities offered by MyTaxiService

**Exit Cnd:** The registered user is acknowledged that MyTaxiService(B) has recognized as valid the inserted credentials. MyTaxiService(B) will grant the registered user the access to all the functionalities reserved to registered users(see functional reqs)

### Exceptions

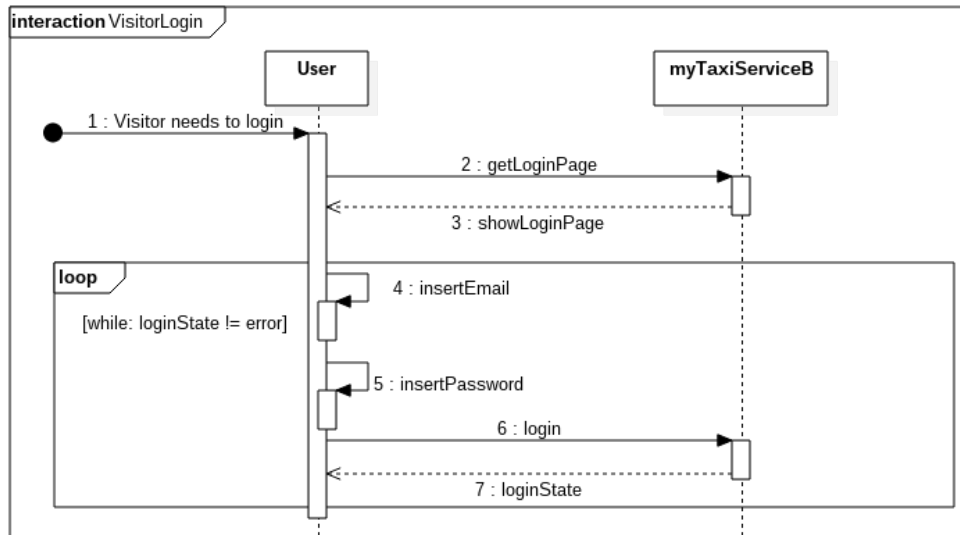
- (a) Connection Lost: the registered user is immediately notified of the event and the entire process has to be redone
- (b) Wrong Credentials(credentials that do not match any registered user): the registered user is asked to insert his credentials again

### Flow of Events

- (a) The registered user opens the MyTaxiService app or access the MyTaxiService website, and a login screen is shown, along with the option to register to the service and to remember the login

- (b) The registered user inserts his credentials in the relative fields
- (c) The registered user clicks/taps the "LOGIN" button

Sequence diagram



- 7. A registered user logs out from MyTaxiService

**Use case name:** Logout

**Actors:** A registered user, MyTaxiService(B)

**Pre cons:** The registered user is logged into MyTaxiService

**Post cons:** The registered user has no access to MyTaxiService functionalities until a new login

**Entry Cnd:** The registered user wants to logout from MyTaxiService

**Exit Cnd:** The registered user is acknowledged that MyTaxiService(B) has logged him out from the service

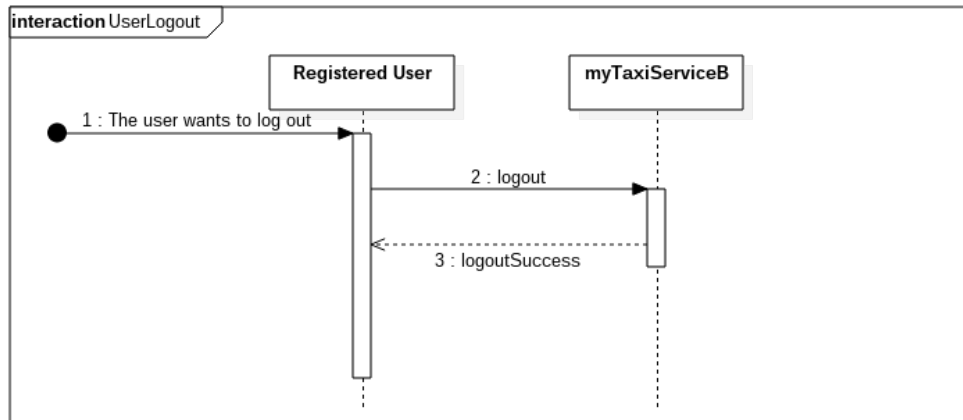
**Exceptions**

- (a) Connection Lost: the registered user is immediately notified of the event and the entire process has to be redone

**Flow of Events**

- (a) The registered user taps/clicks the "LOGOUT" button on a screen of the app/website (every screen of the app/website has the "LOGOUT" button)

