Design document

Figure 1: Politecnico di Milano

Version 1.0

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Contents

1.Introduction

1.1.Purpose

The purpose of this document is to give more technical details than the RASD about MyTaxiService system.
This document is addressed to developers and aims to identify:

- The high level architecture
- The design patterns
- The main components and their interfaces provided one for another
- The Runtime behavior

1.2.Scope

The project myTaxiService, which is a service based on mobile application and web application, has two different targets of people:

- The taxi drivers
- The clients

The system allows clients to reserve a taxi via a mobile or web app, using his GPS position our inserting his position manually to find a taxi in the same zone. On the other side the mobile app also allows taxi drivers to accept or reject a ride request and to communicate automatically their position (and therefore the zone where their are located).
The clients are not registered since the company wants the system to be as easily and fast possible to use. The registration process might dissuade some clients. So the clients have to insert their name and phone number each time (this is faster than creating an account and logging in each time).

The system includes extra services and functionalities such as taxi sharing.

The main purpose of the system is to be more efficient and reliable than the existing one in order to decrease costs of the taxi management and offer a better service to the clients and taxi drivers (by having fair waiting queues).

1.3.Definitions, acronyms, abbreviations

- RASD: Requirements analysis and specifications document
- DD: Design document
- SMS: short message service; it is a notification sent to a mobile phone, an SMS gateway is needed to use it.

- SMS gateway: it is a service which allows to send SMS via standard API.
- API: application programming interface; it is a common way to communicate with another system.
- MVC: model view controller
- URL: uniform resource locator
- Push notification: it is a notification sent to a smartphone using the mobile application, so it must be installed.
- Push service: it is a service that allows to send push notifications with own API
- Matching itineraries: two itineraries (A and B) are matching if one of the two following conditions are fulfilled:

  1. B is included in A: the starting point and the ending point of the itinerary B are both close to the itinerary A and the starting point of B is closer to the starting point of A than the ending point of B.
  2. The beginning of B is the end of A: the starting point of B is close to the itinerary A and the ending point of A is close to the itinerary B.
  3. A is included in B: see condition 1.
  4. The beginning of A is the end of B: see condition 2.

- Path: it's a structure containing at least 2 positions
- Sharing discount percentage: discount percentage applied only if the sharing option is enabled and there is more than one request in the merged request
- API: application programming interface; it is a common way to communicate with another system.
- ETA: estimated time available; it is the time the taxi needs to arrive to client starting position.
- Zone: it is a zone of approximately 2 km^2, the city is split into these zones. From taxi position the system gets his zone and inserts the taxi into the zone queue. So the system guarantees a fair management of taxi queues.
  - A zone is specified by a list of bounds.
  - It has more than 2 positions that compose its bounds.
  - Bounds must be composed by positions and not by none of its subclasses.
  - Bounds must be a set (it must not contain duplicates).

1.4.Reference documents

- RASD produced before 1.1
- Specification Document: Assignments 1 and 2 (RASD and DD).pdf
- Structure of the design document.pdf

1.5.Document structure

- **Introduction:** this section introduces the design document. It contains a justification of his utility and indications on which parts are covered in this document that are not covered by RASD.
- **Architecture Design:** this section is divided into two parts:
  1. High level design
  2. Architecture chosen presented via diagrams
- **Algorithms Design:** this section describes the most critical parts via some algorithms. Pseudo code is used in order to hide unnecessary implementation details in order to focus on the most important parts.
- **User Interface Design:** this section presents mockups and user experience explained via UX and BCE diagrams.
- **Requirements Traceability:** this section aims to explain how the decisions taken in the RASD are linked to design elements.

2.Architectural design

2.1.Overview

The MyTaxiService has a three tier architecture.

