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Software Engineering 2:

”MyTaxiService”

Design Document

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Contents

[1 Introduction 3](#_Toc436571533)

[1.1 Purpose 3](#_Toc436571534)

[1.2 Scope 3](#_Toc436571535)

[1.3 Definitions, Acronyms, and Abbreviations 3](#_Toc436571536)

[1.3.1 Acronyms 3](#_Toc436571537)

[1.4 Reference Documents 3](#_Toc436571538)

[1.5 Document Structure 4](#_Toc436571539)

[2 Architectural Design 5](#_Toc436571540)

[2.1 Overview 5](#_Toc436571541)

[2.2 High level Components and their Interaction 5](#_Toc436571542)

[2.3 Component View 7](#_Toc436571543)

[2.4 Deployment View 9](#_Toc436571544)

[2.5 Runtime View 11](#_Toc436571545)

[2.5.1 Registration 11](#_Toc436571546)

[2.5.2 Authentication 12](#_Toc436571547)

[2.5.3 Normal Request 13](#_Toc436571548)

[2.5.4 Shared Request 14](#_Toc436571549)

[2.5.5 Reservation 15](#_Toc436571550)

[2.5.6 Management 16](#_Toc436571551)

[2.5.7 Emergency 17](#_Toc436571552)

[2.6 Component Interfaces 18](#_Toc436571553)

[2.7 Selected Architectural Styles and Patterns 19](#_Toc436571554)

[2.8 Other Design Decisions 21](#_Toc436571555)

[3 Algorithm Design 23](#_Toc436571556)

[3.1 Request 23](#_Toc436571557)

[4 User Interface Design 25](#_Toc436571558)

[5 Requirements Traceability 31](#_Toc436571559)

[5.1 Goal 1 31](#_Toc436571560)

[5.2 Goal 2 32](#_Toc436571561)

[5.3 Goal 3 32](#_Toc436571562)

[5.4 Goal 4 33](#_Toc436571563)

[5.5 Goal 5 33](#_Toc436571564)

[5.6 Goal 6 34](#_Toc436571565)

[6 References 34](#_Toc436571566)

[7 Revisions Table 35](#_Toc436571567)

# Introduction

## Purpose

This document represents the Design Document (DD).

The main goal of this document is to describe all the components of the system and their interaction.

## Scope

The aim of the project is to create a brand new system for the management and the organization of a city taxi service. This system offers a mobile application and a web interface in order to give the customers the possibility to benefit from the taxi service. Furthermore, the system provides an additional communication interface for the taxi drivers.

The mobile application and the web interface accept requests and reservations for taxis from the users, with the possibility to organise a share ride among different users. The taxi driver is supposed to communicate his availability, acceptances and rejections of requests through the communication interface.

The system is created to simplify the access of passengers to the service and to guarantee a fair management of the taxi queues.

## Definitions, Acronyms, and Abbreviations

### Acronyms

* **DMZ:** Demilitarized Zone
* **DW:** Data Warehouse
* **DB:** Database
* **SOA:** Service-Oriented Architecture
* **RASD:** Requirements Analysis and Specification Document
* **GUI:** Graphical User Interface
* **OS:** Operating System

## Reference Documents

This document refers to the RASD document of the previous deliver.

This document is conformed to the “IEEE Standard for Information Technology—Systems Design— Software Design Descriptions”, (IEEE Std 1016™-2009 (Revision of IEEE Std 1016-1998)).

## Document Structure

* **Introduction:** it gives a description of the document and the information about the project scope
* **Architectural Design:** it contains all the information about the architectures designed for the system and the components that compose them. It provides the Component and Deployment diagram in order to clarify the exact distribution of the components and their interaction. In this chapter all the motivations that have determined the choice of the architecture are also included
* **User Interface Design:** it contains all the mockups useful for the description of the user experience
* **Algorithm Design:** it tries to give an idea of a possible algorithm of a chosen system procedure
* **Requirements Traceability:** it explains how the requirements defined in the RASD map into the design elements that were defined in this document
* **References:** it contains the documentation
* **Revisions Table:** it contains the information of the changes for every revision

# Architectural Design

## Overview

The most important part of the System is structured using the SOA. For this reason, everything that finds place out of our physical system, so all the interfaces used by a person, are defined as Service Requestors. Every operations that the system has to provide are split into atomic services.

In order to manage every request coming from the outside and every message among the services there is a Broker between the service providers and the requestors.

Regarding the data managing, there are two different approaches:

* Storing all the sensitive data in a database, contained into a DMZ, in order to guarantee a high level of security.
* Using a DW, connected to an analyser software, to store all the other data in order to perform data mining operations.

The last component defined is an http Web Server used for the storage of every file needed by the Website.

Push Notifications are used to perform the communication from the service providers to the requestors or directly to the web server, depending on the user/Taxi driver interface involved.

## High level Components and their Interaction

The components of the system are:

* The service providers, which are the software components that must be installed on the servers and that contain the logic in order to manage the services offered to the clients.

In this system the providers are:

* + The requests manager that handles the clients requests for a normal ride
  + The shared rides manager that handles the clients requests for a shared ride
  + The reservations manager that handles the clients reservations
  + The registration manager that handles the users registration to the service, storing their information on the users database
  + The authentication manager that handles the users authentication to the system preventing unauthorized access into the system
  + The taxi manager, which performs the coordination of the queue and the Taxi drivers’ availability
  + The emergency manager that handles the emergency messages from the taxi driver before and during a ride
* The service requestors, which are the interfaces that request the execution of a service. They all have an active internet connection in order to send the requests to the providers.

In this system, according to the RASD description of the devices, the requestors are:

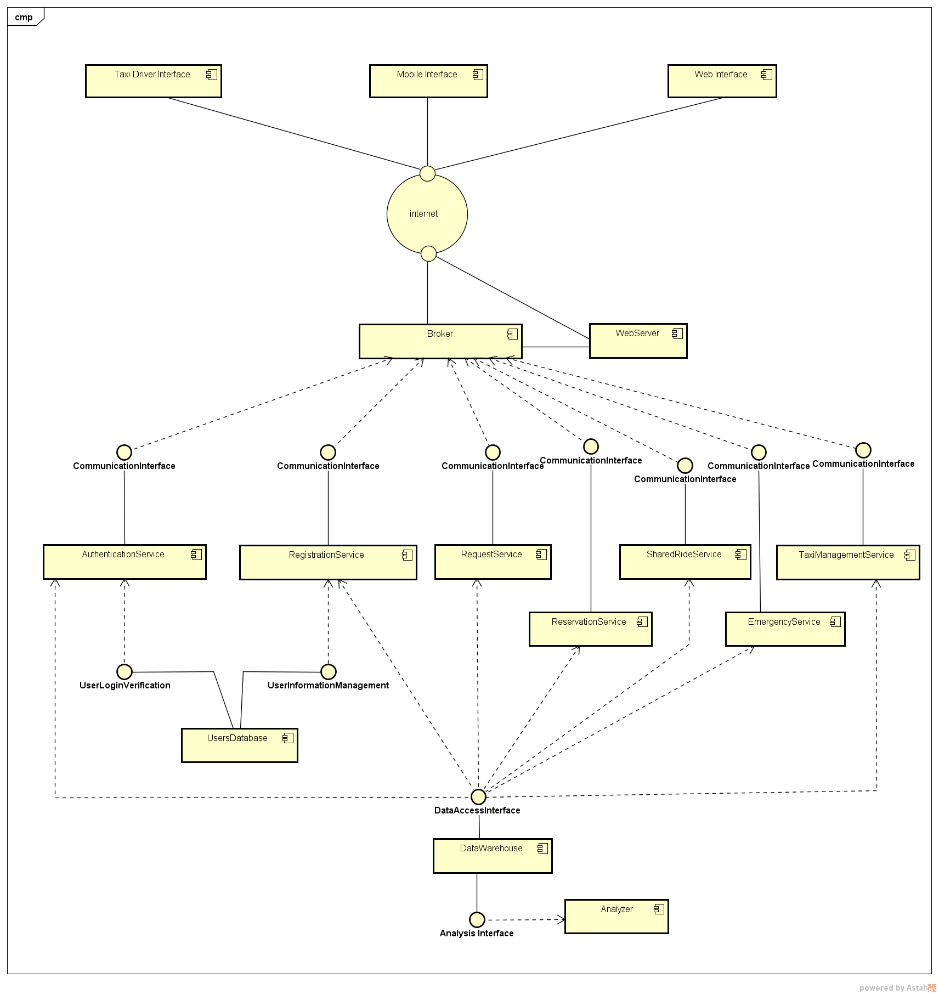
* + The Taxi driver interface that acts as the interface to the system for taxi driver
  + The web interface that is the web browser interface used by the clients to access the system functions and also eventually for administration purposes
  + The mobile interface that is the interface used by mobile devices to access the system functionalities
* The Broker, which is the central core of the system. It manages all the communications between the requestors and the providers or the providers themselves.