## Sequence diagram



### 8. A User wants to register to MyTaxiService

**Use case name:** User Registration

**Actors:** A user, myTaxiService(B)

**Pre cons:** The user has access to the MyTaxiService app or website

**Post cons:** The user becomes a registered user

**Entry Cnd:** The user wants to register to MyTaxiService in order to access its functionalities

**Exit Cnd:** The user is acknowledged that MyTaxiService(B) has registered him

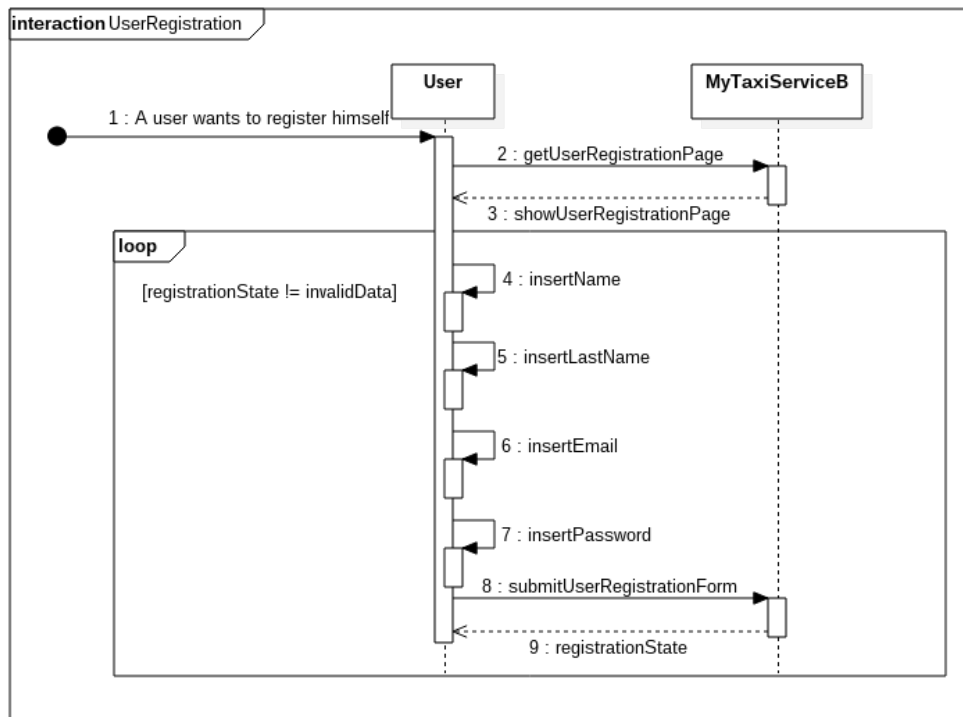
#### Exceptions

- (a) Connection Lost: the user is immediately notified of the event and the entire process has to be redone
- (b) Invalid data(non correctly formatted data or a email already user by another registered user): the user is immediately notified and forced to insert valid data

#### Flow of Events

- (a) The user opens the MyTaxiService app or access the MyTaxiService website, and a login screen is shown, along with the option to register to the service
- (b) The user taps/click the "REGISTER TO THE SERVICE" button
- (c) The user is redirected to a screen with a form to be filled out with Name, Surname, email a password.
- (d) The user fills the form
- (e) The user press the "CONFIRM BUTTON" and so submits the form to MyTaxiService(B)

## Sequence diagram



### 9. A registered user undoes a mtaxi booking

**Use case name:** Mtaxi booking undo

**Actors:** A registered user, MyTaxiService(B)

**Pre cons:** The registered user is logged into MyTaxiService. The registered user has made a successful booking request. The mtaxi booking the registered user wants to undo specifies a pickup time so that:  
 $(pickuptime - currenttime) > 10mins$

**Post cons:** The scheduled mtaxi booking is no more

**Entry Cnd:** The registered user wants to undo a mtaxi booking

**Exit Cnd:** MyTaxiService(B) acknowledges the registered user that the scheduled booking has been deleted

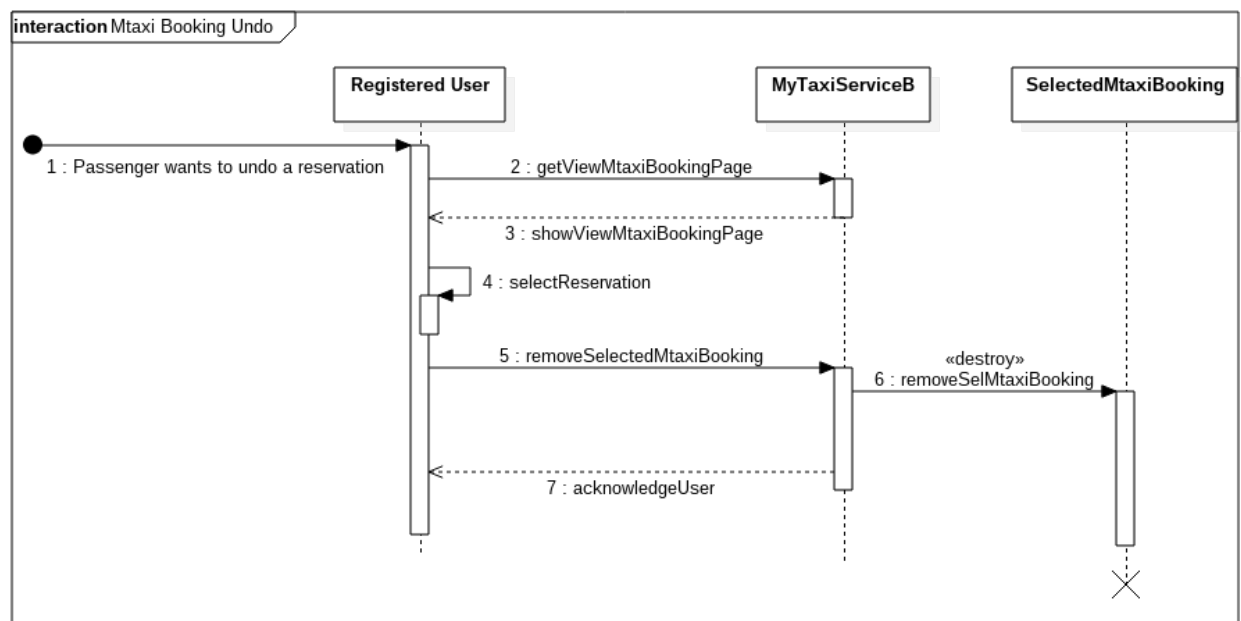
#### Exceptions

- (a) Connection Lost: the registered user is immediatly notified of the event and the entire process has to be redone