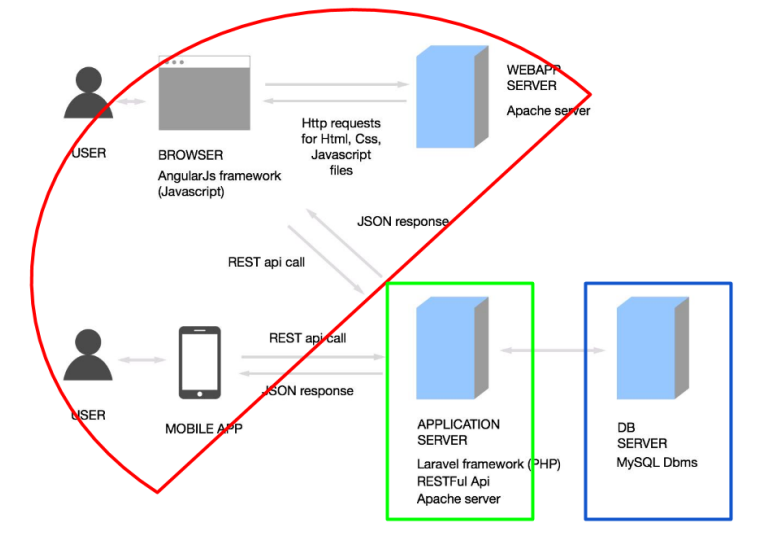


Figure 2: General architecture

On the client there is not a static GUI but a dynamic one that is generated on client side. In fact in the client, there is a module that interacts with the application server via RESTful API.
With this architecture this application can easily be moved to a cloud system, for example to amazon AWS where it would have dedicated cloud servers with load balance for database and other for application logic on demand.

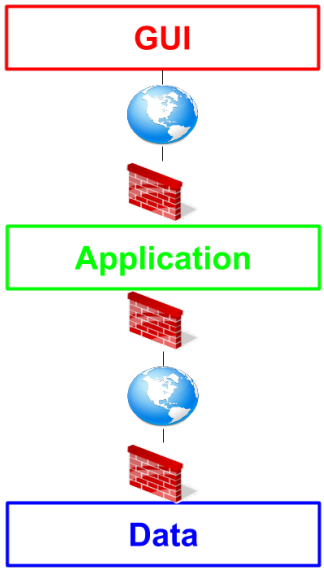


Figure 3: Tiers

2.2.High level components and their interaction

The high level components architecture is composed of four different elements types. The main element is a singleton, the central. The central receives requests or reservations from other elements, the clients. The client can initiate this communication from his mobile application or from the webpage of the application. This communication is made in a synchronous way since the client, who initiates the communication, has to wait the answer of the central that acknowledge him that his request has been taken into account. The Central will later send an asynchronous message to the client in the form of an SMS to inform him about the code of the incoming taxi as well as the ETA.
The central communicates also with a third type of component, the taxi drivers. The central can send synchronous messages to the taxi drivers to propose them different requests that the taxi drivers can accept or reject. The taxi drivers can send two types of messages to the central. First, they can change their availability. This must be done in a synchronous way since the central may have to respond with the position of the taxi driver in the waiting queue. The taxi drivers can also send his position to the central. This can be done asynchronously. Taxi drivers also have to communicate with synchronous message with the central to log in.
A final type of components is also present, the old application. The old application still manages the registration of the new taxi drivers. Therefore, the central communicates synchronously with the old data base to extract the taxi drivers information when needed.