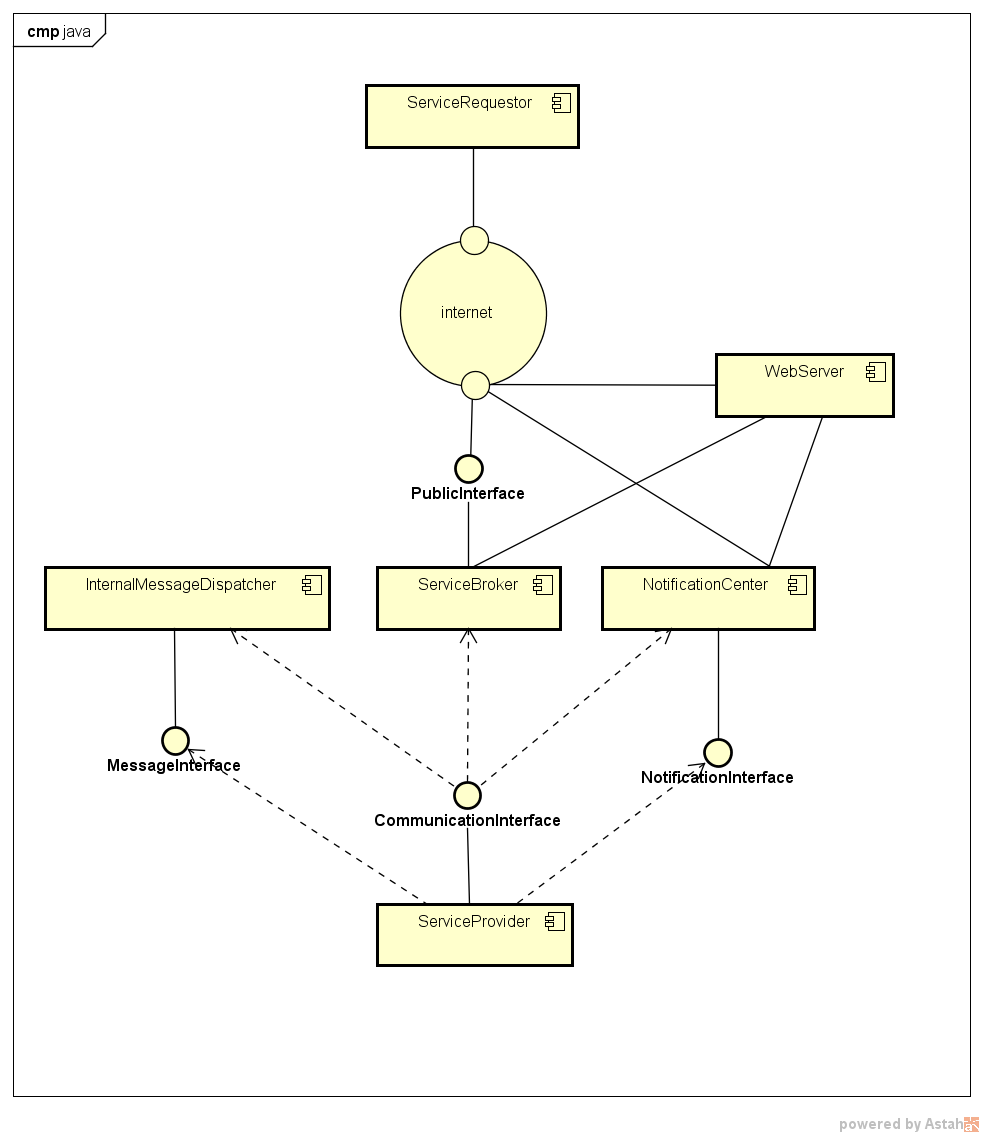
It is composed of three elements:

* **Service Broker**: this component receives the requests from the requestors through an internet connection and is able to forward them to the designated provider. Consequently, it has a direct connection to the internet and all the Service Providers.
* **Notification Center**: this component allows the service providers to communicate to the requestors using the Push Notification messaging protocol. In order to perform his job, it is connected with internet and all the Service Providers, just like the Service Broker.
* **Internal Message Dispatcher**: the aim of this component is to allow and manage the communication among the service providers, so it has a direct connection with each of them.
* The Web Server, which manages all the https requests and where all the files useful for the website are stored. It is also connected to the Service Broker and, together with it and the Notification Center, they are the only components that are connected to internet
* A Data Warehouse, which is used directly by the providers in order to store or read any useful or sensitive data. It works with an OLAP technology for the storage of the data
* A Database, storing the users information, contained into a DMZ in order to increase the security and prevent unauthorized accesses to sensitive information
* The Analyser, a software application that have access to the data in the Data Warehouse and performs the statistical analysis

## Component View

In this component diagram, the internal division of the Broker and the interfaces of each single part are implied, in order to increase the overall comprehensibility.

 This diagram, instead, shows the division and the interfaces connection aforementioned in more details. In this diagram, all the service providers and the requestors are compressed in a single component in order to focus the attention on the interaction of the Broker’s parts.



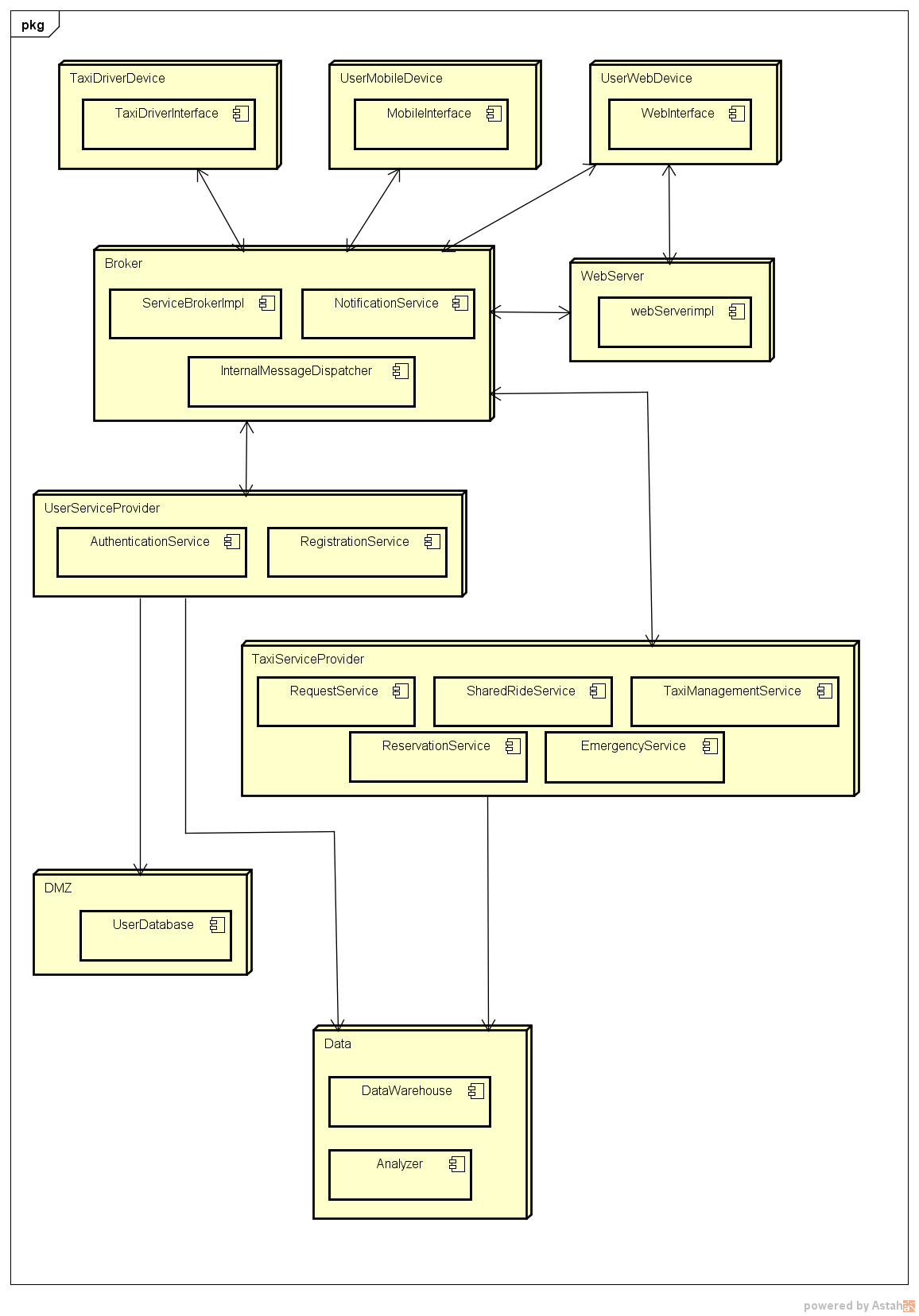
## Deployment View

In this view are shown the interactions between the different functionalities, showing the logical division between services, in particular:

* The deployment of the users database into a DMZ to prevent unauthorized access to the users data as much as possible
* The presence of the data warehouse as the location of the data storage for everything not related to user authentication

The division in nodes of the deployment diagram is just logical and it does not represent a constrain for future hardware implementations.

Because of this reason, the components are grouped only by functionalities, as they were presented in the High level Components and their Interaction paragraph (2.2).