#### Flow of Events

- (a) The registered user accesses the MyTaxiService app/website area where he can see the list of his bookings
- (b) The registered user taps/click the recycle bin icon located in the row that corresponds to the mtaxi booking he wants to undo
- (c) The registered user confirm his choice by clicking/tapping the "CONFIRM" button on the popup that has just appeared

Sequence diagram



10. A mtaxi driver receives a zone change order

**Use case name:** Zone change

**Actors:** A mtaxi driver, MyTaxiService(B)

**Pre cons:** The mtaxi is available

**Post cons:** The distribution of mtaxies in the city's zones is more balanced with respect to the average number of ride requests per zone

**Entry Cnd:** MyTaxiService(B) has detected that some city's zones have too much mtaxies assigned and some others not, all with respect to average number of ride requests per zone. MyTaxiService has assigned the mtaxi in discussion to another city's zone

**Exit Cnd:** MyTaxiService(B) is acknowledged by the mtaxi driver that he has received successfully the zone change order

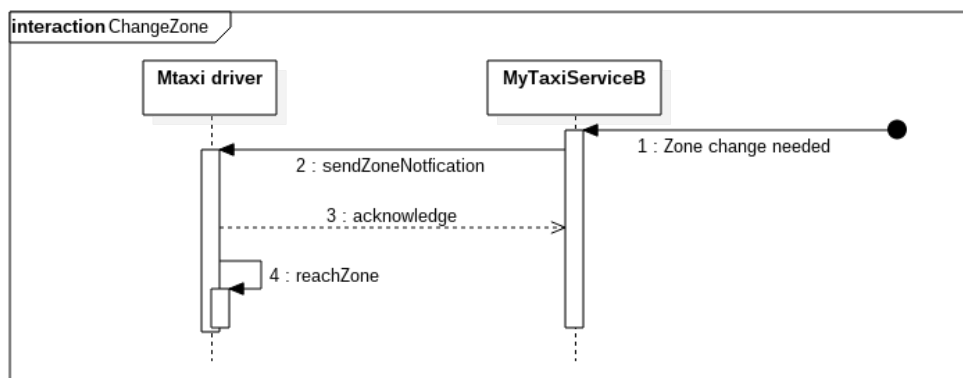
### Exceptions

- (a) Connection Lost: the mtaxi driver is immediately notified of the event and the entire process has to be redone

### Flow of Events

- (a) MyTaxiService(B) forwards to the mtaxi a change zone order, since the mtaxi has been assigned to another city's zone in order to guarantee a more balanced distribution of mtaxis among all the city's zones
- (b) The mtaxi driver receives the order

Sequence diagram



## 11. A mtaxi driver reports an accident

**Use case name:** Accident report

**Actors:** A mtaxi driver, MyTaxiService(B)

**Pre cons:** The mtaxi driver has access to and can use MYT. MYT has not been damaged and so is fully functional

**Post cons:** MyTaxiService(B) considers the mtaxi unavailable and stores the data relative to the accident for statical uses

**Entry Cnd:** A mtaxi driver had an accident and wants to report it(has to report it)

**Exit Cnd** MyTaxiService(B) acknowledges the driver about the fact that it has received successfully the accident report

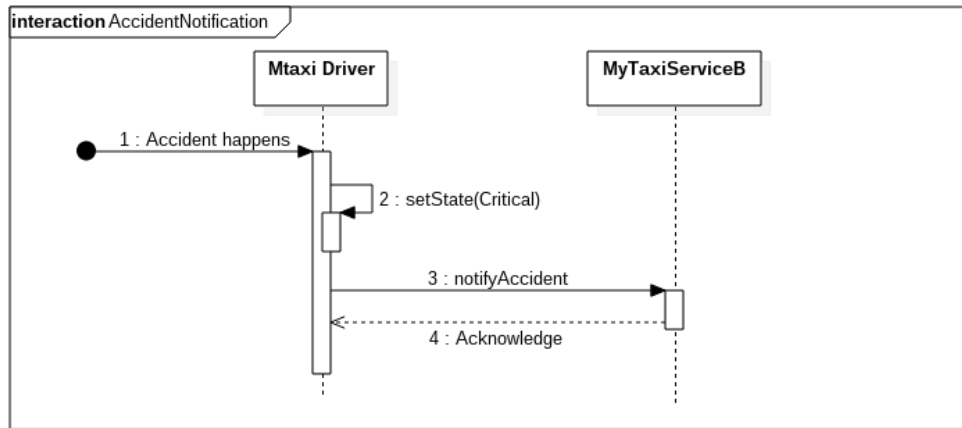
### Exceptions

- (a) Connection Lost: the mtaxi driver is immediately notified of the event and the entire process has to be redone

### Flow of Events

- (a) The mtaxi driver taps the "REPORT ACCIDENT" button on the screen of his MYT

Sequence diagram



12. A taxi driver wants to register to MyTaxiService

**Use case name:** Taxi driver Registration

**Actors :** A taxi driver, MyTaxiService(B)

**Pre cons :** The taxi driver is not yet registered to MyTaxiService

**Post cons :** The taxi driver becomes a mtaxi driver.

**Entry Cnd :** A taxi driver wants to register to MyTaxiService

**Exit Cnd :** The taxi driver is acknowledged that MyTaxiService(B) has registered him. MyTaxiService(B) assigns to the taxi a unique identification number