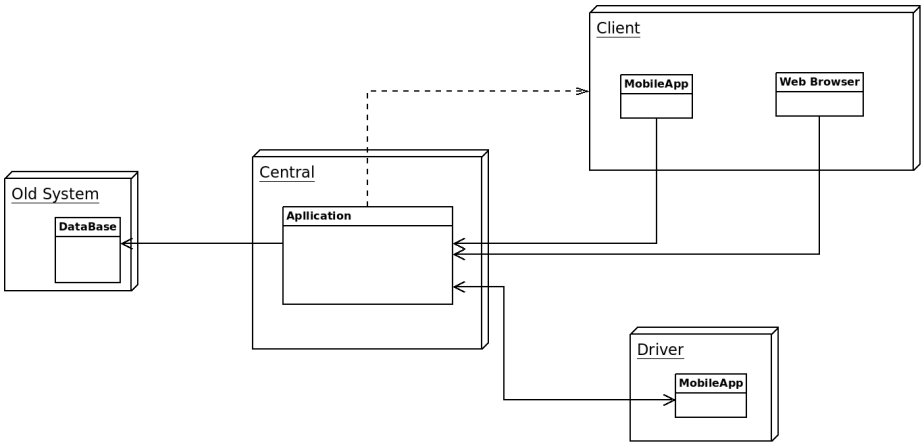


Figure 4: High level components

2.3.Component view

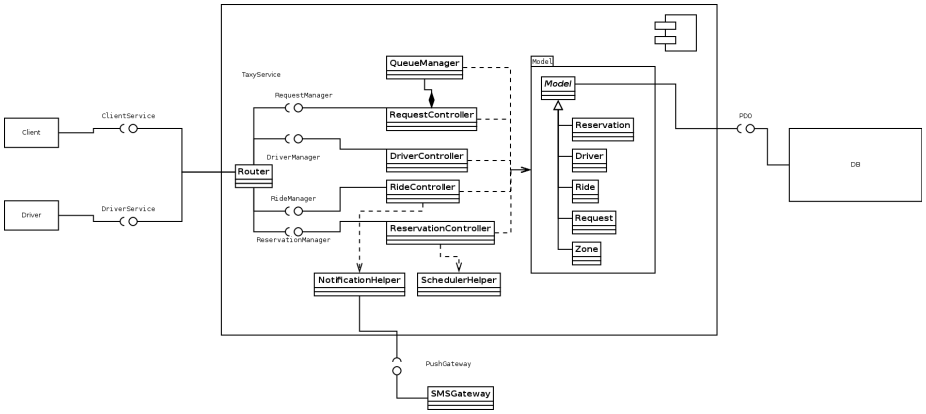


Figure 5: Component view

2.4.Deploying view

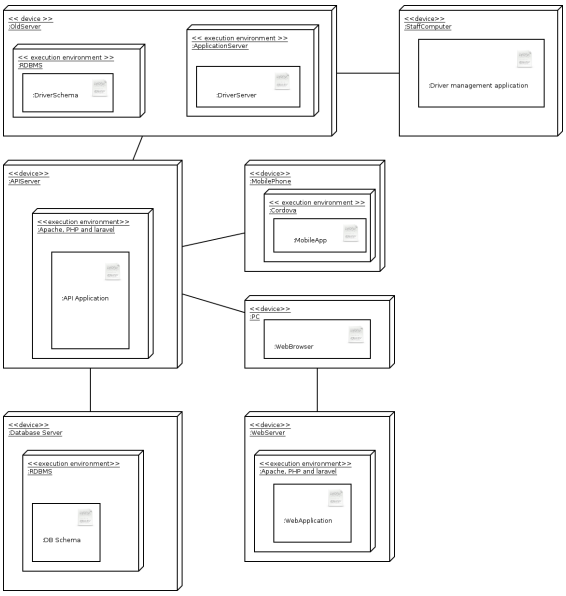
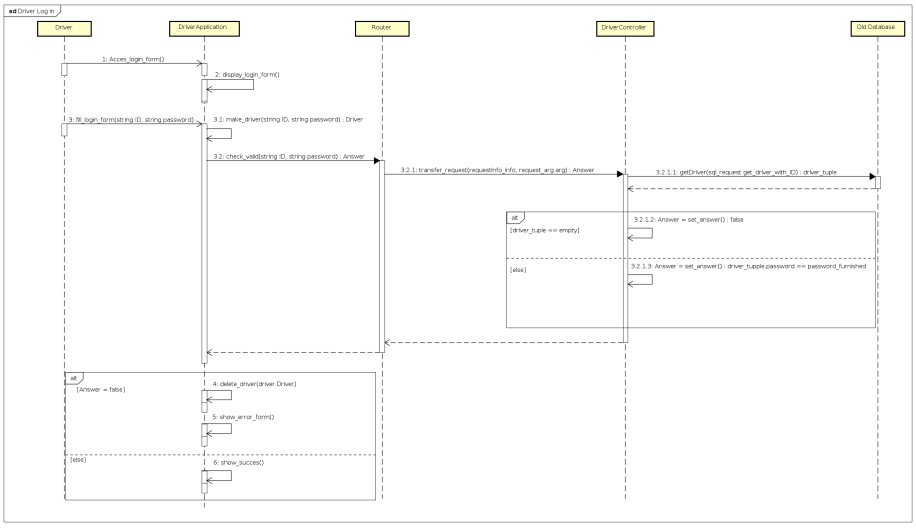


