Politecnico di Milano

Software Engineering 2 Project
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MyTaxiService
Integration Test Plan Document
Version 1.0

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Contents

Chapter 1

Introduction

1.1 Revision History

Version	Date	Author(s)	Summary
1.0	21/01/16	Valerio Castelli & Fabrizio Casati	Initial release

1.2 Purpose and Scope

This document represents the Integration Testing Plan Document for myTaxiService. Integration testing is a key activity to guarantee that all the different subsystems composing myTaxiService interoperate consistently with the requirements they are supposed to fulfill and without exhibiting unexpected behaviors. The purpose of this document is to outline, in a clear and comprehensive way, the main aspects concerning the organization of the integration testing activity for all the components that make up the system. In the following sections we're going to provide:

- A list of the subsystems and their subcomponents involved in the integration activity that will have to be tested
- The criteria that must be met by the project status before integration testing of the outlined elements may begin
- A description of the integration testing approach and the rationale behind it
- The sequence in which components and subsystems will be integrated
- A description of the planned testing activities for each integration step, including their input data and the expected output

- A list of all the tools that will have to be employed during the testing activities, together with a description of the operational environment in which the tests will be executed

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

- Subcomponent
- SubsystemTBD tbd

1.3.2 Acronyms

- SDD: Software Design Description.
- DD: Design Document. Used as a synonym of SDD.
- DBMS: Database Management System.
- API: Application Programming Interface.
- RASD: Requirement Analysis and Specification Document.
- SRS: Software Requirements Specifications. Synonym of RASD.
- ETA: Estimated Time of Arrival.
- UI: User Interface.
- GPS: Global Positioning System.
- SDK: Software Development Kit.

1.3.3 Abbreviations

- Req. as for Requirement.
- WebApp as for Web Application.

1.4 Reference Documents

- The project description document: Assignments 1 and 2 (RASD and DD).pdf
- Assignment document: Assignment 4 - integration test plan.pdf
- myTaxiService Requirement Analysis and Specification Document: RASD.pdf

- myTaxiService Design Document: DD.pdf
- The Integration Test Plan Example document: Integration Test Plan Example.pdf

Chapter 2

Integration Strategy

2.1 Entry Criteria

In order for the integration testing to be possible and to produce meaningful results, there are a a number of conditions on the progress of the project that have to be met.

First of all, the **Requirements Analysis and Specification Document** and the **Design Document** must have been fully written. This is a required step in order to have a complete picture of the interaction between the different components of the system and of their required functionalities.

Secondly, the integration process should start only when the estimated percentage of completion of every component with respect to its functionalities is:

- **100%** for the **Data Access Utilities** component
- At least **90%** for the **Taxi Management System** subsystem
- At least **70%** for the **System Administration** and **Account Management** subsystems
- At least **50%** for the **client applications**

It should be noted that these percentages refer to the status of the project at the beginning of the integration testing phase and they do not represent the minimum completion percentage necessary to consider a component for integration, which must be at least **90%**. The choice of having different completion percentages for the different components has been made to reflect their order of integration and to take into account the required time to fully perform integration testing.

2.2 Elements to be Integrated

In the following paragraph we're going to provide a list of all the components that need to be integrated together.

As specified in myTaxiService's Design Document, the system is built upon the interactions of many high-level components, each one implementing a specific set of functionalities. For the sake of modularity, each subsystem is further obtained by the combination of several lower-level components. Because of this software architecture, the integration phase will involve the integration of components at two different levels of abstraction.

At the lowest level, we'll integrate together those components that depend strongly on one another to offer the higher level functionalities of myTaxiService. In our specific case, this involves the integration of the **Reservation Management**, **Request Management**, **Location Management** and **Taxi Management** subcomponents in order to obtain the **Taxi Management System** subsystem.

For what concerns the building of the **System Administration** and **Account Management** subsystems, the integration activity is actually quite limited; in fact, they simply represent a collection of functionalities belonging to the same area which however are not dependent on one another. As a result of this, their subcomponents don't really interact with each other, and the integration phase will be limited to the task of ensuring that the set of functionalities of each subcomponent is properly exposed by the subsystem. The components involved in this phase are:

- The **API Permissions Management**, **Zone Division Management**, **Taxi Driver Management**, **Service Statistics** and **Plugin Management** subcomponents in order to obtain the **System Administration** subsystem.
- The **Passenger Registration**, **Login**, **Password Retrieval** and **Settings Management** subcomponents in order to obtain the **Account Management** subsystem.