**Exceptions**

- (a) Connection Lost: the taxi driver is immediately notified of the event
- (b) The taxi is not registered as a city's taxi: the taxi driver is immediately notified and forced to change personal and taxi cab information inserted

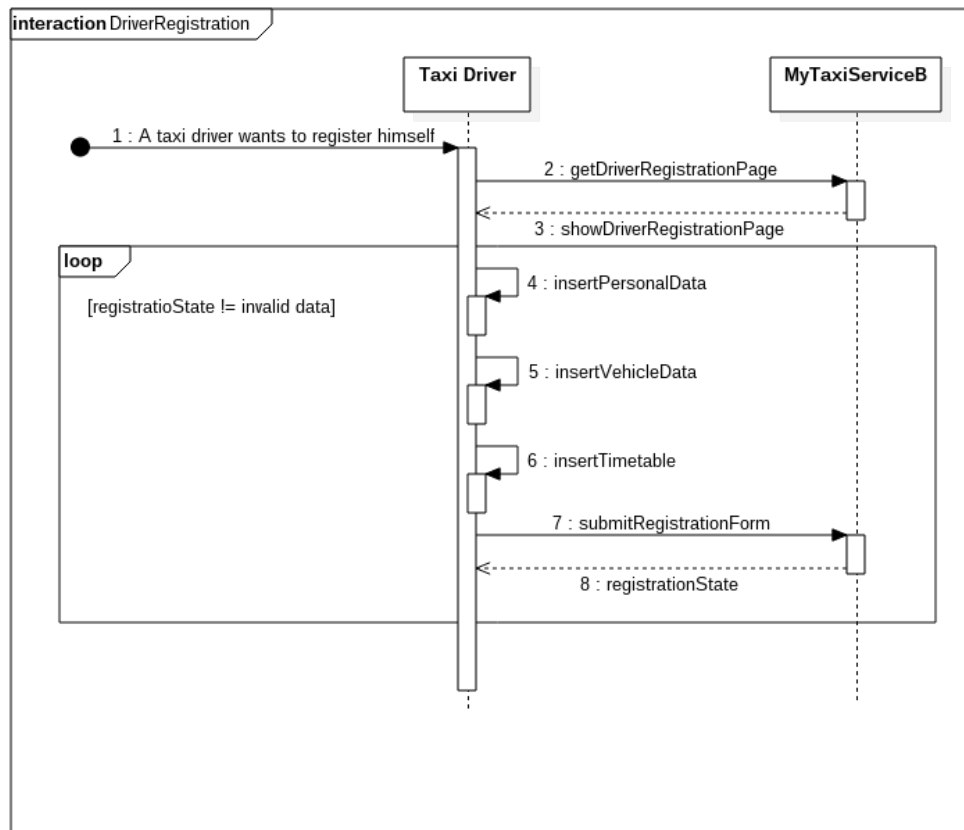
**Flow of Events**

- (a) The taxi driver accesses the MyTaxiService website
- (b) The taxi driver click the "REGISTER AS DRIVER" button
- (c) The taxi driver is redirected to a screen with a form to be filled out with personal information (name, last name, address, SSN), taxi cab information (brand and model, license plate number) and working work timetable information
- (d) The taxi driver fills the form



- (e) The taxi driver press the "CONFIRM BUTTON" and so submits the form to MyTaxiService(B)

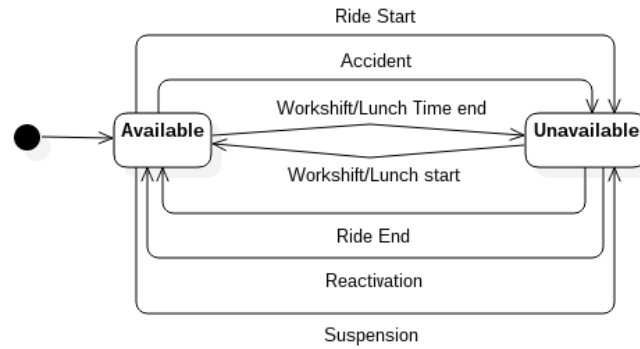
Sequence diagram



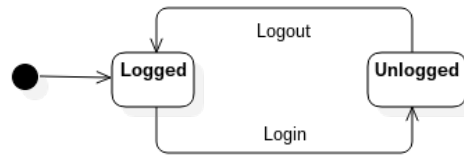
### 3.3 State chart diagrams

In this section are present some state chart diagrams to illustrate the dynamic behaviour of MyTaxiService.