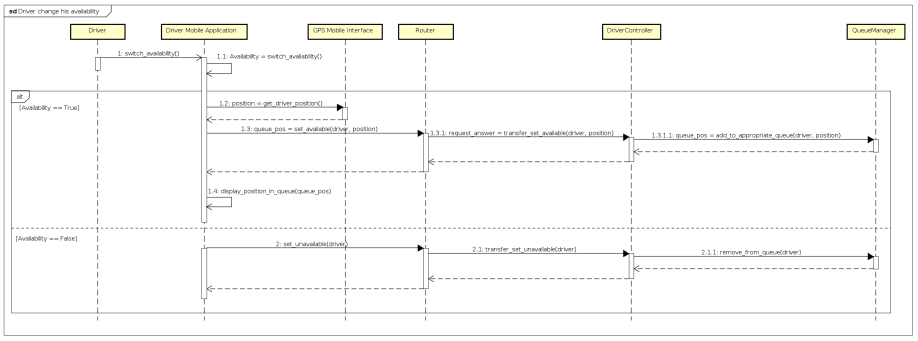
Figure 6: Deployment view

2.5.Runtime view

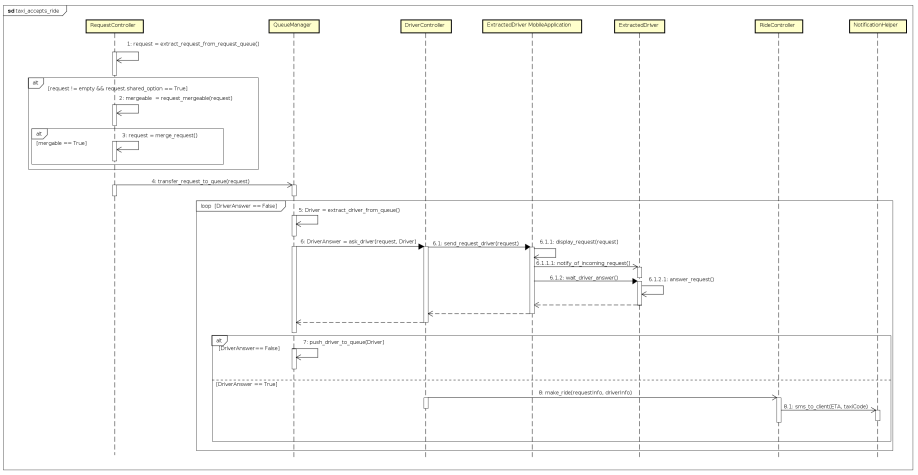


In this sequence diagram it can be seen that the user (in this case a non identified taxi driver) has to input his login information on the taxi driver's

mobile application. The login request is then sent with these information as parameter to the systems. Once arrived to the system's router the request is transferred to the DriverController which first checks on the old database if the login inserted by a user belongs to an existing driver, and if the answer is positive, if the password furnished is correct. The DriverController then returns the results of these checks to the DriverApplication.

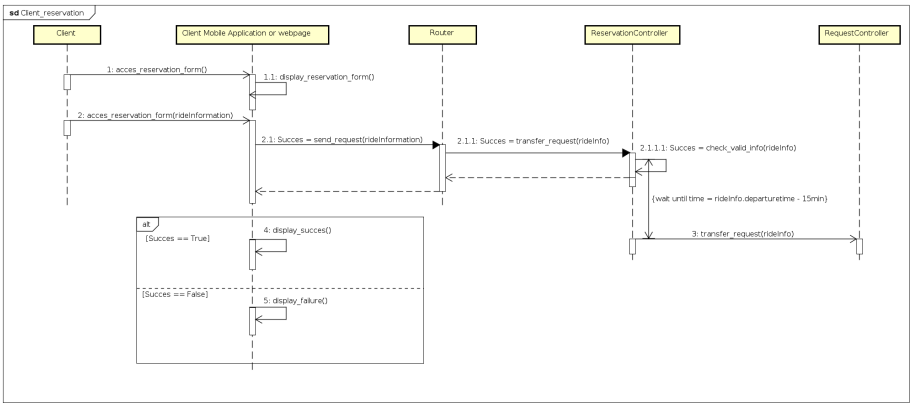


In this sequence diagram it can be seen that when a driver changes his availability, the request is transferred to the DriverController via the Router. If the driver asks to be available, the DriverController will have to ask to the QueueManager to add the driver to the appropriate queue according to the driver's position. The QueueManager then returns to the position of the driver in his queue. This information goes all the way back to the driver's mobile application. In the other case, when the driver does not want to be available anymore, the DriverController has to ask to the QueueManager to remove the driver from the queue the driver is in.



In this sequence diagram it can be seen that when a request has to be handeled, first of all the RequestController checks if it is a request for a shared ride. If it is the case, the RequestController will check with other shared requests if they can be merged together in one. After that, the request is transferred to the

QueueController which will have to ask to the appropriate driver if he wants to take care of the Ride. The Queue controller extracts the driver from the appropriate queue, then asks to the DriverController to transfer the demand to the driver. If the driver has rejected the ride he is put back at the end of his queue and the new first driver is extracted and is asked if he wants to take care of the ride and so on until a driver accepts the ride. When a driver accepts a ride, he is not put back in the queue. The DriverController will then ask the RideController to make a new ride and to notify the appropriate clients via the SMSGateway.



In this sequence diagram it can be seen that a client needs to indicate the request information. Once done, the request can be transferred via a the Router to the ReservationController which is in fact a sort of scheduler. Once the time indicated for the reservation by the client has nearly been reached, the reservation is handled by the RequestController like a normal request. If some information indicated by the user is not valid (like a wrong departure time for the reserved ride) the RequestController detects it and sends an error back to the client mobile application or webpage. The sequence diagram when a client makes a request for an immediate ride is not provided here since its only difference with this one is that the request does not go to the ReservationController but directly to the RequestController.