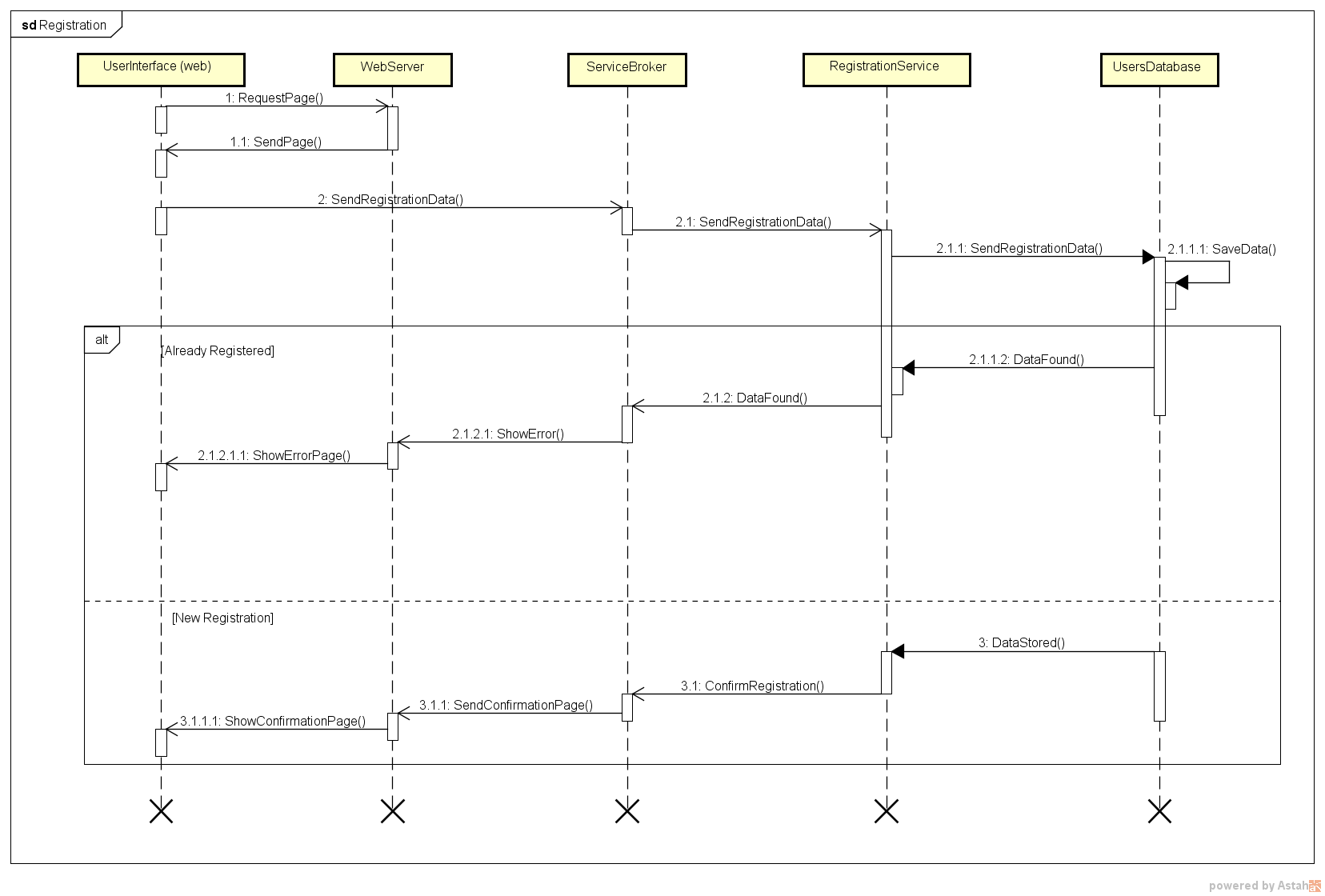
## Runtime View

Here are shown the sequence diagrams that show how the components interact to accomplish the tasks described above and in the RASD document.

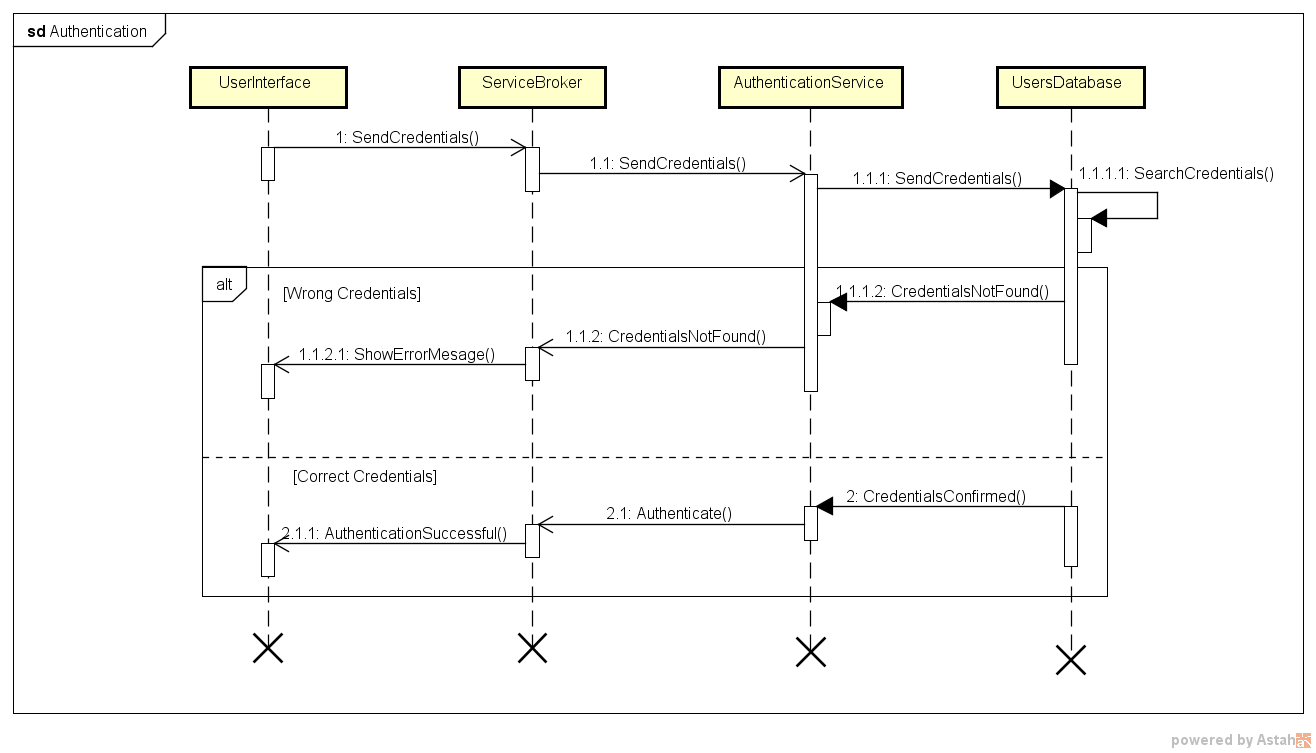
The request of every web page is always made by the user web interface or a specific service to the web server, which answers sending the requested web pages.

It was decided to show this process only in the first sequence diagram, as it would have been too complex and chaotic to show this process every time that a web page was requested.