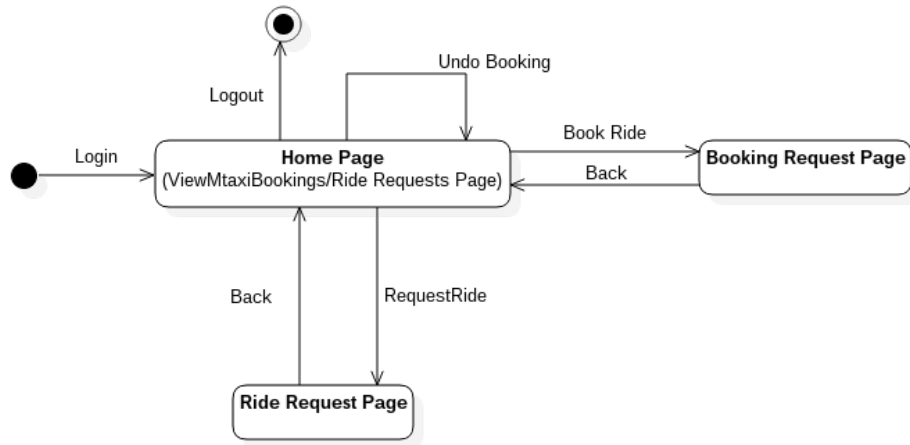
This state chart diagram illustrates the state of a generic Mytaxi driver



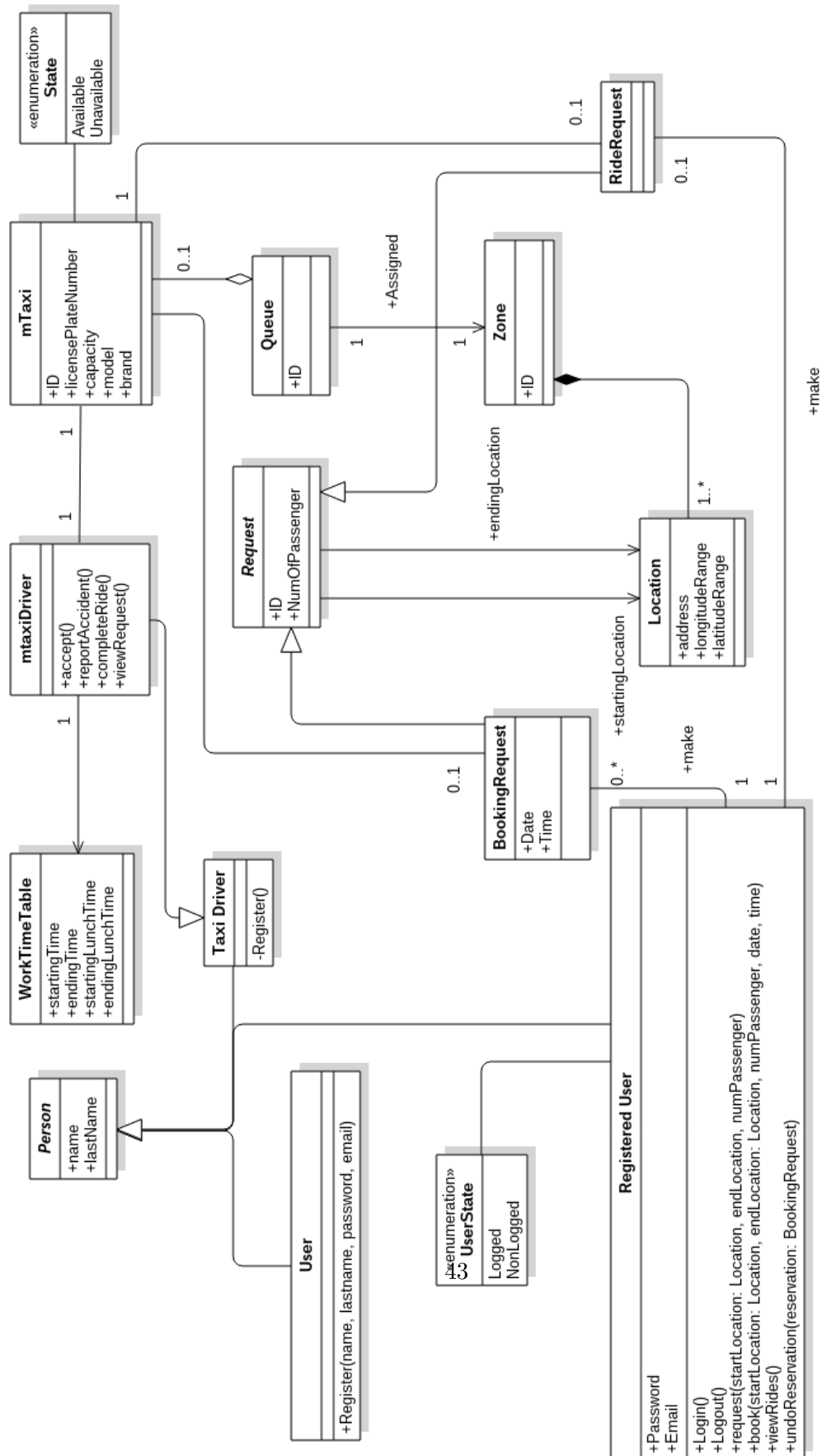
This state chart driver illusrates the state of a generic registered user



This state chart diagram illustrates the behaviour of a generic registered user during the use of MyTaxiService