2.6.Component interfaces

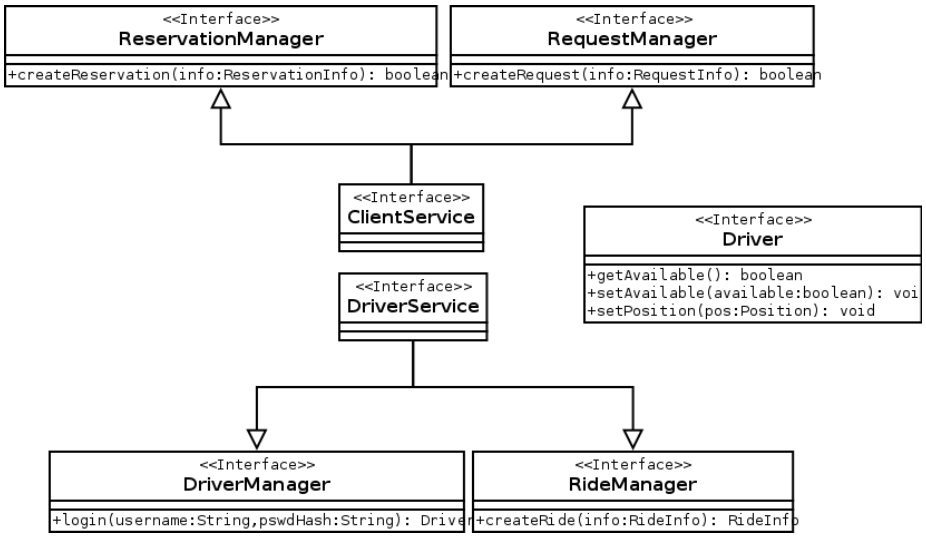


Figure 7: Component interfaces

2.7.Selected architectural styles and patterns

2.7.1.Overall Architecture

Our application will be divided into 3 tiers:

1. Database (DAL: Data Access Layer)
2. Application Logic (BLL: Business Logic Layer)
3. Thin Client (a simple and easy interface to BLL)

2.7.2.Protocols

Our tiers are connected through network and exchange data with the following protocols.

PDO: PHP Data Objects used by the BLL to communicate with the DAL.

currently supported databases:

- DBLIB: FreeTDS / Microsoft SQL Server / Sybase
- Firebird: Firebird/Interbase 6
- IBM (IBM DB2)
- INFORMIX - IBM Informix Dynamic Server
- MYSQL: MySQL 3.x/4.0
- OCI: Oracle Call Interface
- ODBC: ODBC v3 (IBM DB2 and unixODBC)
- PGSQL: PostgreSQL
- SQLITE: SQLite 3.x

RESTful API with JSON used by clients (both mobile apps and web browsers) to interact with the BLL. API calls that need authentication are required to authenticate via HTTP basic authentication for each request. exchanged data will be secured using SSL.

as now (v1) our exposed methods are the following:

- api/v1/driver [auth]
  - GET: get driver info
  - PATCH/PUT: update driver data (position and available status)
- api/v1/request
  - POST: create a new request

- api/v1/reservation
  - POST: create a new reservation
- api/v1/ride
  - POST: create a new ride

N.B. To end the ride we use the position of the driver, when the position it's nearby the final location the ride will be canceled.

2.7.3.Design patterns

MVC Model-View-Controller pattern has been widely in our application.

Our Application server will use the Laravel PHP framework, which is an MVC framework. Our Web interface will use AngularJS, which is an MVC framework.

Adapter Adapters are used in our mobile application to adapt the Driver interface to the RESTful API one.

Client-Server The application is strongly based on a Client-Server communication model. The clients being the taxi drivers mobile application, the client's mobile application and client's web browsers. The clients are thin, thus to let the application run on low-resources devices. This approach has been chosen for different reasons:

- it's pratical.
- Data synchronization: there is only one application that mange the data.
- Having one unique server application improves the maintenability of our system.
- the application is indipendednt from the number of clients connected (it can be scaled up).
- improves the security between clients, that known only the server endpoint but not other clients.

2.8.Other design decisions

We have also to integrate our web application and our mobile applications with a map service, to do this have chosen to use an openmap service.

3.Algorithm design

Here we give just an idea of the most critical parts, we don't write complete code

Merging requests

As we said in RASD we use merged request to manage sharing option

```
function mergeRequests(Request[] $requests)
{
    $newRequests = array();
    foreach($requests as $request){
        if($request instanceof SharedRequest)
            if($match = findRequestMacthing($newRequests, $request))
                $newRequests[] = createMerge($math, $request);
            else
                $newRequests[] = new MergedRequest($request);
        else
            $newRequests[] = $request;
    }

    return $newRequests;
}

function findRequestMacthing(Requests[] &$newRequests, Request $request)
{
    foreach($newRequests as $key=>$newRequest)
        if(($newReuqets instanceof MergedRequest || $newReuqets instanceof SharedRequest)
                && matching($newRequest, $request)){
            unset($newRequests[$key]);
            return $newRequest;
        }
}

function matching(Request $request1, Request $request2)
{
    //...
    //this is explained in Definitions, acronyms, abbreviations
}

function createMerge(Request $request1, Request $request2)
{
    if($request1 instanceof MergedRequest)
        return $request1->add($request2);
```

```
    else
        return new MergedRequest($request1, $request2);
}
```