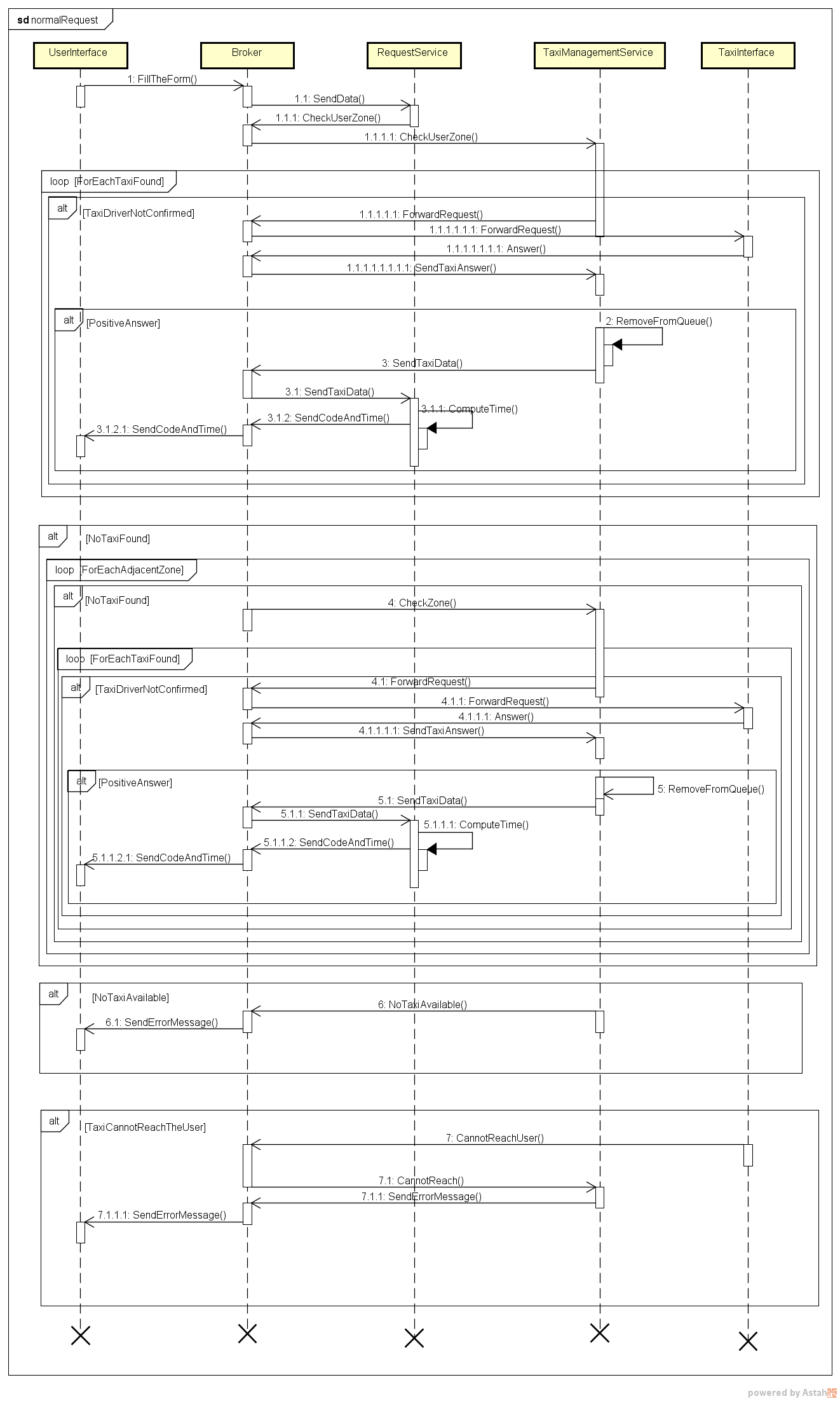
### Registration



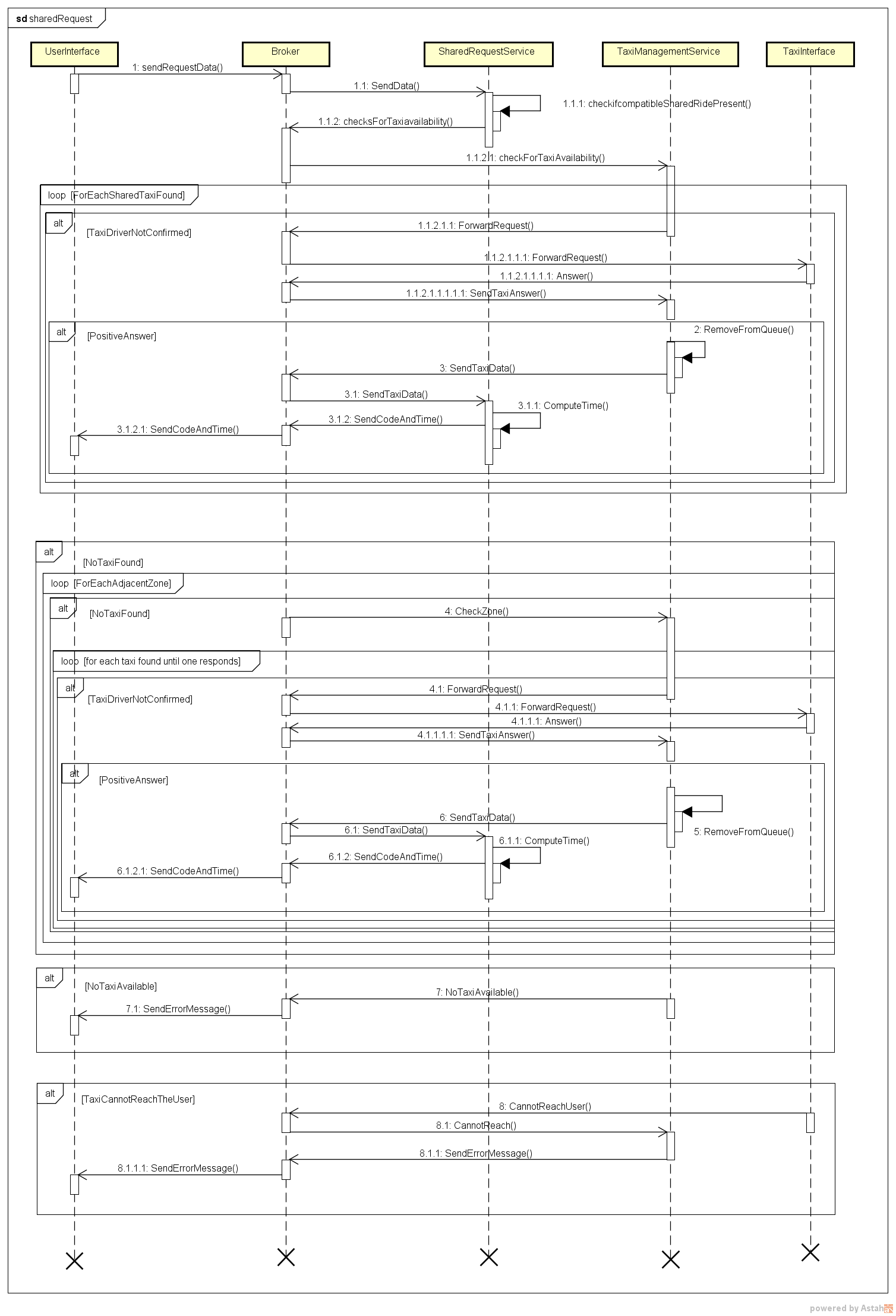
### Authentication



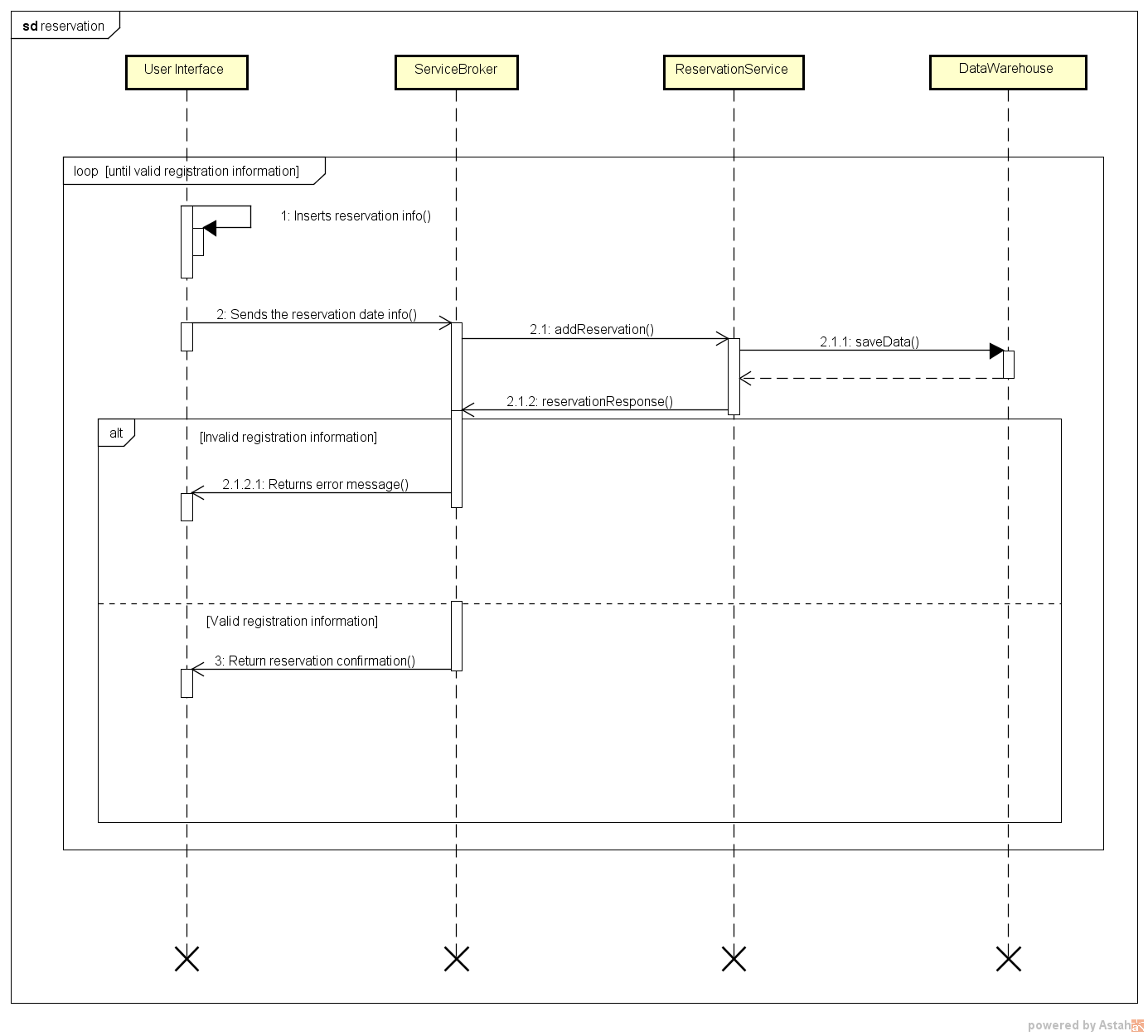
### Normal Request



### Shared Request



### Reservation

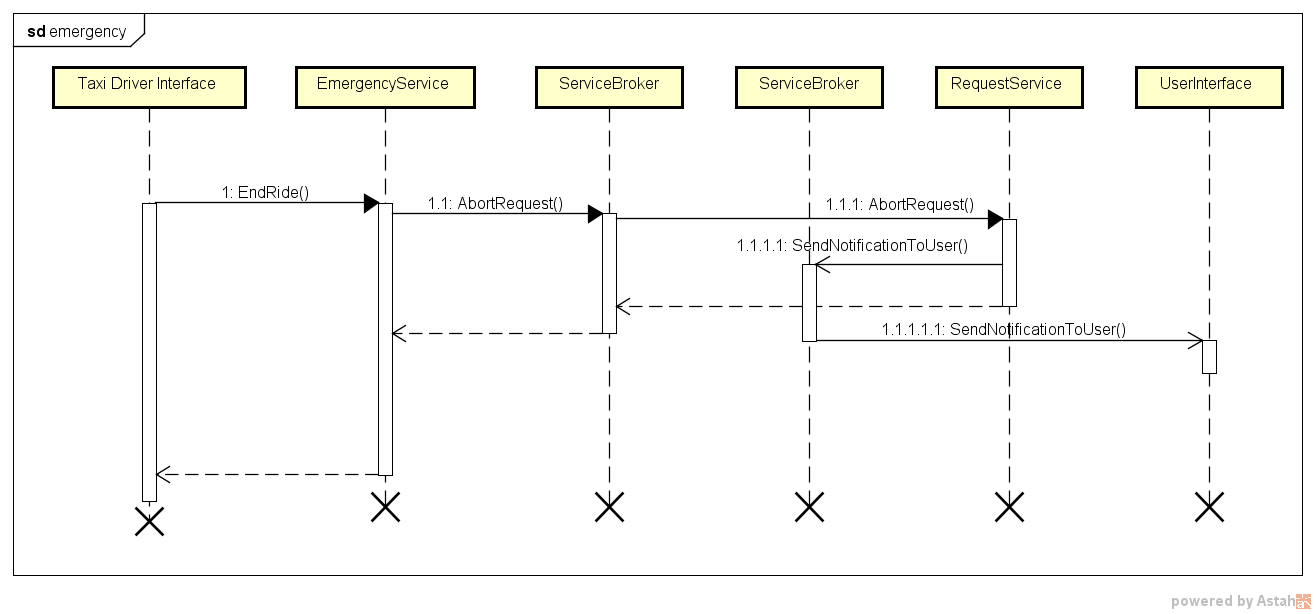


### Management

### Emergency

This sequence diagram contains the flow of events of a ride cancellation done by the taxi driver and the communication of the cancellation to the user interface.

