PowerEnJoy
Software Engineering II

Integration Test Plan Document

Giovanni Scotti, Marco Trabucchi

Document version: 1
January 2, 2017

Contents

Section 1

Introduction

1.1 Purpose and Scope

1.1.1 Purpose

The Integration Test Plan Document (ITPD) is intended to provide the guidelines to accomplish the integration test phase planning in sufficient detail. This also includes determining which tools are needed and will be used during the testing process itself, as well as the required stubs, drivers and data structures that will be useful during said process.

1.1.2 Scope

PowerEnJoy is a car sharing service that only employs electric vehicles; it is provided for a large city, and aims to support the sharing process and car management of the electric cars, as well as the booking and payments for the service itself.

1.2 Definitions, Acronyms, Abbreviations

RASD: Requirements and Specification Document.

DBMS: DataBase Management System.

DD: Design Document.

ITPD: Integration Test Plan Document.

JEB: Java Entity Bean.

JSP: Java Server Pages.

SB: Session Bean.

1.3 Reference Documents

The indications provided in this document are based on the ones stated in the previous deliverables for the project, the RASD document [1] and the DD document [2].

Moreover it is strictly based on the test plan example [4] presented during lectures and on the specifications concerning the RASD assignment [3] for the Software Engineering II project, part of the course held by professors Luca Mottola and Elisabetta Di Nitto at the Politecnico di Milano, A.Y. 2016/17.

Section 2

Integration Strategy

2.1 Entry Criteria

This section expresses the prerequisites needed to be met before the integration phase takes place.

Documentation: The documentation for every method and class must be provided for each individual component, in order to make it easier to reuse classes and understand their functioning; this is in fact also a prerequisite for the unit tests to be performed before the integration test phase. When necessary, a formal language specification of the classes' behaviours can be used (such as JML - Java Modelling Language).

Unit tests: All the classes and methods must be tested thoroughly using JUnit, in order to assure a properly correct behaviour of the internal mechanics of the individual components. It is required that the test coverage of each class and package reaches 90% of the code lines; moreover, test cases must be written with continuity and executed at every consecutive build of the project: this is needed in order to ensure that newly added lines do not interfere with the stability of the rest of the code.

Code Inspection and Analysis: Both automated data-flow analysis and code inspection must be performed on the whole project classes. This will reduce the risk that, during the integration test phase, any code-related issues or bugs rise, leading to more complex problematic situations to be solved in latter phases of the project development, with much greater effort for the development team.

RASD and DD: Along with the indications provided in this very document (ITPD), the two previous documents for this project, RASD and DD, must be delivered before the integration test phase can begin.

2.2 Elements to be Integrated

The integration test phase for the *PowerEnJoy* system will be structured based on the architectural division in tiers that is described in the Design Document [2], as well as the indication of the elements of which said subsystems are composed of.

With respect to this, the subsystems to be integrated in this phase are the following four:

Database Tier This includes all the commercial database structures that will be used for the data storage and management of the system, namely the DBMS and the Database Engine; the two data layer components are already developed to work properly when coupled together, so the only component to be integrated is the DBMS.

Application Logic Tier This includes all the business logic for the application, the data access components and the interface components towards external systems and clients. All the interactions among internal logic components must be tested and all the subsystems that interact with this tier must be individually integrated.

Web Tier This includes all the components in charge of the web interface and the communication with the application logic tier and the browser client. The integration tests must be performed both ways for this tier, and the Web Controller must be thoroughly tested also for the interaction with the Java Server Pages component.

Client Tier This includes the various types of clients, which is to say the Mobile Application Client, the Web Browser Client and the On-Board Application Client, and their internal components. Single clients must behave properly with respect to their internal structure, and must be individually integrated with the tier they interface with.

The integration process will be performed in two steps:

- A *first phase* in which the individual components of the subsystems (i.e. Java classes, Java Beans and Containers), are integrated one by one.

- A *second phase* in which, after having ensured a proper internal behaviour, the above specified subsystems are integrated as well.

2.3 Integration Testing Strategy

As far as the integration testing process is concerned, a **bottom-up approach** will be followed.