Make ride and calculate fees

```
function makeRide(Request $request, Driver[] $drivers)
{
    $ride = New Ride();
    //$ride->set... //set data like drivers
    $paths = $request->path();
    $clients = array();

    //order paths
    foreach($paths as $path)
        if($path instanceof LoadPosition)
            $clients[$path->client->id]['LoadPosition'] = $path;
        else
            $clients[$path->client->id]['DropPosition'] = $path;

    //calcualte fees
    if($request instanceof MergedRequest && count($clients)>2)
        foreach($clients as $client)
            $ride->setPrices($client->client->id, calcualteFee($client, true));
    else
        $ride->setPrices($client->clients[0]->id, calcualteFee($clients[0], false));
}

function calculateFee(Array $client, boolean $discount)
{
    return calculateDistance($client['LoadPosition'], $client['DropPosition']) *
    $request->passengers * ($discount?(1-SHARING_DISCOUT):1);
}
```

4.User interface design

4.1.Mockups

We have already done mockups in RASD in section 3.2.1 and 3.2.2

4.2.UX diagrams

We insert UX (user experience) diagrams to show how our user performs main actions

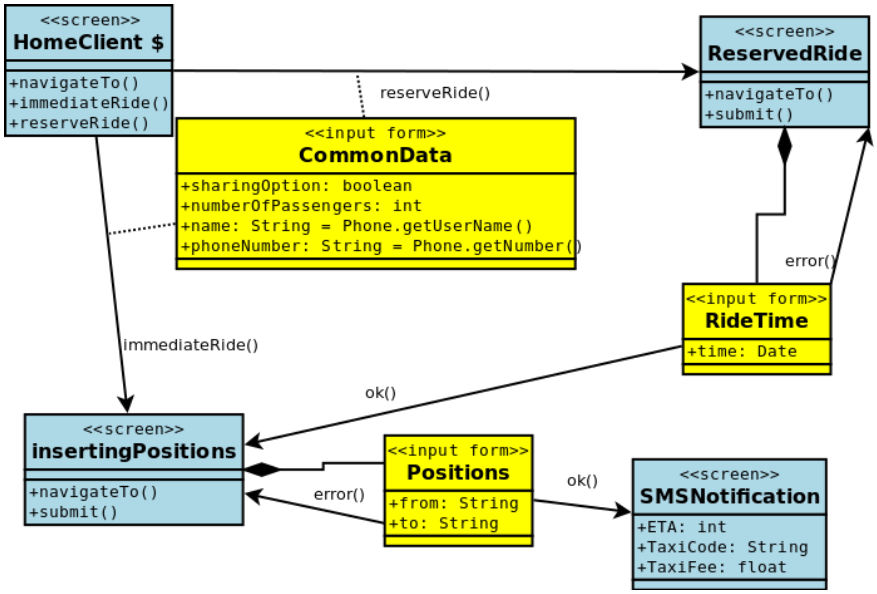


Figure 8: UX user mobile

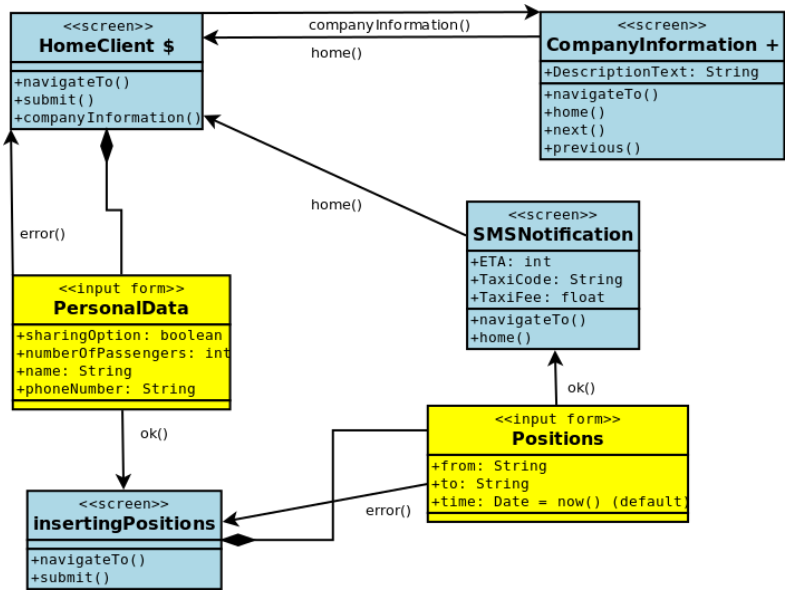


Figure 9: UX user desktop

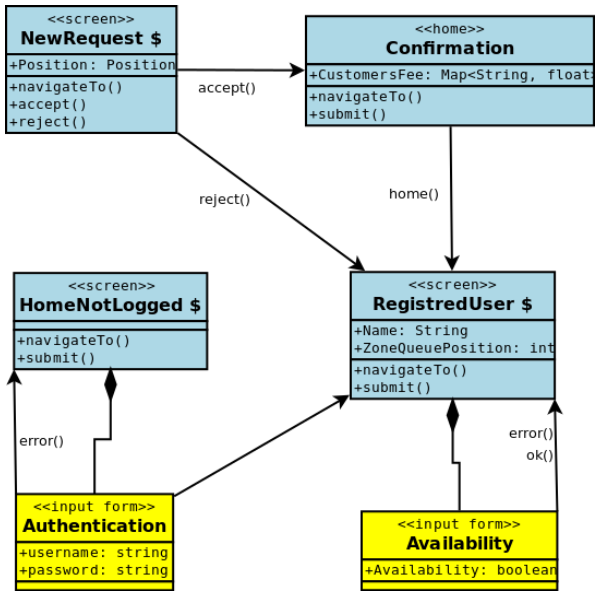


Figure 10: UX taxi driver mobile

4.3.BCE diagrams

We insert BCE (business controller entity) diagrams to show how each user action is managed internally and how it's linked with our model. This diagram is very useful since we use MVC.