In the case that the user requests another taxi, the sequence diagram follows the steps of the 2.5.3 except for the fact that the request starts from the Emergency Service, which itself notifies the user of the arrival of the new taxi.



## Component Interfaces

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Component | Interface | Interface method Prototype | Parameters | | | | | | | Output |
| Service Broker | Public Interface | DispatchMessage | Source | Destination | | Content | | | | Result Data |
| Internal Message Dispatcher | Message Interface | DispatchMessage | Source | Destination | | Content | | | | Result Data |
| Notification Center | Notification Interface | SendNotification | Destination | | | | Message | | | Success |
| Authentication Service | Communication Interface | Login | User Login Credentials | | | | | | | Login Success state |
| Login related Information |
| Registration Service | Communication Interface | Registration | User Data | | | | | | | Registration success state |
| Request Service | Communication Interface | NewRequest | Starting Location | | User | | | | | Request |
| LinkTaxi | Request | | Taxi | | | | | Success |
| AbortRequest | Request | | Motivation | | | | | Success |
| StartReservation | Reservation | | User | | | | | Request |
| Reservation Service | Communication Interface | ReserveTaxi | Reservation Info | | User | | | | | Reservation |
| CancelReservation | Reservation ID | | User | | | | | Success |
| Emergency Service | Communication Interface | EndRide | User | | Taxi Driver | | | | | Success |
| SendNewTaxi | Location | | User | | | | | Taxi |
| Taxi Management Service | Communication Interface | FindTaxi | Starting Location | | Request | | | | | Taxi |
| SendTaxiAnswer | Request | | Taxi Driver | | | | | Success |
| SetAvailability | Taxi Driver | | Value | | | | | Success |
| Shared Ride Service | Communication  Interface | StartSharedRide | Starting Location | | Destination | | | | User | Request |
| FindCompatibleRide | Starting Location | | Destination | | | | User | Request |
| Users Database | User Information  Management | RegisterUser | User Data | | | | | | | Registration Success State |
| Registration Errors |
| User Login Verification | Login | User Login Credentials | | | | | | | Login Success State |
| Data Warehouse | Data Access Interface | Save Data | Key | | | | | Data | | Saving success state |
| Analysis Interface | Analyze | Type of analysis | | | | | Data | | Analysis Results |

## Selected Architectural Styles and Patterns

The main architectural style designed for this system is the SOA.

In fact, as described in the High Level Components and Their Interaction paragraph (2.2), it is possible to recognize the typical SOA three-ways division. There are both the Service Requestors and the Service Providers, other than the Service Broker that allows the communication between each element.

It was decided to design the project with this architecture for these reasons:

* **Good management of a big number of users**

Thanks to the division in atomic services that the system provides, the application is able to manage a large amount of different requests in parallel

* **Future developments**

The division in services ensures a simple way for the addition of new implementations and service upgrades made with the APIs considered in the RASD

* **Scalability**

The division in services allows a better management of the resources also in the case of an unexpected increase of the requests

* **Reliability**

Having the possibility to add new servers to our cluster, a high level of availability can be guaranteed. For example, we can have one or more auxiliary servers that in case of failure can be easily used in order to keep on managing the external requests in a transparent way towards the external users.

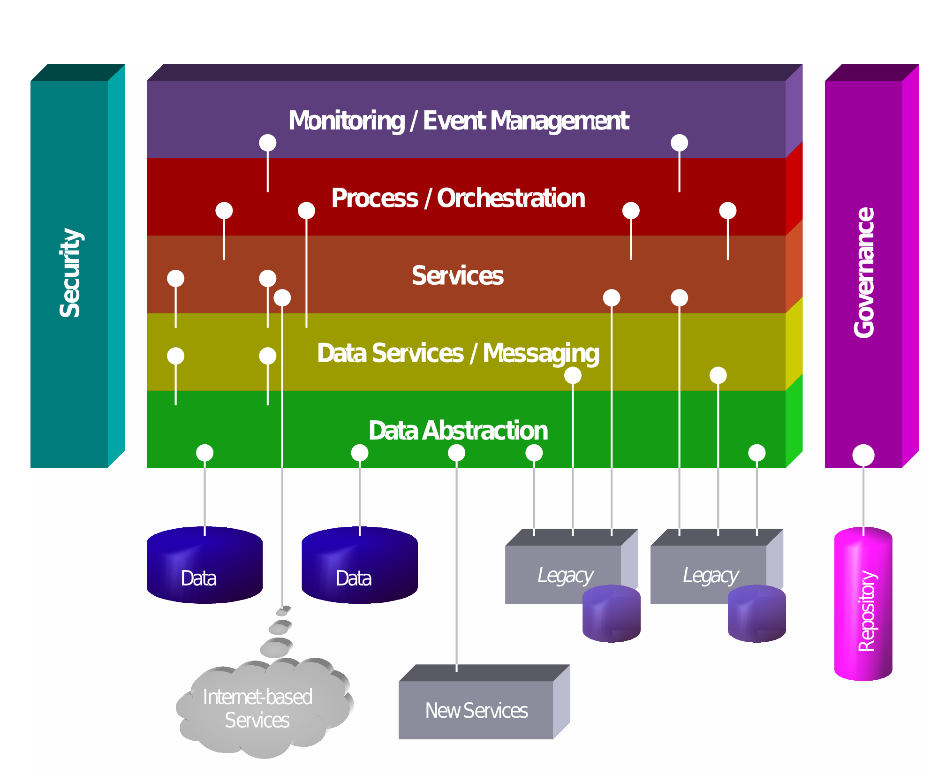
* **Maintainability**

The quite small range of our application makes it easy to handle the maintenance of the individual services. If the application becomes bigger, this point will forcedly become an issue

The most important issue in this design is how to perform the communication between each service.

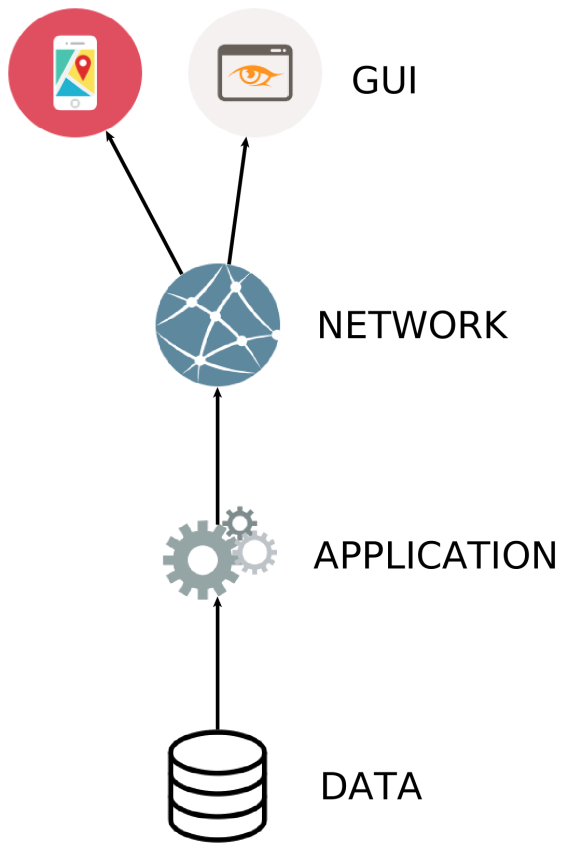
As told in the paragraph above and explained in the component diagrams, each service exhibits a communication interface. Thanks to this, each service is able to guarantee some methods to the others and to the users/taxi drivers. In this way, it is possible to perform a call to these methods by sending a message containing some identification codes (as an example: both the ID of the caller and the called) and useful parameters to the dispatcher and then, if necessary, waiting for the answer.

Moreover, it was decided to allow the communication only through the Internal Message Dispatcher because it is not necessary that every service knows the physical location of the others; this guarantees a better scalability and reliability.



Example of SOA style

The other architectural style designed for this system is a Client-Server, regarding everything about the management of the website. As shown by the image below, In order to give the possibility to use our website from every html 5 compliant browser, a Two-tiers architecture was chosen, where both the data and the application find place in the system server and the GUI is handled directly by the browser of the device.