The choice of the bottom-up testing strategy is natural since the integration testing can start from the smallest and lowest-level components, that are already tested at a unit level and do not depend on other components or not-already-developed components. In this way the total amount of needed stubs to accomplish the integration will be deeply reduced, but temporary programs for higher-level modules (drivers) will be necessary to simulate said modules and invoke the unit under test.

The bottom-up strategy will be mixed with a **critical-module-first approach**, in order to avoid issues related to the failures of core components and threats to the correct implementation of the entire *PowerEnJoy* system.

Moreover the higher-level subsystems described in section 2.2 are loosely coupled and fairly independent from one another because they correspond to different tiers. In this case, the critical-module-first approach is used to establish the integration order and get to the full system.

Notice that the DBMS is a commercial component already developed that can be used directly in the bottom-up approach and does not have any dependency.

At this level of integration testing, the communication functionalities with external systems must be covered as well, especially considering the relevance of said interaction in the context of the application. With respect to this, stubs and drivers will be used appropriately, based on the type of interface and interaction with the individual external systems.

2.4 Sequence of Components/Function Integration

The following sections aim to describe the integration testing sequence of the different components and subsystems of *PowerEnJoy*. From now on the following notation will be used: C1 $\rightarrow$ C2 indicates that C2 is necessary for C1 to work properly.

2.4.1 Software Integration Sequence

The components of each subsystem are tested starting from the most to the least independent one.

Data Access

The first components to be integrated are those relative to the data access, starting from the database core: the DBMS. This will be integrated with all the Java Entity Beans (JEB) defined in the Design Document [2].

In order to do so, the DBMS will need a driver for each Entity Bean to carry out queries and verify their correctness on a dummy database, containing a greatly reduced number of test information. Said test database will be structured based on the E-R schema that will be adopted for the final implementation of the data layer.

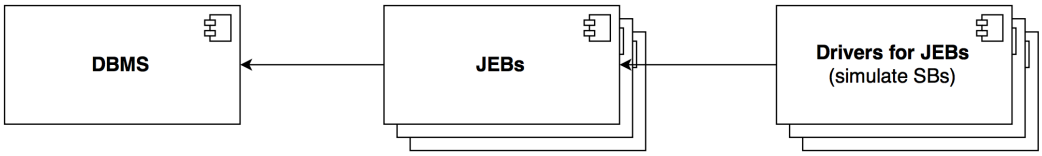
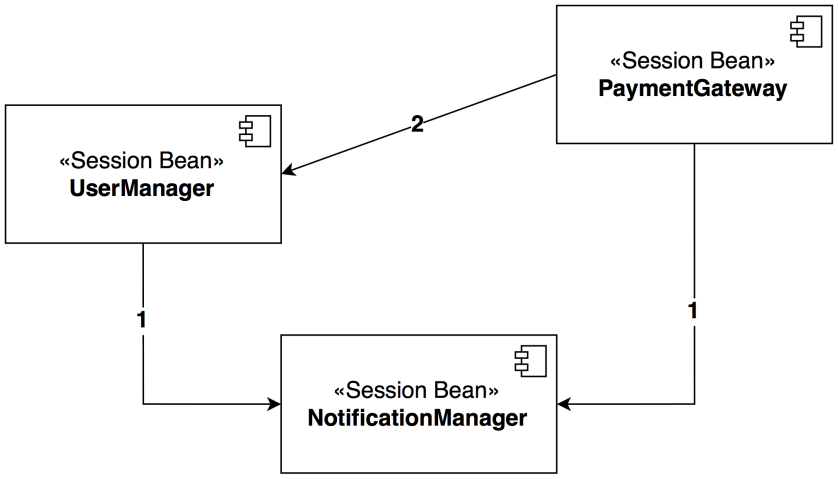


Figure 2.1: The integration of the system components at a Data Access level. The detailed integration steps are described at the end of the section in an overall comprehensive diagram.

The next steps involve the integration of the Session Beans which take advantage of said Entity Beans and are in charge of accessing them in the final application.