Some of these subcomponents also directly rely on higher level, atomic components: that is the case, for instance, of the dependency on the **Data Access Utilities** component. This dependency will be taken care of in the integration process.

Finally, we will proceed with the integration of the higher level subsystems. In particular, the integration activity will involve:

- A number of commercial, already existing components, used to achieve specific functionalities: these are the **DBMS**, **Mapping Service**, **Notification System** and **Remote Services Interface** components.
- Those components and subsystems specifically developed for myTaxiService, specifically:

- On the server side: the **Taxi Management System**, **System Administration**, **Account Management** subsystems, together with the **Data Access Utilities** component.
- On the client side: the **Administration Web Application**, **Passenger Web Application**, **Passenger Mobile Application** and **Taxi Driver Mobile Application** components.

2.3 Integration Testing Strategy

The approach we're going to use to perform integration testing is based on a mixture of the bottom-up and critical-module-first integration strategies.

Using the bottom-up approach, we will start integrating together those components that do not depend on other components to function, or that only depend on already developed components. This strategy brings a number of important advantages. First, it allows us to perform integration tests on "real" components that are almost fully developed and thus obtain more precise indications about how the system may react and fail in real world usage with respect to a top-down approach. Secondly, working bottom-up enables us to more closely follow the development process, which in our case is also proceeding using the bottom-up approach; by doing this we can start performing integration testing earlier in the development process as soon as the required components have been developed in order to maximize parallelism and efficiency.

Since subsystems are fairly independent from one another, the order in which they're integrated together to obtain the full system follows the critical-module-first approach. This strategy allows us to concentrate our testing efforts on the riskiest components first, that is those that represents the core functionalities of the whole system and whose malfunctioning could pose a very serious threat to the correct implementation of the entire myTaxiService infrastructure. By proceeding this way, we are able to discover bugs earlier in the integration progress and take the necessary measures to correct them on time.

2.4 Sequence of Component/Function Integration

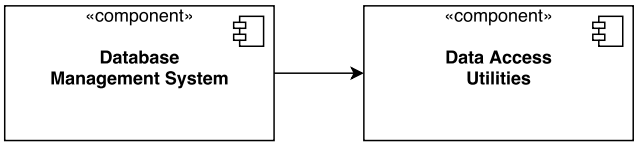
In this section we're going to describe the order of integration (and integration testing) of the various components and subsystems of myTaxiService. As a notation, an arrow going from component C1 to component C2 means that C1 is necessary for C2 to function and so it must have already been implemented.

2.4.1 Software Integration Sequence

Following the already mentioned bottom-up approach, we now describe how the various subcomponents are integrated together to create higher level subsystems.

Data Access Utilities

The first two elements to be integrated are the **Data Access Utilities** and the **Database Management System** components. We start from here because every other component relies on **Data Access Utilities** to perform queries on the underlying data structure.



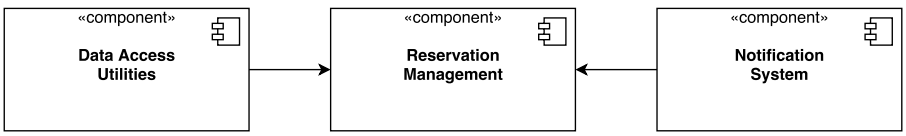
Taxi Management System

The second step in the integration process is to appropriately connect the subcomponents implementing the **Taxi Management System**. This choice comes from the critical-module-first approach, because the taxi management is the single most important functionality of myTaxiService.