## Other Design Decisions

It was decided to divide the Broker into three parts for this reasons:

* **Better distribution of work**

The division of the request amount allows us to avoid an overloading of a single element and to perform more different requests at the same time

* **Better quality of service**

A malfunction of the internal message dispatcher can be masked keeping online the Service Broker and performing all the atomic operations like the authentication or the registration

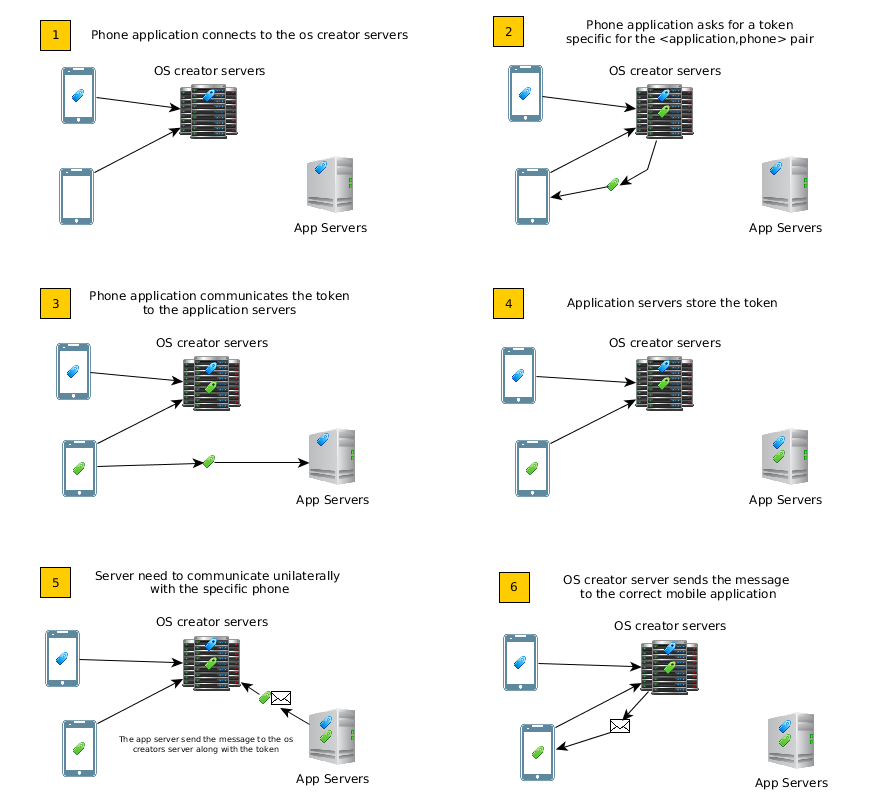
The Notification Center stores a mapping of the User IDs and the User Interfaces in order to univocally link every user to the related interface.

It was decided to use a Data Warehouse in order to exploit its peculiarity of knowledge extraction from data. In fact, the aim is to use it for the prevision of a possible future increase of the requests and the creation of statistics useful for the economy of the company.

Usage data can also be used to manage the work division on the various components in the best way. Finally, through the traffic analysis, it is possible to forecast the time of the day when there are both the maximum and the minimum usage peaks and consequently to adapt the behaviour of the system.

In order to send the requests to the taxi drivers and to communicate to the clients which taxi is arriving to pick him, it was needed a way to communicate unilaterally from the services to the taxi drivers and from the services to the mobile application. The solution is to use push notifications.

This functionality uses a technology developed for mobile devices, it creates a unique link between the phone and the OS creator servers, saving battery life and reducing usage of mobile data connection. All the steps required in order to create this link are presented in the Image below.

**Simple explanation of the push notification service used in this application**

# Algorithm Design

The abstraction level of the documents has always been high and it was decided to appoint the implementation of the behaviour of each component to the developers. For this reason, the definition of detailed algorithms would be inaccurate and out of place.

It was decided to show an idea about the management of the available taxis and the queues in the context of a normal request.

In the pseudo code below, the expressions specifying the calls made to the other services are written as pseudo object oriented method calls like the one below:

**ServiceBroker**.**Service**(service\_parameters).**method**(method\_parameters)

Where:

* ServiceBroker: is the interface object of the service broker
* Service: is the name of the service that the call wants to access
* service\_parameters: are the parameters to send to the interface
* method: is the method of the interface to call
* method\_parameters: are the parameters to send to the method

## Request

//support function used to call a taxi and wait for the response

Boolean callTaxi(zone) {

**if** (taxi\_driver\_not\_confirmed){

//send the request to the taxi interface

ServiceBroker.TaxiInterface(taxi).ForwardRequest(clientzone);

//waiting for taxi driver response

**while** (answer not received){

Wait\_for\_response();

}

**if** (taxi\_answer\_positive) {

RemoveFromQueue(zone,taxi);

//Links the taxi to the request on the request service algorithm

ServiceBroker.RequestService.linkTaxi(request,taxi);

**return** **true**;

}

}

**return** **false**;

}

Taxi findTaxi(startingLocation,Request){

Taxis = taxi queue of the zone of the starting location;

TaxiFound=**false**;

SelectedTaxi=nil;

**foreach** taxi **in** Taxis {

**if** (callTaxi(taxi)){

TaxiFound=**true**;

SelectedTaxi=taxi;

**break**;

{

}

**if** (!TaxiFound) then

Zones=list of the zones each containing its queue;

**foreach** (zone **in** Zones) {

Taxis = taxi queue of the zone: zone

**foreach** (taxi **in** Taxis) {

**if** (callTaxi(taxi)){

TaxiFound=**true**;

SelectedTaxi=taxi;

**break**;

}

}

**if** (TaxiFound){

**break**;

}

}

}

**if** (!TaxiFound) {

//no taxi can be fund so the request is aborted

ServiceBroker.RequestService.abortRequest(request,“no taxi anywhere”);

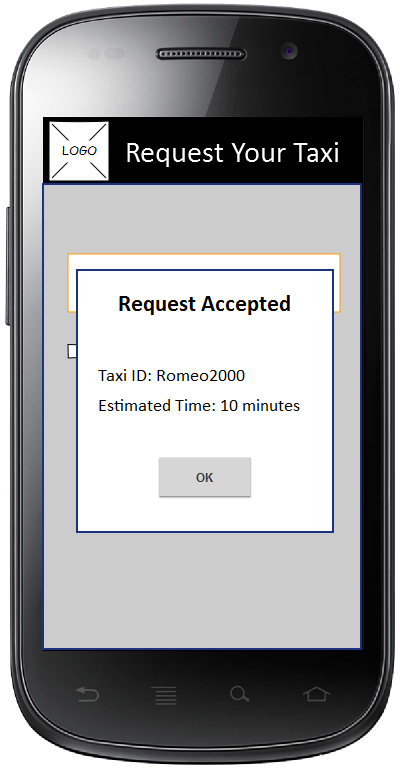
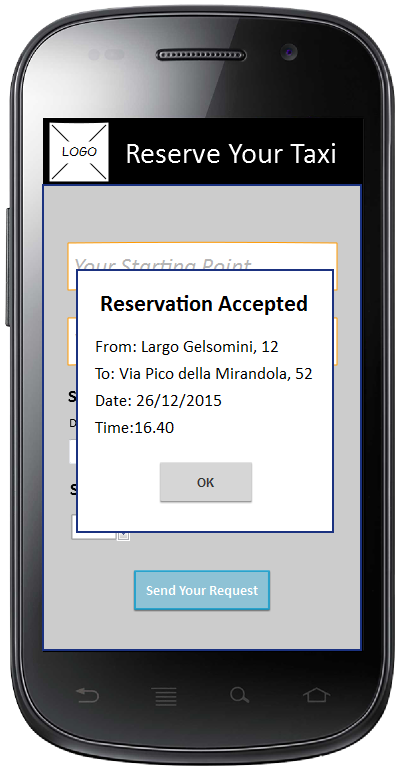
}