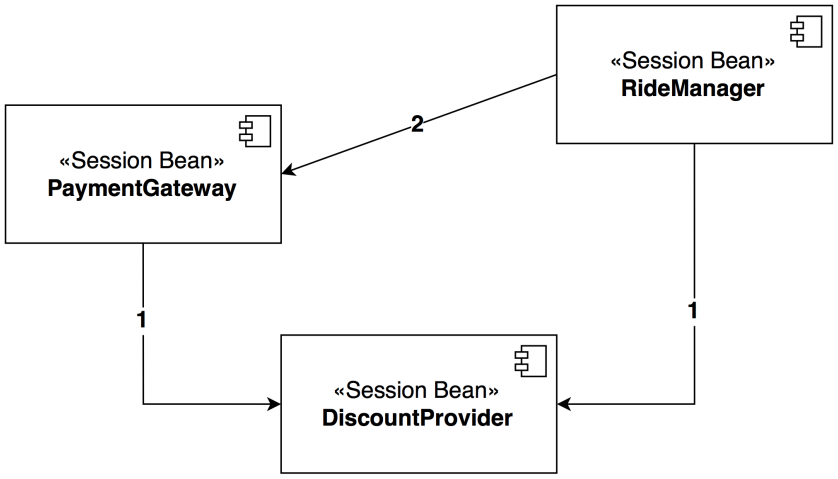
User and Utilities Management

The integration can begin by covering the user management and the business logic utilities, that are considered relevant to support the rest of the application functionalities. To begin with, the most independent bean is, in this case, the NotificationManager, that requires two drivers to invoke and test methods later used by UserManager and PaymentGateway (1). The UserManager component can then in turn be integrated (2), using a driver to be replaced with the PaymentGateway together with the previously mentioned one, and to call the needed methods appropriately for the case.



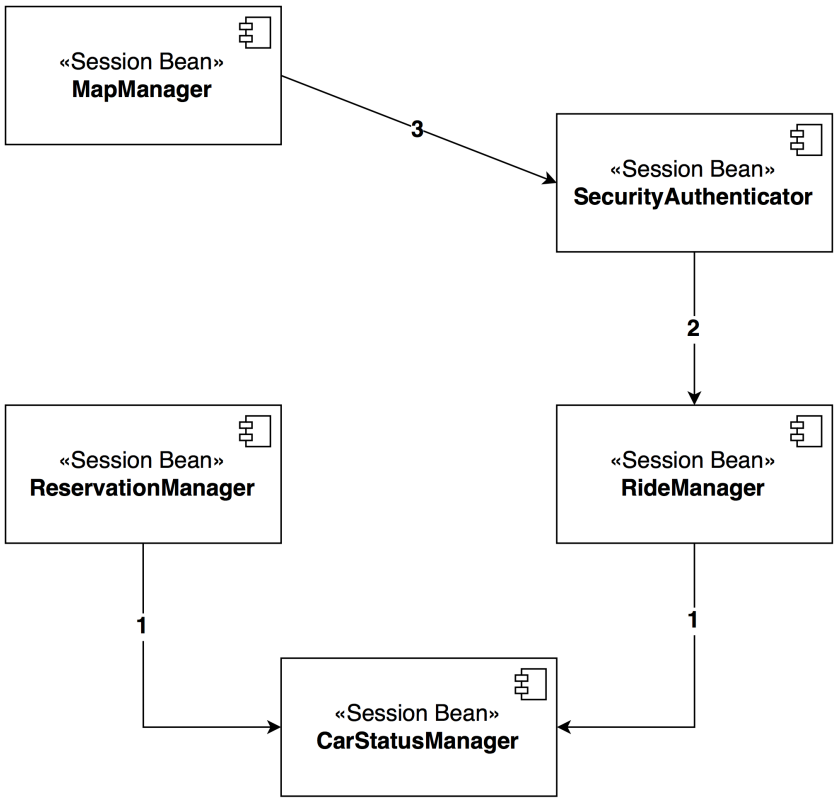
Payment Management

The payment management context can be covered next in the integration process, starting once more from the most independent component, represented by the DiscountProvider. This will need two different drivers, one for the methods called by the RideManager and another for the PaymentGateway (1). The PaymentGateway itself can in turn be integrated by using another driver, that will be replaced with the RideManager (2). RideManager is then going to replace the two drivers that simulated its behaviour altogether.