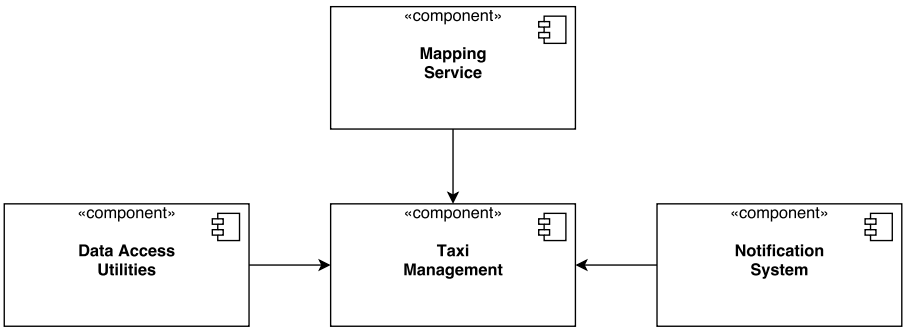
In the following diagrams, we are going to show exactly which components must be integrated together in order to implement this functionality using a bottom-up approach.

First, we procede by integrating together the **Request Management** subcomponent with the **Data Access Utilities** and the **Notification System** components.

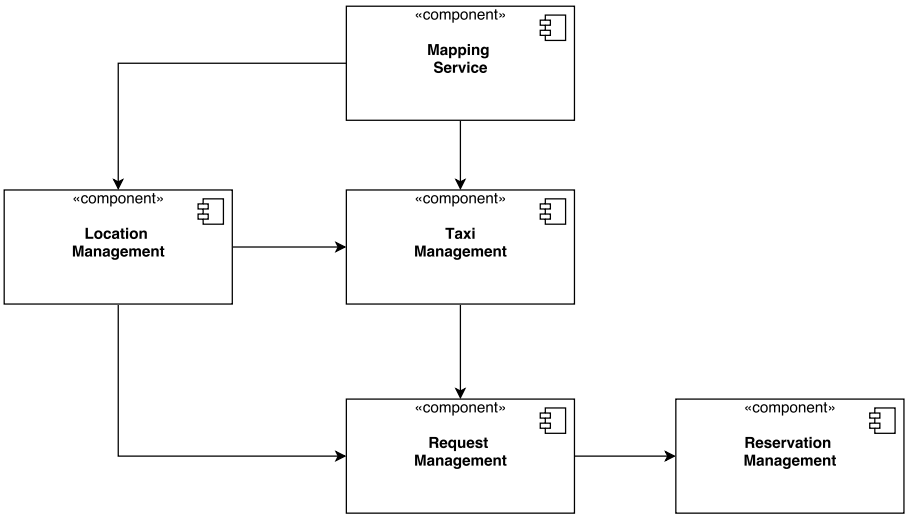
The same activity is performed between the **Reservation Management** subcomponent and the **Data Access Utilities** and the **Notification System** components.



Finally, we integrate together the **Taxi Management** component with the **Data Access Utilities**, the **Notification System** and the **Mapping Service** components.



At this point, the four sub-components of **Taxi Management System** are ready to be integrated together.