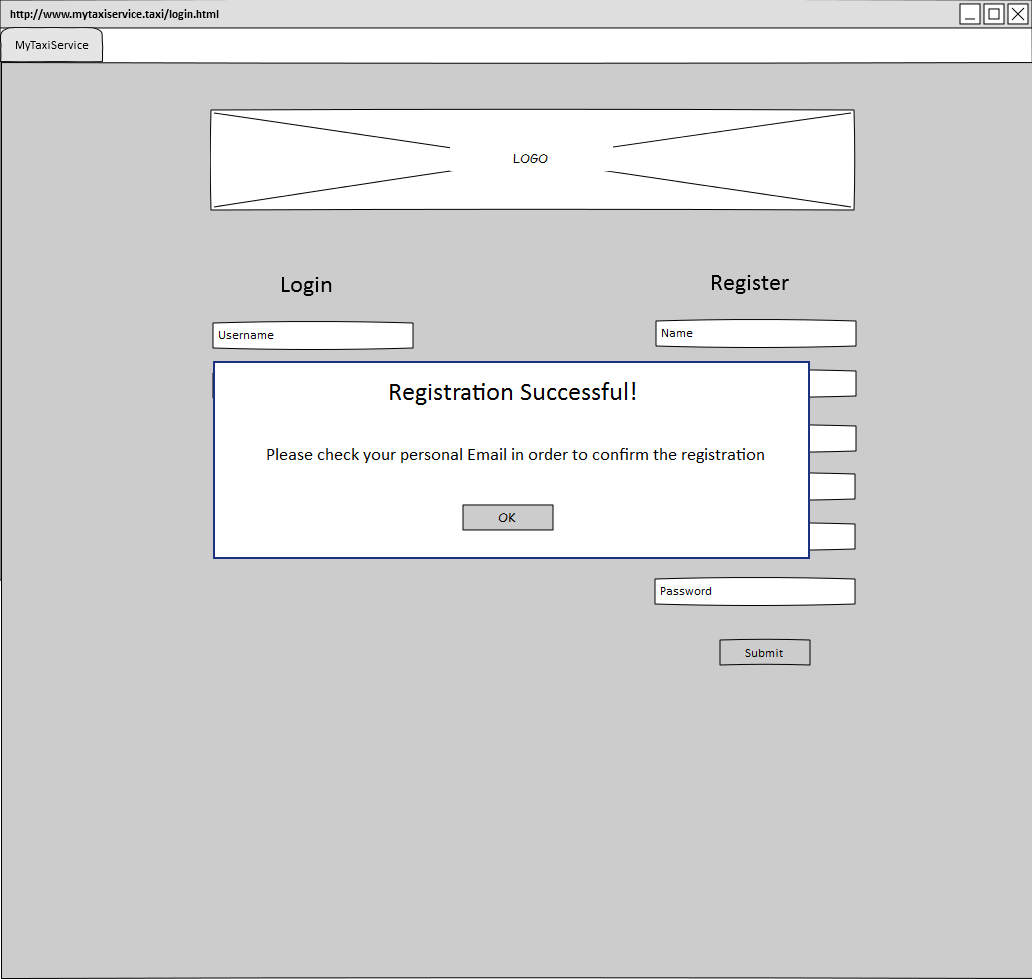
}

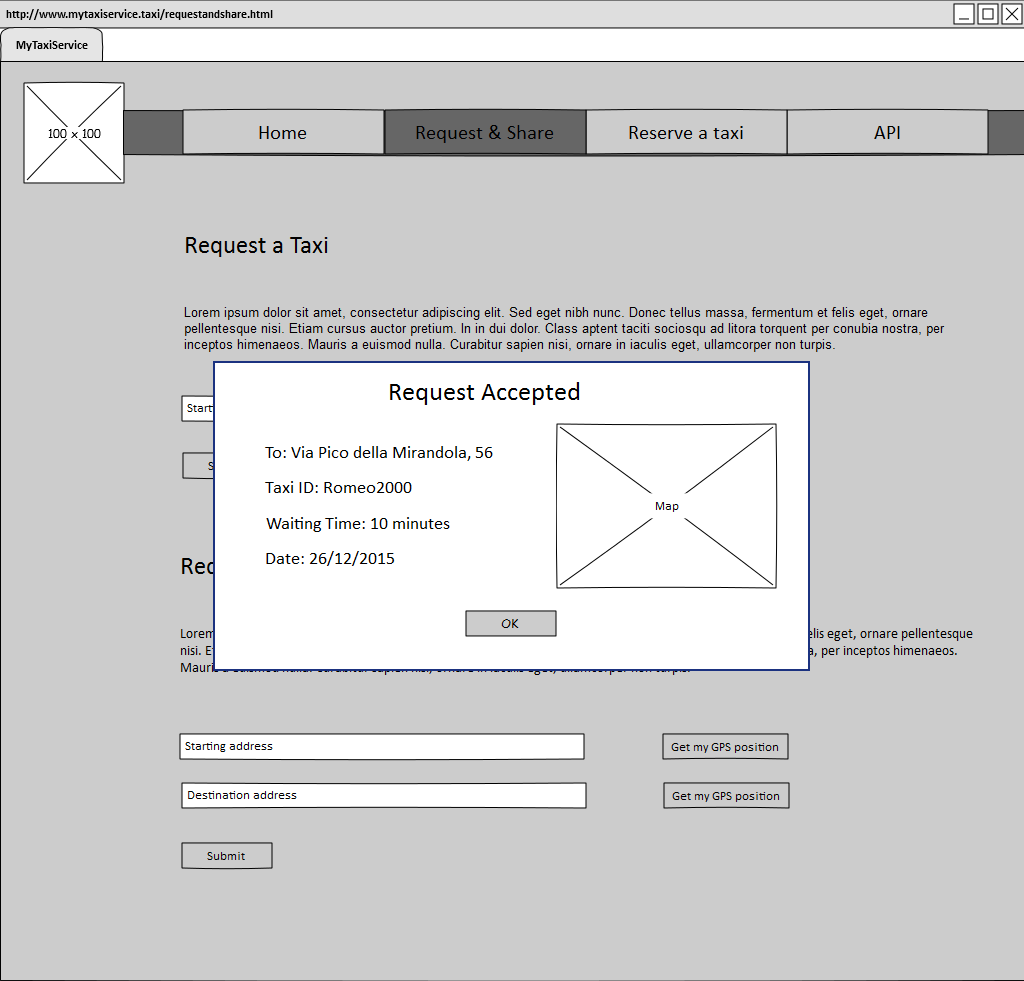
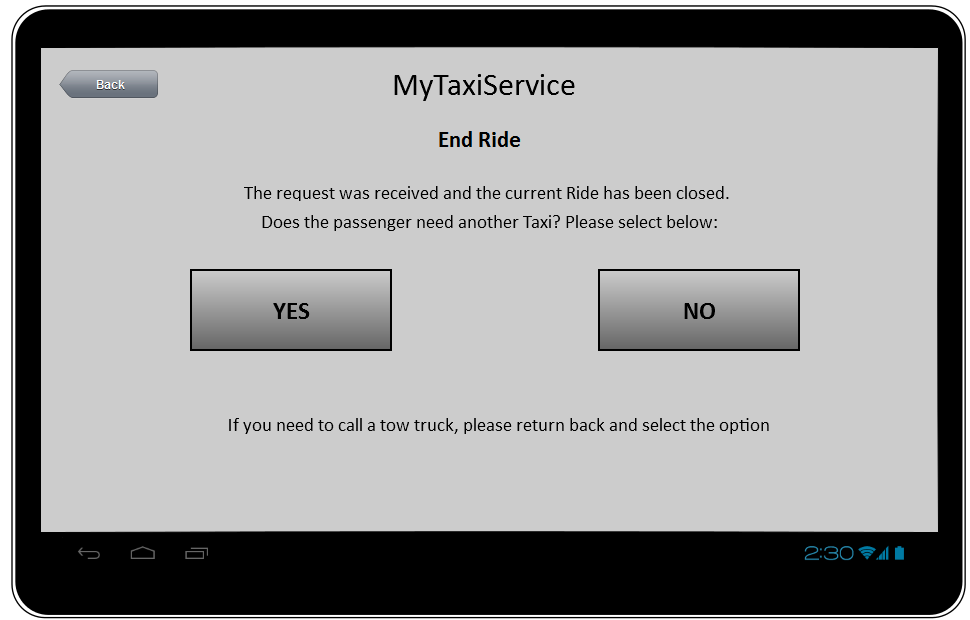
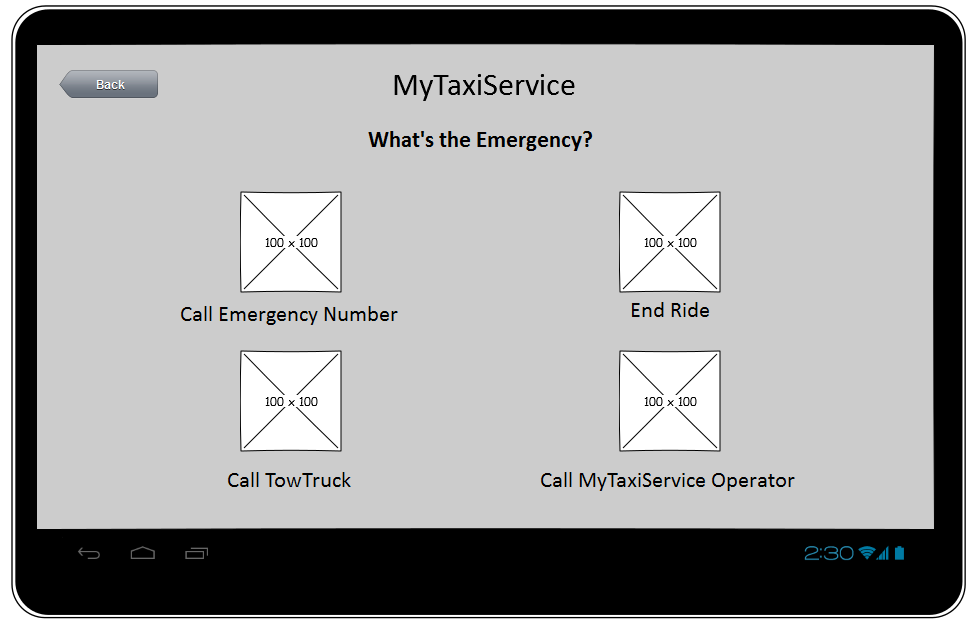
# User Interface Design