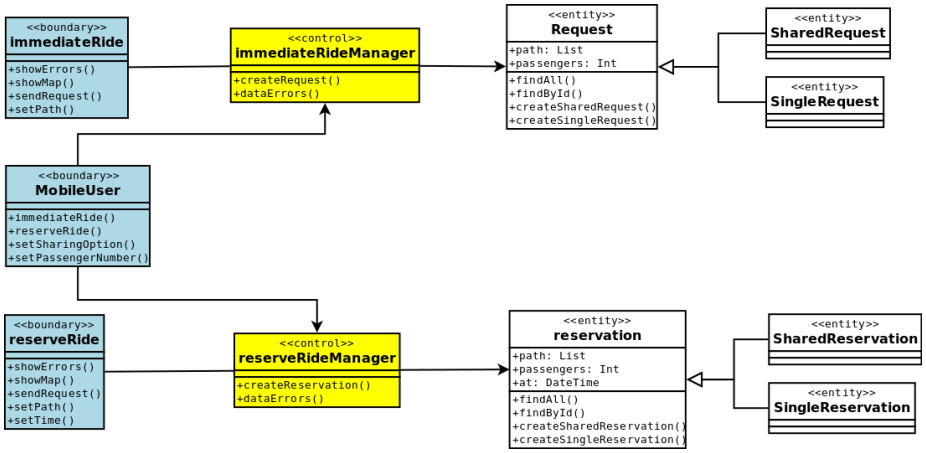


Figure 11: BCE user mobile

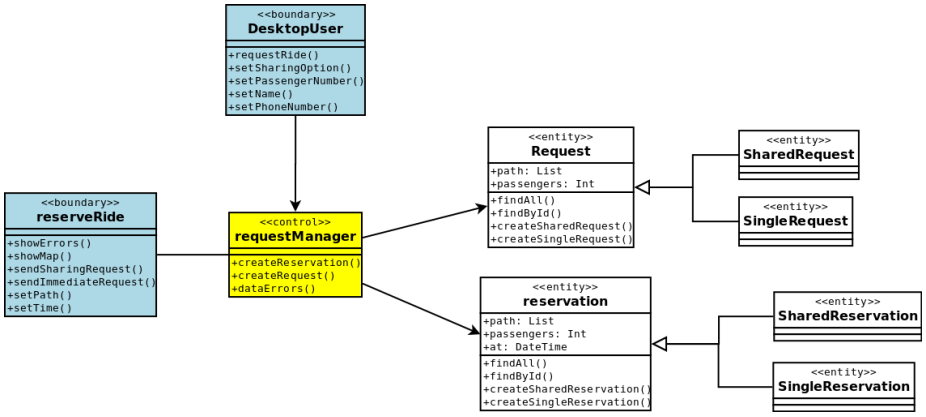


Figure 12: BCE user desktop

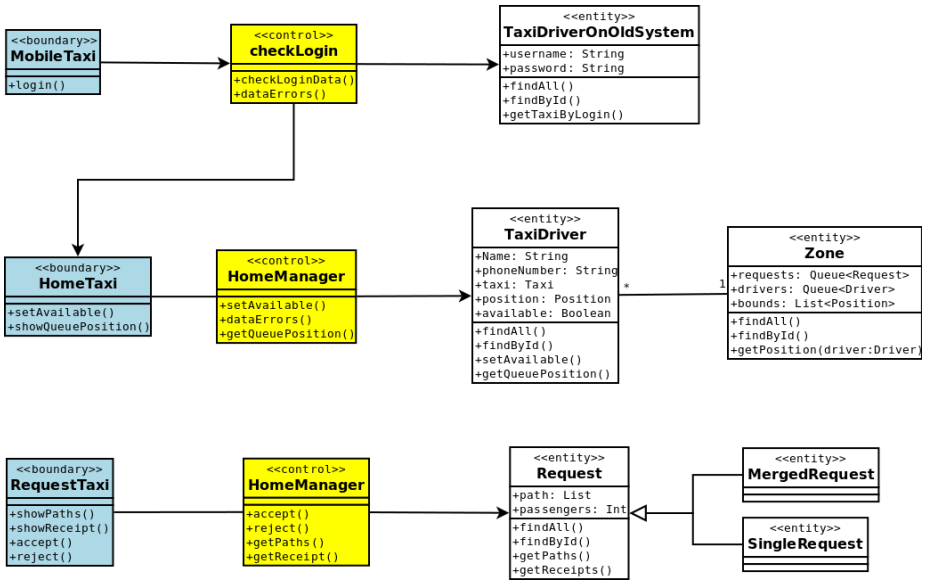


Figure 13: BCE taxi driver mobile

5.Requirements traceability

The design of this project was made aiming to fulfill optimally the requirements and goals specified in the RASD. The reader can find here under the list of these requirements and goals and the designed component of the application which will assure its fulfillment.

- [G1] Allows taxi drivers to log in the system.
  - The DriverController and its interface to the old database.
- [G2] Allows taxi drivers to precise to the system if they are available or not.
  - The DriverController
  - The Router
  - The DriverMobileApp component
  - The QueueManager
- [G3] Taxi drivers should receive a push notification for incoming request.
  - The DriverController
  - The Router
  - The DriverMobileApp component
  - The Push notification gateway
- [G5] Allows taxi drivers to accept or decline incoming requests for an immediate ride.
  - The DriverMobileApp component
  - The DriverController
  - The QueueManager
  - The RideController
  - The RequestController
- [G6] Allows taxi drivers to accept or decline incoming request for a later reservation.
  - The DriverMobileApp component
  - The DriverController
  - The QueueManager
  - The RideController
  - The ReservationController
  - The RequestController
- [G7] Allows taxi to know the fee for each ride before it starts via the request notification (but after he has accepted).
  - The RideController
  - The DriverController

  - The Router