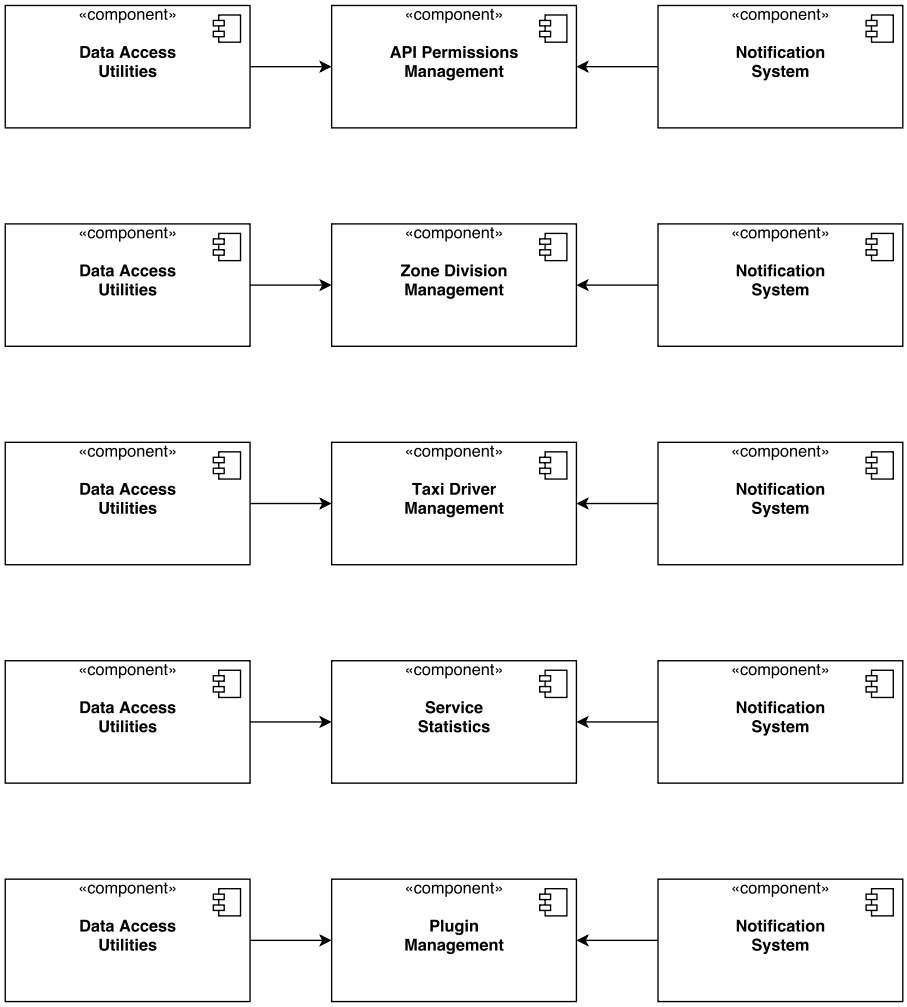
System Administration

The third step in the integration process is to appropriately connect the subcomponents implementing the **System Administration** subsystem. This choice comes from the critical-module-first approach, because the system administration is the second most important functionality of myTaxiService. Once it has been integrated and tested, we can use this functionality to more easily populate the database for the following integration tests.

It should be noted that the subcomponents of **System Administration** are loosely coupled together as they cover different aspects of the system

administration activity. Because of this, they can be integrated with the other components of the system independently from one another.

In the following diagrams, we are going to show exactly how these subcomponents interact with the other components using a bottom-up approach. The **System Administration** subsystem, which here is not explicitly represented, is simply a wrapper for the methods of these subcomponents that have to be exposed to the other parts of the system and performs additional preprocessing to ensure these methods are properly called. It will be discussed more in depth in the **Subsystem Integration Sequence** section.



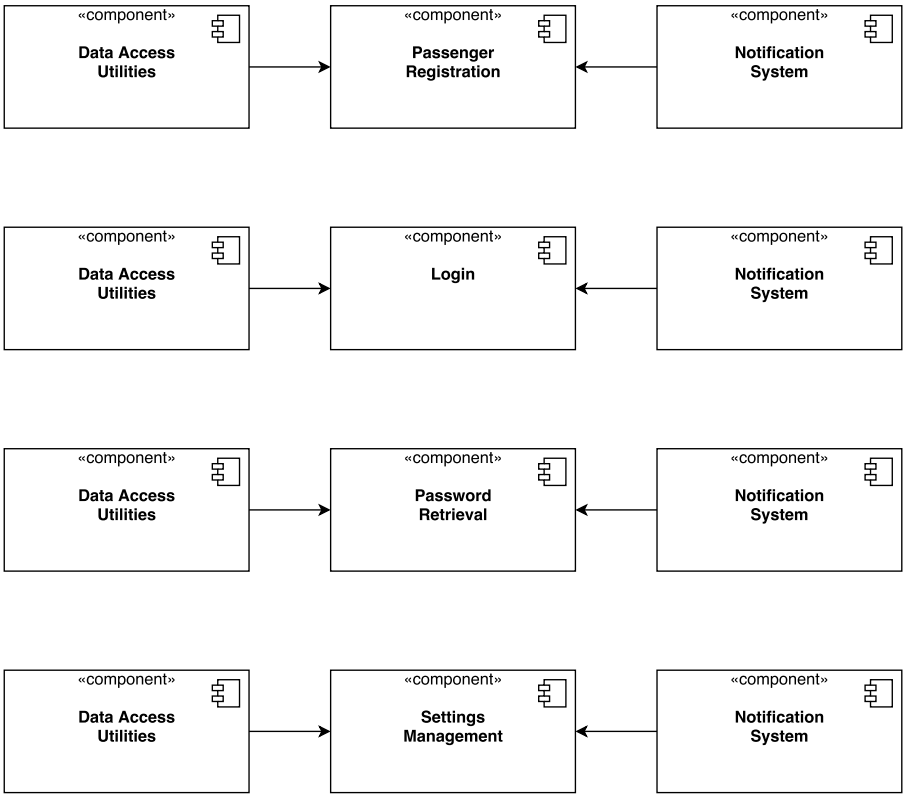
Account Management

The fourth step in the integration process is to appropriately connect the subcomponents implementing the **Account Management** subsystem. This