Ride and Reservation Management

The most critical features of the application revolve around the management of rides and reservations. Within this context, the most independent functionality is provided by the CarStatusManager bean, since no other bean depends on it apart from the already integrated Entity Beans. In order to integrate the CarStatusManager, there will be the need of two drivers: invoking methods in place of the ReservationManager and of the RideManager (1). In its turn, the RideManager itself needs a driver in order to be integrated (2), which will represent the SecurityAuthenticator session bean and call the methods exposed by RideManager in its place. The last component to be integrated in this context is the SecurityAuthenticator, which will need a driver to simulate method calls by the MapManager bean on it (3).



Application Logic Overall Integration

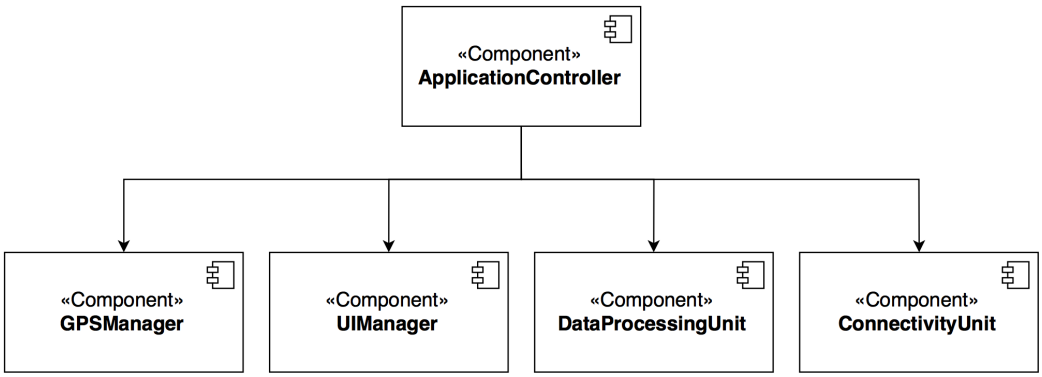
To conclude the integration process for the application logic tier, drivers for the EJB Containers must be provided, in order to have a means to emulate multiple requests for session bean instances; this will help in testing the

underlying system effectiveness in managing heavy loads and concurrency during ordinary activity. Hence, in order to simulate the correctness of requests to the individual containers, a driver for each individual container must be used to bypass the runtime behaviour and reproduce said requests in a deterministic way. This approach will avoid the necessity of implementing the whole system before having the possibility to test the correctness of the requests to the containers.

Figure 2.2: The integration of the system components at a container level. The detailed integration steps are described at the end of the section in an overall comprehensive diagram.

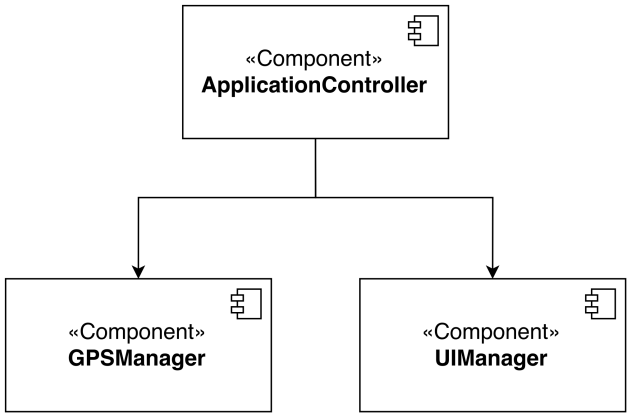
On-Board Application

With respect to the On-Board Application, the integration process must proceed for each of the base components individually with the application controller.