- [G8] Allows clients to request for an immediate taxi ride.
  - The Client component
  - The Router
  - The RequestController

- [G9] Allows clients to request for the reservation of a taxi at least two hours in advance.
  - The Client component
  - The Router
  - The RequestController
  - The ReservationController

- [G10] Clients should receive an SMS notification with the ETA and code of the taxi that takes care of the client's request.
  - The RideController
  - The SMS gateway

- [G11] Allows clients to require to share the taxi.
  - The Client component
  - The RequestController

- [G12] Allows clients to identify themselves via phone number (and name) not via login, they are not registered into the system.
  - The Client component
  - The RequestController

- [G13] Allows clients to specify the number of passengers.
  - The Client component
  - The Router
  - The RequestController

- [G14] Allows clients to know the fee for the ride via SMS notification of taxi assigned see [G10]
  - The Client component
  - The RideController
  - The SMS gateway

6.References

Used tools

The tools we used to create this DD document are:

- DIA: for uml models
- Github: for version controller
- Gedit and ReText: to write MarkDown with spell check
- Pandoc: to create pdf

7.Hours of work

Claudio Cardinale

- 16/11/15: 1h
- 23/11/15: 30m
- 24/11/15: 5h
- 25/11/15: 3h
- 27/11/15: 4h
- 01/12/15: 30m
- 03/12/15: 2h
- 04/12/15: 2h

Gilles Dejaegere

- 24/11/15: 3h
- 25/11/15: 3h reunion + 2h before
- 27/11/15: 1h30
- 28/11/15: 3h30
- 30/11/15: 3h
- 01/12/15: 1h30
- 02/12/15: 2h
- 04/12/15: 2h

Massimo Dragano

- 24/11/15: 6h
- 25/11/15: 6h
- 01/12/15: 4h