choice is dictated by the bottom-up approach that we are following, because account management is the last functionality that can be implemented without depending on anything but already implemented components.

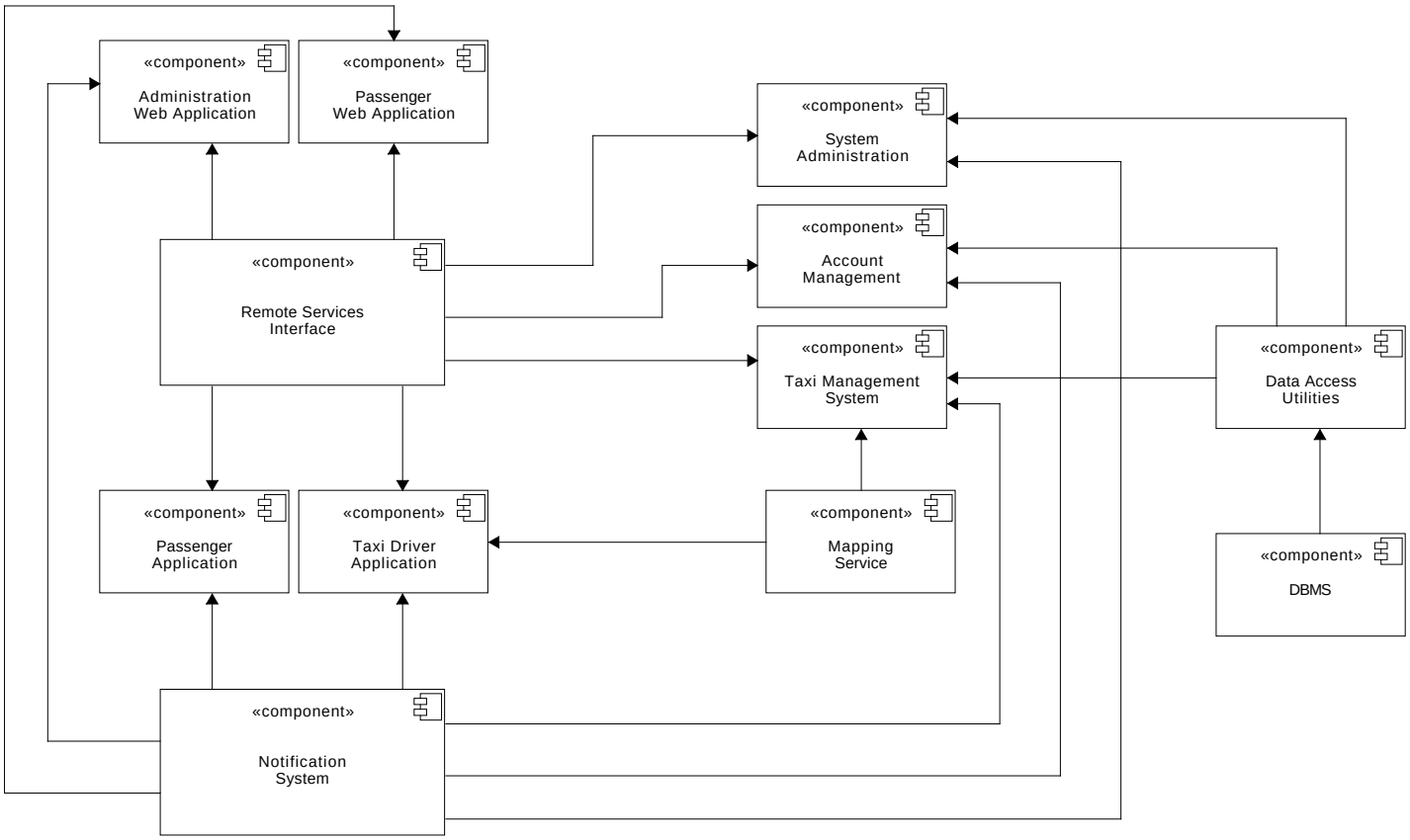
It should be noted that the subcomponents of **Account Management** are loosely coupled together as they cover different operations that can be performed on accounts. Because of this, they can be integrated with the other components of the system independently from one another.