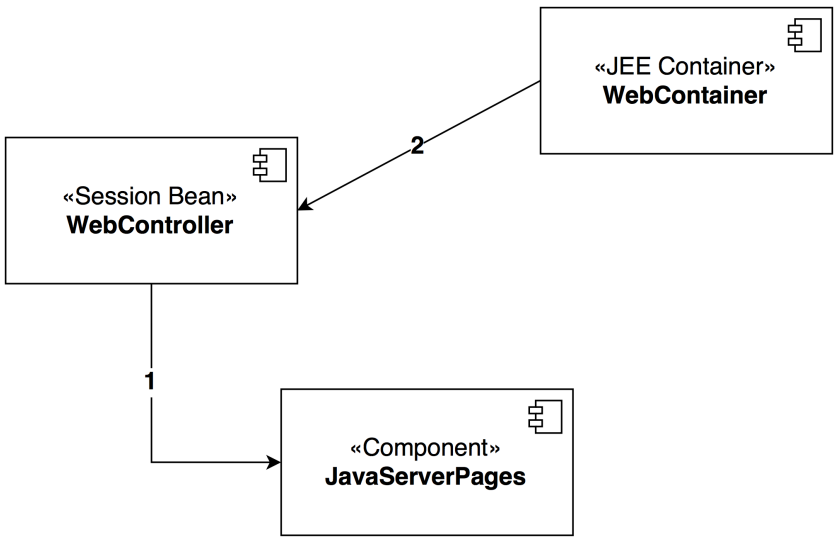
Mobile Application

Similarly to what is stated for the on-board application, the mobile application will follow the order imposed by the centrality of the application controller; the other components will be integrated individually with the controller itself.



Web Application

As far as the Web Application is concerned, the Java Server Pages will be integrated with the web controller, which will be in turn integrated with the container in which it is defined.



An overall view of the integration sequence is provided below: blue arrows highlight interactions between EJBs and the DBMS, red arrows highlight interactions between Containers and the respectively contained Session Beans.