### 3.4 Class diagram



## 4 Alloy model

### 4.1 Sigs

```
1 //START ENTITIES
2
3 //Models integer values
4 sig Integer{}
5 //Models string values
6 sig Strings{}
7
8
9 abstract sig Person {
10   name : one Strings,
11   lastName: one Strings
12 }
13
14 sig User extends Person {}
15
16 sig RegisteredUser extends Person {
17   email : one Strings,
18   password: one Strings,
19   rideRequest: lone RideRequest,
20   bookingRequest: set BookingRequest,
21   userState: one UserState
22 }
23
24 abstract sig UserState{}
25
26 one sig Logged, NonLogged extends UserState {}
27
28 sig Mtaxi {
29   id : one Integer,
30   licensePlateNumber: one Strings,
31   capacity: one Integer,
32   model: one Strings,
33   brand: one Strings,
34   driver: one MtaxiDriver,
35   state : one TaxiState
36 }
37
38 abstract sig TaxiState{}
39
40 one sig Available, Unavailable extends TaxiState {}
41
42 sig TaxiDriver extends Person {}
43
44 sig MtaxiDriver extends TaxiDriver{
45   workTimeTable : one WorkTimeTable,
46   taxi : one Mtaxi,
47 }
48
49 abstract sig Request{
```

```

50     id : one Integer,
51     numPassengers: one Integer,
52     startingLocation : one Location,
53     endingLocation: one Location,
54     user : one RegisteredUser
55 }
56
57 sig RideRequest extends Request {
58     taxi : one Mtaxi,
59 }
60
61 sig BookingRequest extends Request{
62     taxi: lone Mtaxi, //MOD
63     date : one Strings,
64     time: one Strings
65 }
66
67 sig Location {
68     address : one Strings,
69     longitudeRange: one Strings,
70     latitudeRange: one Strings
71 }
72
73 sig Zone {
74     id: one Strings,
75     locations: some Location
76 }
77
78 sig Queue {
79     id : one Strings,
80     taxies: set Mtaxi,
81     zone : one Zone
82 }
83
84 sig WorkTimeTable {
85     startingTime: one Strings,
86     endingTime: one Strings,
87     startingLunchTime: one Strings,
88     endingLunchTime: one Strings
89 }
90 //ENDING ENTITIES

```

## 4.2 Facts

```
93 // D -> Different
94 //Different requests correspond to different mtaxies
95 fact DRequestsDMtaxies {
96   //Different requests correspond to different mtaxies
97   all r1, r2 : RideRequest | r1!=r2 implies r1.taxi != r2.taxi
98   //Different booking requests correspond to different mtaxies if these
   two different requests are associated to two taxies
99   all r1, r2 : BookingRequest | r1!=r2 implies r1.taxi != r2.taxi
100   //Mixed case
101   all r1 : RideRequest, r2: BookingRequest | r1.taxi != r2.taxi
102 }
103 //A zone is associated to a specif queue and a queue is associated to a
   specific zone
104 fact zonesQueues {
105   //Every zone is associated with just one queue
106   all z : Zone | one q: Queue | q.zone = z
107   //Different queues correspond to different zones
108   all q1, q2 : Queue | q1!=q2 implies q1.zone != q2.zone
109 }
110
111 fact IdsConsistency {
112   //Different requests have different request ids
113   all r1, r2 : Request | r1!=r2 implies r1.id != r2.id
114   //Different mtaxies have different mtaxi ids
115   all t1, t2 : Mtaxi | t1!=t2 implies t1.id != t2.id
116   //Different queues have different ids
117   all q1, q2: Queue | q1 != q2 implies q1.id != q2.id
118 }
119 //Different registered users have different emails
120 fact DUsersDMails {
121   all u1, u2 : RegisteredUser | u1!=u2 implies u1.email != u2.email
122 }
123 //Different requests are associated to different users
124 fact DRideRequestsDUsers {
125   //Ride requests case
126   all r1, r2 : RideRequest | r1!=r2 implies r1.user != r2.user
127   //Booking request case
128   all r1, r2 : BookingRequest | r1!=r2 implies r1.user != r2.user
129 }
130 //A ride request has to be performed by a logged user
131 fact RequestLoggedUser {
132   all r : RideRequest | (r.user).userState = Logged
133 }
134 //If a registered user is associated with a request than that request is
   associated with that user
135 fact TwoWayBindingUserRequests{
136   //Ride requests case
137   all u : RegisteredUser, r: RideRequest | u.rideRequest=r iff r.user = u
138   //Booking requests case
139   all u : RegisteredUser, r: BookingRequest | u.bookingRequest = r iff r.
   user = u
```

```

140 }
141 //Two different zones aggregate different locations
142 fact DZonesDLocations {
143     all z1, z2: Zone | z1 != z2 implies no l: Location | l in z1.locations
144         and l in z2.locations
145 }
146 fact LocationConstancy {
147     //Two different location can't have the same address
148     all l1, l2: Location | l1 != l2 implies l1.address != l2.address
149     //Like above but for longitude range
150     all l1, l2: Location | l1 != l2 implies l1.longitudeRange != l2.
151         longitudeRange
152     //Like above but for latitude range
153     all l1, l2: Location | l1 != l2 implies l1.latitudeRange != l2.
154         latitudeRange
155 }
156 //Only available mtaxies can fullfil a requests
157 fact RideRequestAvailableMtaxi {
158     //Ride requests case
159     all r: RideRequest | (r.taxi).state = Available
160     //Booking requests case
161     all r: BookingRequest | (r.taxi).state = Available
162 }
163 //If a mtaxi is associated with a mtaxi driver than that driver is
164     associated with that mtaxi
165 fact OneDriverOneTaxi {
166     all t: Mtaxi, d: MtaxiDriver | t.driver = d iff d.taxi = t
167 }
168 //A request has a diffrent start and ending location
169 fact DStartingEndingLocations {
170     all r: Request | r.startingLocation != r.endingLocation
171 }
172 fact WorktimeTableConsistency {
173     //All mtaxies are actually supposed to work
174     all w: WorkTimeTable | w.startingTime != w.endingTime
175     //All mtaxies are actually supposed to have time to have lunch
176     all w: WorkTimeTable | w.startingLunchTime != w.endingLunchTime
177 }
178 //A registered user can't book two or more taxis for the same date and
179     time
180 fact NonUbiquosUsers {
181     all u: RegisteredUser | all b1,b2:BookingRequest | b1 != b2 and b2 in u
182         .bookingRequest and b1 in u.bookingRequest implies b2.date != b1.
183         date and b2.time != b1.time
184 }
185 //A queue aggregates only available mtaxies
186 fact queuesOfAvailableTaxies {
187     all q: Queue, t: Mtaxi | t in q.taxies implies t.state = Available
188 }
189 //Each mtaxi belong(if available) to exactly one queue
190 fact EachQueueDiffTaxi {
191     all q1, q2: Queue | no t: Mtaxi | q1 != q2 and t in q1.taxies and t in
192         q2.taxies