In the following diagrams, we are going to show exactly how these subcomponents interact with the other components using a bottom-up approach. The **Account Management** subsystem, which here is not explicitly represented, is simply a wrapper for the methods of these subcomponents that have to be exposed to the other parts of the system and performs additional preprocessing to ensure these methods are properly called. It will be discussed more in depth in the **Subsystem Integration Sequence** section.



2.4.2 Subsystem Integration Sequence

In the following diagram we provide a general overview of how the various high-level subsystems are integrated together to create the full myTaxiService infrastructure.



Chapter 3

Individual Steps and Test Description

Chapter 4

Performance analysis

While a full fledged performance analysis of the entire myTaxiService infrastructure will be executed only in the system integration phase, it is still useful to perform some preliminary measures on components whose performances can be tested in isolation.

In particular, it is appropriate to verify that the applications for all the target mobile platforms, regardless whether they're destined to taxi drivers or to passengers, have reasonable CPU and main memory usages.

As specified in the RASD, the performance requirements of the mobile applications are the followings:

- It must run correctly on smartphones with single core processors clocked at 800Mhz or more.
- It must use no more than 64 MB of RAM to execute.

Furthermore, even though no strict value is fixed at this point, the storage occupation should be reasonably small. Given the current trends in the size of the image assets needed to support high resolution devices, it is reasonable to expect a 30MB size cap; however, this number should be reconsidered during the development phase taking into account the improvements in the smartphone and tablet technology that may occur meanwhile.

These tests will be performed using the appropriate performance analysis tool provided with the SDK of each mobile platform.

Chapter 5

Tools and Test Equipment Required

5.1 Tools

In order to test the various components of myTaxiService more effectively, we are going to make usage of a number of automated testing tools.

For what concerns the business logic components running in the Java Enterprise Edition runtime environment, we are going to take advantage of two tools. The first one is the **Arquillian integration testing framework**. This tool enables us to execute tests against a Java container in order to check that the interaction between a component and its surrounding execution environment is happening correctly (as far as the Java application server is involved). Specifically, we are going to use Arquillian to verify that the right components are injected when dependency injection is specified, that the connections with the database are properly managed and similar container-level tests. The second tool is the **JUnit framework**. Though this tool is primarily devoted to unit testing activities, it's still a valid instrument to verify that the interactions between components are producing the expected results. In particular, we are going to use it in order to verify that the correct objects are returned after a method invocation, that appropriate exceptions are raised when invalid parameters are passed to a method and other issues that may arise when components interact with each other.

Furthermore, as we have already mentioned briefly in the previous chapter of this document, we are going to use specific performance analysis tools to make sure that the applications for all the target mobile platforms, regardless whether they're destined to taxi drivers or to passengers, have reasonable CPU and main memory usages. Depending on the specific platform we are targeting, the tools we are going to use are:

- On Android: the Memory Profiler, Memory Monitor and Allocation Tracker tools to monitor main memory usage; the Traceview Walk-

through to monitor method execution time and the battery profiler to monitor energy consumption.

- On iOS: the full suite of performance analysis tools provided by the Xcode IDE. This includes Instruments as a general performance profiling tool, MallocDebug to find memory leaks, Activity Monitor and BigTop to monitor system statistics such as CPU, disk, network and memory usage.
- On Windows Phone: the Windows Phone Application Analysis toolkit, specifically the Windows Performance Analyzer tool.

Finally, it should be noted that despite the usage of automated testing tools, some of the planned testing activities will also require a significant amount of manual operations, especially to devise the appropriate set of testing data.

5.2 Test Equipment

All the integration testing activities have to be performed within a specific testing environment.

Since myTaxiService incorporates both a set of client components and a backend infrastructure, we must define the characteristics of the devices that have to be used in each of these two areas.