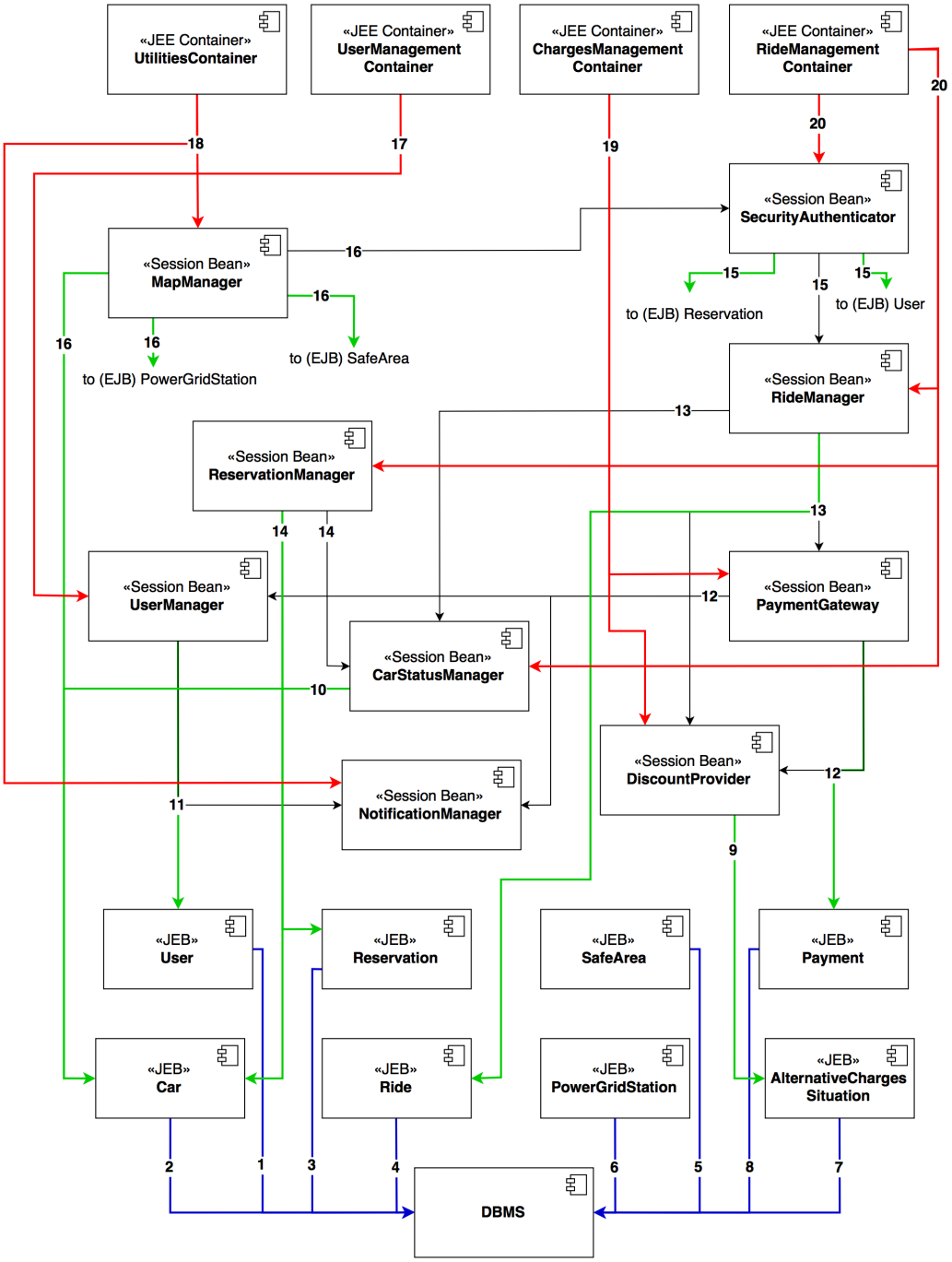


Figure 2.3: Overall diagram of the components integration. Numbers point out the integration order.

N.	Subsystems	Component	Integrates with
I01	Database, App. Logic	(JEB) User	DBMS
I02	Database, App. Logic	(JEB) Car	DBMS
I03	Database, App. Logic	(JEB) Reservation	DBMS
I04	Database, App. Logic	(JEB) Ride	DBMS
I05	Database, App. Logic	(JEB) SafeArea	DBMS
I06	Database, App. Logic	(JEB) PowerGridStat.	DBMS
I07	Database, App. Logic	(JEB) AlternativeChargesSit.	DBMS
I08	Database, App. Logic	(JEB) Payment	DBMS
I09	App. Logic	(SB) DiscountProvider	(JEB) Alternative ChargesSit.
I10	App. Logic	(SB) CarStatusManager	(JEB) Car
I11	App. Logic	(SB) UserManager	(JEB) User (SB) NotificationManager
I12	App. Logic	(SB) PaymentGateway	(JEB) Payment (SB) UserManager (SB) DiscountProvider (SB) NotificationManager
I13	App. Logic	(SB) RideManager	(JEB) Ride (SB) PaymentGateway (SB) DiscountProvider (SB) CarStatusManager
I14	App. Logic	(SB) ReservationManager	(JEB) Car (JEB) Reservation (SB) CarStatusManager
I15	App. Logic	(SB) SecurityAuthenticator	(JEB) User (JEB) Reservation (SB) RideManager
I16	App. Logic	(SB) MapManager	(JEB) Car (JEB) SafeArea (JEB) PowerGridStation (SB) SecurityAuthenticator
I17	App. Logic	(Cont.) UserManagement-Cont.	(SB) UserManager
I18	App. Logic	(Cont.) UtilitiesContainer	(SB) MapManager (SB) NotificationManager
I19	App. Logic	(Cont.) ChargesManagement-Cont.	(SB) PaymentGateway (SB) DiscountProvider

I20	App. Logic	(Cont.) RideManagement-Cont.	(SB) RideManager (SB) ReservationManager (SB) SecurityAuthenticator (SB) CarStatusManager
I21	On-Board Client	ApplicationController	UIManager GPSManager ConnectivityUnit DataProcessingUnit
I22	Mobile Client	ApplicationController	UIManager GPSManager
I23	Web	WebController	JavaServerPages
I24	Web	WebContainer	WebController

Table 2.1: Integration order of the system components.