```



### 4.3 Assertions

```
189 assert NoRequestsWithoutUserOrMtaxies {
190     //RideRequest case
191     all r: RideRequest | one u: RegisteredUser, t: Mtaxi | r.taxi = t and r
        .user = u
192     //BookingRequest case
193     all r: BookingRequest | one u: RegisteredUser, t: Mtaxi | r.taxi = t
        and r.user = u
194 }
195 check NoRequestsWithoutUserOrMtaxies for 5
196
197 assert NoUserUbiquos {
198     all u: RegisteredUser | no b1,b2 : BookingRequest | b1 != b2 and b1 in
        u.bookingRequest and b2 in u.bookingRequest
199     and b1.date = b2.date and b1.time = b2.time
200 }
201 check NoUserUbiquos for 5
202
203 assert NoMtaxiWithoutDriver {
204     all t: Mtaxi | one d: MtaxiDriver | t.driver = d
205 }
206 check NoMtaxiWithoutDriver for 5
207
208 assert RequestsMapOnlyAvailableMtaxies {
209     //Ride request case
210     all r: RideRequest | (r.taxi).state = Available
211     //Booking request case
212     all r: BookingRequest | (r.taxi).state = Available
213 }
214 check RequestsMapOnlyAvailableMtaxies for 5
215
216 //Verify that remove and add operations are consistent
217 assert DelUndoAdd {
218     all q,q1,q2: Queue, t: Mtaxi | t not in q.taxies and addTaxiToQueue[q,q1
        ,t]
219     and delTaxiFromQueue[q1,q2,t] implies q.taxies = q2.taxies
220 }
221 check DelUndoAdd for 5
```

## 4.4 Predicates

```
227 //Simulates the add of a taxi to a queue
228 pred addTaxiToQueue(q,q1: Queue, t: Mtaxi) {
229     q1.taxies = q.taxies + t
230 }
231 run addTaxiToQueue for 5
232
233 //Simulates the deletion of a taxi from a queue
234 pred delTaxiFromQueue(q,q1: Queue, t: Mtaxi) {
235     q1.taxies = q.taxies - t
236 }
237 run delTaxiFromQueue for 5
238
239 //General world generation
240 pred show {
241     #RegisteredUser = 2
242     #RideRequest = 1
243     #BookingRequest = 1
244     #Mtaxi = 2
245     #WorkTimeTable = 1
246     #Queue = 1
247 }
248 run show for 5
249
250 //Show a world which enlights ride/booking request properties
251 pred RideBookingRequestProperties {
252     #Mtaxi = 2
253     #MtaxiDriver = 2
254     all d: Mtaxi | d.state = Available
255     #RideRequest = 1
256     #BookingRequest = 1
257     #WorkTimeTable = 1
258 }
259
260 run RideBookingRequestProperties for 3
```