For what concerns the mobile client side of the testing environment, the following devices are required:

- For the Taxi Driver Mobile Application:
  - At least one Android smartphone for each display size from 3” to 6” at steps of 1/2”. .
  - At least one Android tablet for each display size from 7” to 12” at steps of 1/2”.
  - At least one iOS smartphone for each member of the iOS product family.
  - At least one iOS tablet for each display size of the iOS product family.
  - At least one Windows Phone smartphone for each display size from 3” to 6” at steps of 1/2”.

These devices will be used to test both the native mobile applications and the mobile versions of the web applications. It should be noted that these are general guidelines to drive the selection of the testing devices in a way that covers the widest range of possible configurations. Some display sizes or

resolutions may not be offered by all product families. As a general note, we should consider the possibility of performing an analysis of the smartphone market to identify the most common display sizes and resolutions right before starting the integration testing phase, in order to better reflect the typical usage scenarios we will encounter in the real operating environment.

Regarding the desktop web applications, they will be tested using a set of normal desktop and notebook computers. There are no specific requirements on display resolution, operating system and processing power.

As for the backend testing, the business logic components should be deployed on a cloud infrastructure that closely mimics the one that will be used in the operating environment. Specifically, the testing cloud infrastructure needs to run the same operating system, the same Java Enterprise Application Server, the same **Notification System** and **Remote Services Interface** middleware (message brokers) and the same DBMS. As such, it is strongly required to use a scaled down version of the final operating cloud infrastructure chosen from the same service provider.

Depending on the actual implementation decisions, the specific software components may change. As a preliminary draft we assume to be using the **Red Hat OpenShift cloud infrastructure**, that is built upon the following software components:

- The **Red Had Enterprise Linux** distribution.
- The **Java Enterprise Edition** runtime.
- The **GlassFish Java Application Server**.
- The **GlassFish Message Broker**.
- The **Apache Web Server** as an HTTP load balancer.
- The **Oracle Database Management System**.

Chapter 6

Required Program Stubs and Test Data

6.1 Program Stubs and Drivers

As we have mentioned in the Integration Testing Strategy section of this document, we are going to adopt a bottom-up approach to component integration and testing.

Because of this choice, we are going to need a number of drivers to actually perform the necessary method invocations on the components to be tested; this will be mainly accomplished in conjunction with the JUnit framework. While the bottom-up approach in general doesn't require the usage of any stubs as the system is developed from the ground up, we are still going to introduce a number of them to test some specific parts of the system, namely the **Remote Services Interface** and the **Notification System** components. We think this approach is useful to be able to test whether the interaction between these components and the sender (receiver) of a message is working correctly, independently from the behavior of the corresponding receiver (sender). This allows us to improve the bug tracking process, as it automatically eliminates all the possible issues stemming from a bug on the other end of the communication channel and that could be confused as a sign that the channel itself is not working properly.

Here follows a list of all the drivers that will be developed as part of the integration testing phase, together with their specific role.

- **Data Access Driver**: this testing module will invoke the methods exposed by the **Data Access Utilities** component in order to test its interaction with the **DBMS**.
- **Request Management Driver**: this testing module will invoke the methods exposed by the **Request Management** component, including those with package-level visibility, in order to test its interaction

with the **Data Access Utilities**, the **Notification System**, the **Reservation Management**, the **Location Management** and the **Taxi Management** components.

- **Reservation Management Driver**: this testing module will invoke the methods exposed by the **Reservation Management** component, including those with package-level visibility, in order to test its interaction with the **Data Access Utilities**, the **Notification System** and the **Request Management** components.
- **Location Management Driver**: this testing module will invoke the methods exposed by the **Location Management** component, including those with package-level visibility, in order to test its interaction with the **Mapping Service** external component.
- **Taxi Management**

FIX DIAGRAM OF TAXI MANAGEMENT REMEMBER TO ADD A STUB TO FIRST TEST REQ. MAN. VS RES. MAN. CONNECTION, IF IT EVEN EXISTS!!

fix diagram of taxi management remember to add a stub to first test req. man. vs res. man. connection, if it even exists!!

6.2 Test Data

Appendix A

Hours of work

To redact this document, we spent 20 hours per person.