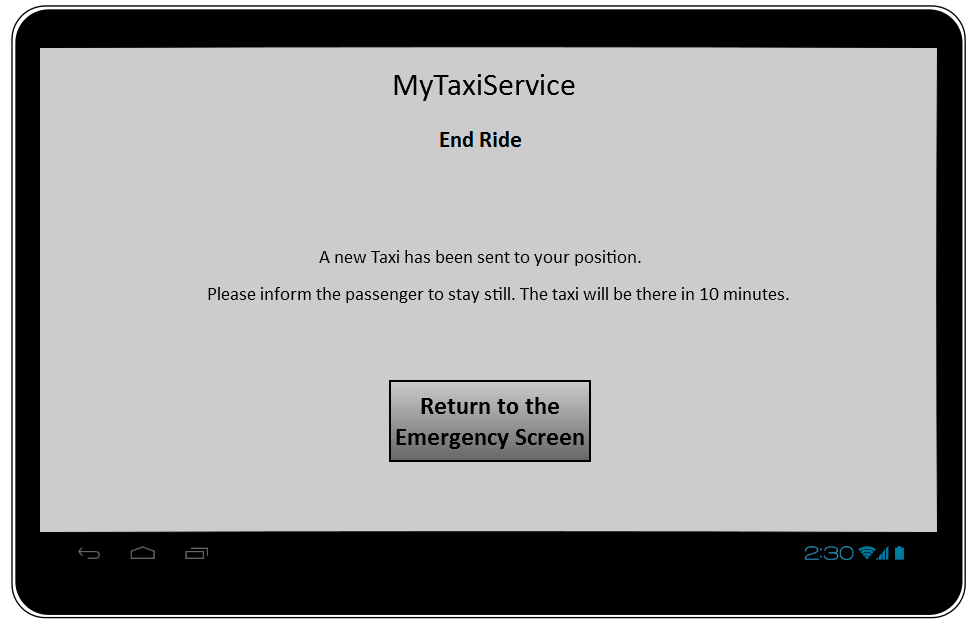
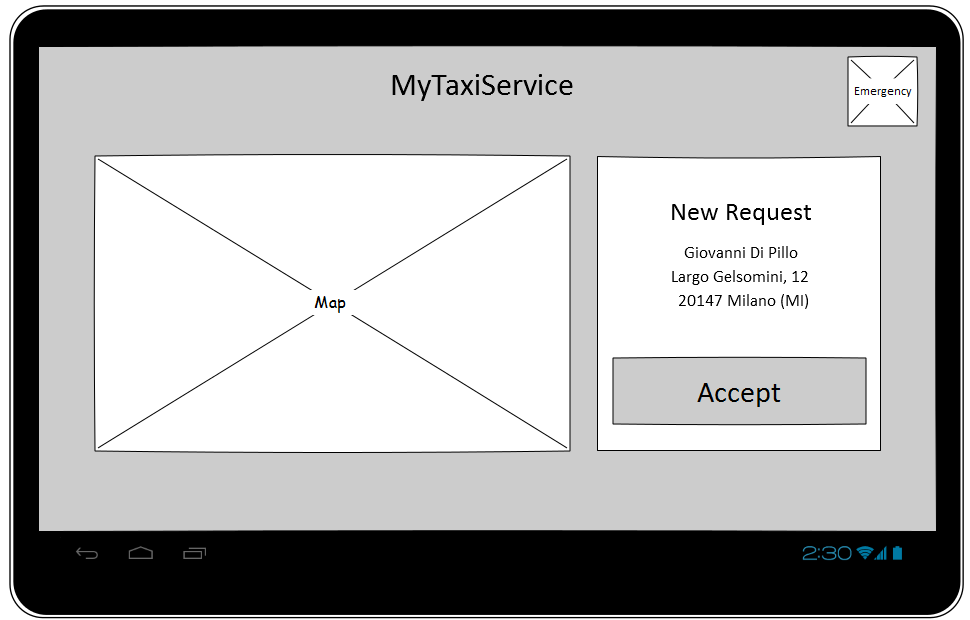
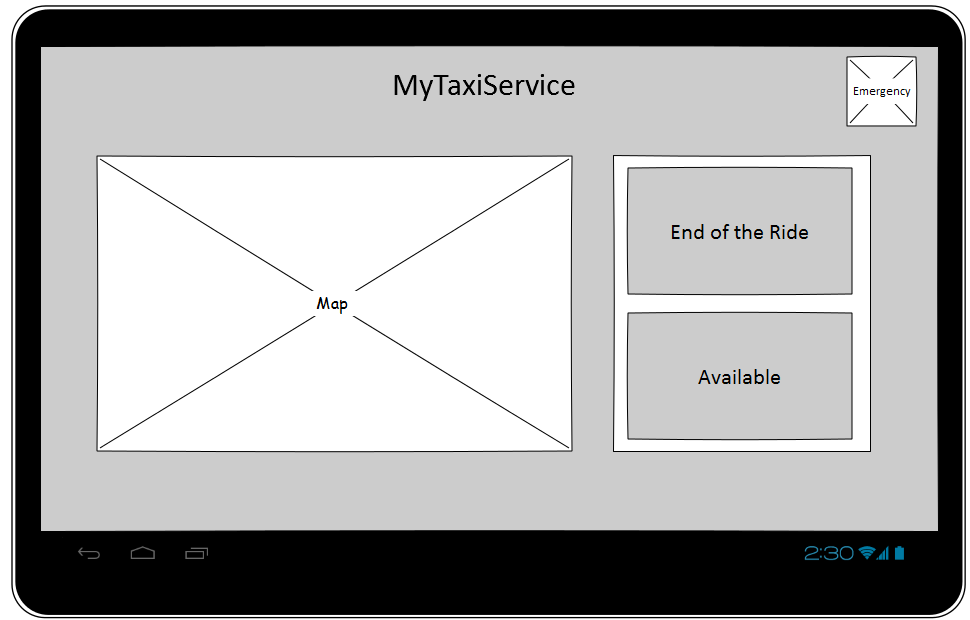
In addition to the mock-ups defined in the RASD document, this chapter presents other examples showing some situations that were not taken into account in the RASD document.

The following two mock-ups show how the visualization of a notification sent by the server is displayed in the app.



The two mockups below show the visualization of a notification in the Website.

 The three following mock-ups illustrate all the layout concerning the emergency process.

 The following mock-ups are an update of those presented in the RASD and, in addition, show the button used for the emergency functionality.

# Requirements Traceability

This section links the requirements of the goals specified in the RASD to the component that satisfies it, also adding further information to better explain the link or the role of the component.

In order to increase the focus only on the service components, all the components that perform the communication are not mentioned here.

## Goal 1

|  |  |  |
| --- | --- | --- |
| Requirement | Component | Further Information |
| The user must not be already registered | Registration Service | Same registration information cannot be used for another registration, at most the user must be provided with a way to recover his credentials |
| The username chosen by the user in the registration phase must be unique | Registration Service |  |
| The user must confirm his email address in order to become a registered user | Registration Service | The system must be able to know that the email is under the user control, the method to implement this is up to the developer |
| The authentication data inserted must be correct in order to authenticate | Authentication Service | The authentication data provided by the user must correspond to the data stored in the system databases |
| If the user is not authenticated, he can only see the authentication or registration page | Mobile Interface & Web Interface | The app and the web will be developed in order to show all the functionality only after the user’s authentication |

## Goal 2

|  |  |  |
| --- | --- | --- |
| Requirement | Component | Further Information |
| The user must be authenticated | Authentication Service |  |
| The taxi driver must accept the forwarded request using his mobile app | Taxi Driver Interface | As the system structure, the Taxi driver can receive notification only by the app installed in his Device |
| The system must calculate the estimated time for the arrival of the taxi and inform the user | Request Service | The system knows the taxi location at least on the moment the taxi driver accepts the requests, so it can calculate a possible route and then an arrival time |
| The system must forward the request to an available taxi | Taxi Management Service |  |

## Goal 3

|  |  |  |
| --- | --- | --- |
| Requirement | Component | Further Information |
| The system puts the taxis at the bottom of the queue of the area where they finish the rides | Taxi Management Service |  |
| When a user makes a request, the system must send the nearest taxi available | Taxi Management Service & Request Service | Request service asks the Taxi management service for a taxi |
| If there isn’t any available taxi when a user makes a request, the system must warn the user | Taxi Management Service & Request Service | For example in the case of a strike or an extremely busy time |
| A taxi driver can remove his availability and restore it whenever he wants, but that implies the loss of his priority in the queue | Taxi Management Service | The action can be performed by clicking on a dedicated button on the home page of the taxi driver interface |

## Goal 4

|  |  |  |
| --- | --- | --- |
| Requirement | Component | Further Information |
| The user must be authenticated | Authentication Service |  |
| The system must dispatch a taxi for the reservation 10 minutes before the requested time | Reservation Service & Taxi Management service |  |
| If something happens to the taxi while driving towards the user, the system must warn the user | Emergency Service | The taxi Driver must, through the emergency app page, warn the system and then the system will warn the User |

## Goal 5

|  |  |  |
| --- | --- | --- |
| Requirement | Component | Further Information |
| The users must be authenticated | Authentication Service |  |
| In order to share a ride, the different users must be on the same route | Shared Ride Service |  |
| The system must calculate the fee for every user, dividing the total fee and weighting it on the amount of kilometres done by each of them | Shared Ride Service |  |
| There can’t be more than 4 passengers in a taxi at the same time | Shared Ride Service |  |
| If a shared ride is made for a single user, the system calculates the fee as a normal ride | Shared Ride Service |  |

## Goal 6

|  |  |  |
| --- | --- | --- |
| Requirement | Component | Further Information |
| Allow the taxi driver to call the emergency number and a tow truck | Taxi Driver Interface | This Functionality is perform taking advantage of a Phone Calls app preinstalled in the device |
| Allow the taxi driver to cancel the current ride and, with the consent of the user, send a substitute taxi | Emergency Service & Request Service & Taxi Management Service |  |
| Allow the taxi driver to call an operator | Taxi Driver Interface | This Functionality is perform taking advantage of a Phone Calls app preinstalled in the device |

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* IEEE Recommended Practice for Software Requirements Specifications - IEEE Std 830-1998
* IEEE Standard for Information Technology—Systems Design—Software Design Descriptions - IEEE Std 1016TM-2009
* Claus T. Jensen . SOA Design Principles For Dummies ® , IBM Limited Edition - John Wiley & Sons, Inc. 2013
* Wikipedia article about SOA architectural style: <https://en.wikipedia.org/wiki/Service-oriented_architecture>
* Slides regarding Java EE provided during the course
* Slides regarding Data Wharehouses of the Course “Sistemi Informativi”
* Java EE at a Glance - <http://www.oracle.com/technetwork/java/javaee/overview/index.html>

# Revisions Table

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| --- | --- | --- |
| Version | date | Modifications |
| 1.0 | 2015/12/04 | First version |
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