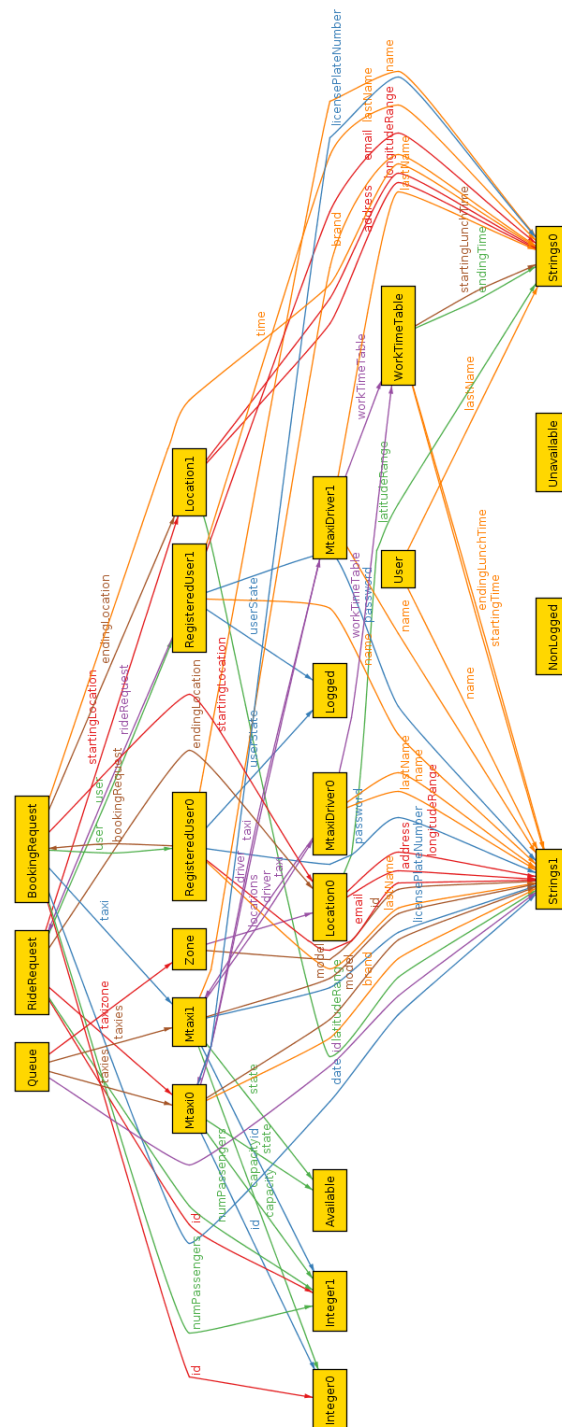
## 4.5 Results

In this section is shown the results produced by Alloy Analyzer

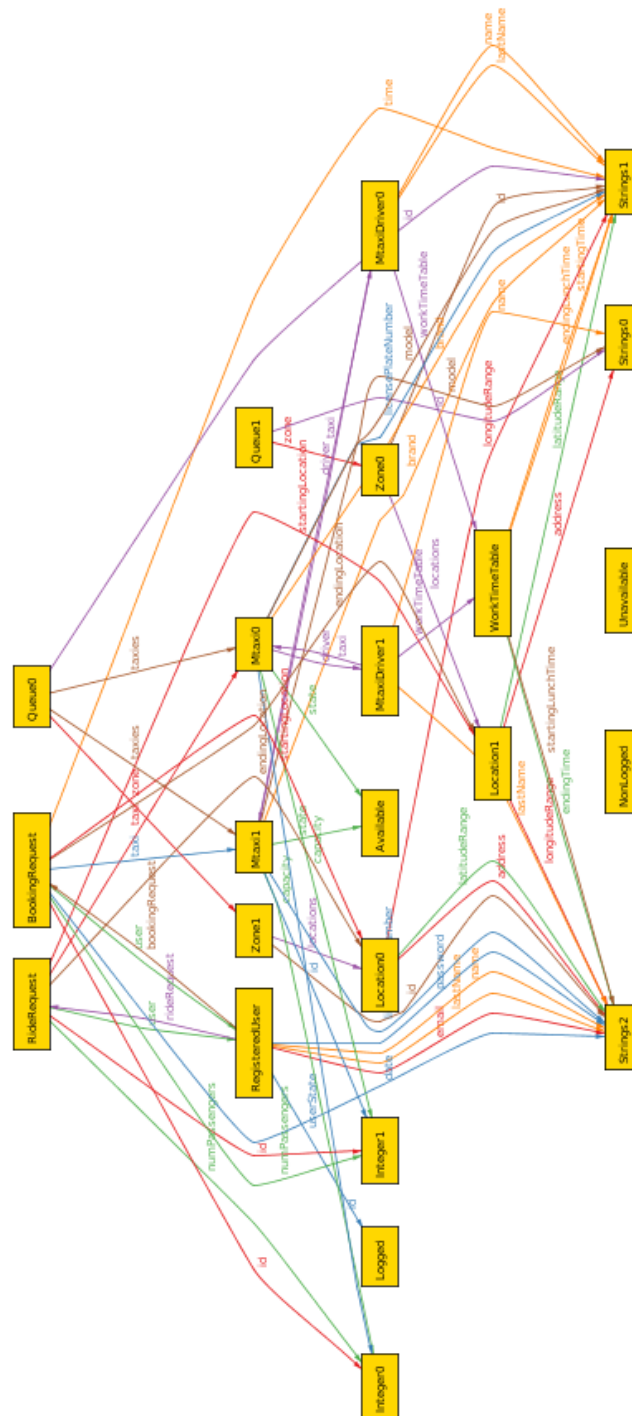
Here is represented the output of Alloy Analyzer: all predicates are consistent and all assertions are (may be) valid.

```
9 commands were executed. The results are:  
#1: No counterexample found. NoRequestsWithoutUserOrMtaxies may be valid.  
#2: No counterexample found. NoUserUbiquos may be valid.  
#3: No counterexample found. NoMtaxiWithoutDriver may be valid.  
#4: No counterexample found. RequestsMapOnlyAvailableMtaxies may be valid.  
#5: No counterexample found. DelUndoAdd may be valid.  
#6: Instance Found. addTaxiToQueue is consistent.  
#7: Instance Found. delTaxiFromQueue is consistent.  
#8: Instance Found. show is consistent.  
#9: Instance Found. RideBookingRequestProperties is consistent.
```

This graph shows the model produced by the execution of the predicate show



This graph shows the model produced by the execution of the predicate RideBookingRequestProperties



## 5 Appendix

### 5.1 Tools

- Latex/Atom: to redact and produce this document
- Git: to manage the collaboration of the team members
- Start UML: to produce the UML diagrams attached to this document
- Alloy Analyzer 4.2: to prove the consistency of the model defined in this document
- Mockups.com: to produce the mockups for the interfacesS

### 5.2 Hours of work

- Giorgio Pea: 36 hours
- Andrea Sessa: 36 hours

### 5.3 Revision

Date	Description	Authors
13/11/2015	Modified assumption section	Pea, Sessa
3/12/2015	Added administrator requirements and mockups	Pea, Sessa
1/01/2016	Revised alloy model and JZ model	Sessa