2.4.2 Subsystem Integration Sequence

The integration sequence of the high-level subsystems is described in Figure 2.4 and Table 2.2.

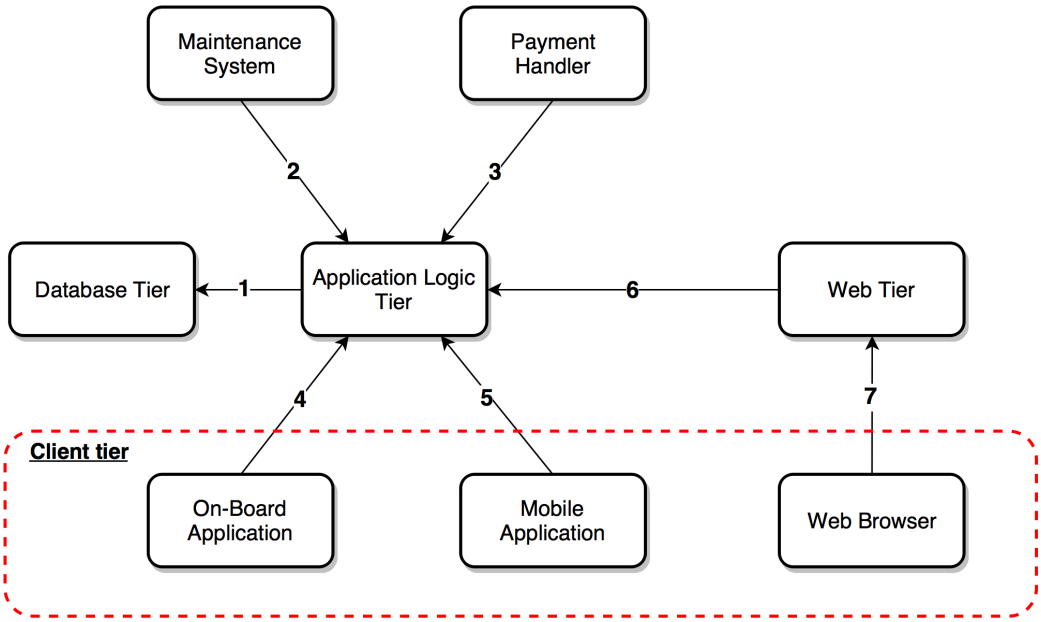


Figure 2.4: Diagram representing the order of the subsystems integration.

N.	Subsystem	Integrates with
SI1	Application Logic Tier	Database Tier
SI2	Application Logic Tier	(EXT) MaintenanceSystem
SI3	Application Logic Tier	(EXT) PaymentHandler
SI4	On-Board Application	Application Logic Tier
SI5	Mobile Application	Application Logic Tier
SI6	Web Tier	Application Logic Tier
SI7	Web Browser	Web Tier

Table 2.2: Integration order of the subsystems described in Section 2.2. External system interfaces to be integrated with *PowerEnJoy*'s subsystems are marked with (EXT).

Note that the base for the subsystem integration is the data tier, which is considered the most critical component; for the same reason, the application logic tier comes before all kinds of clients, since a working business logic is mandatory to have properly functioning clients. The choice of integrating the on-board application before other clients is due to the critical-module-first approach that has been chosen for this step of the integration process, since the on-board functionalities are meant to be core for the application itself. Lastly, the mobile application will be integrated first, since the integration of the web tier and browser client is heavier and more complex; moreover, this choice will allow the development team to have a working part of the system implementing a client-server structure even before having fully developed the web application.

External Systems

As stated in Section 2.3 of this document, the relevance of the interactions with external systems makes it necessary to integrate some of said functionalities at an application logic level. To be precise, the components to be integrated are the endpoints of the Payment Handler and of the Maintenance System. Since in the final implementation of the application the Payment Handler will provide the APIs to interface with it, the integration will need a *stub* of the Payment Handler endpoint, which will simulate the behaviour of the external payment system upon being invoked for any function. The Maintenance System will instead use the APIs provided by the *PowerEnJoy* system itself, hence the integration process will need a *driver* to simulate its calls to the *PowerEnJoy* system.

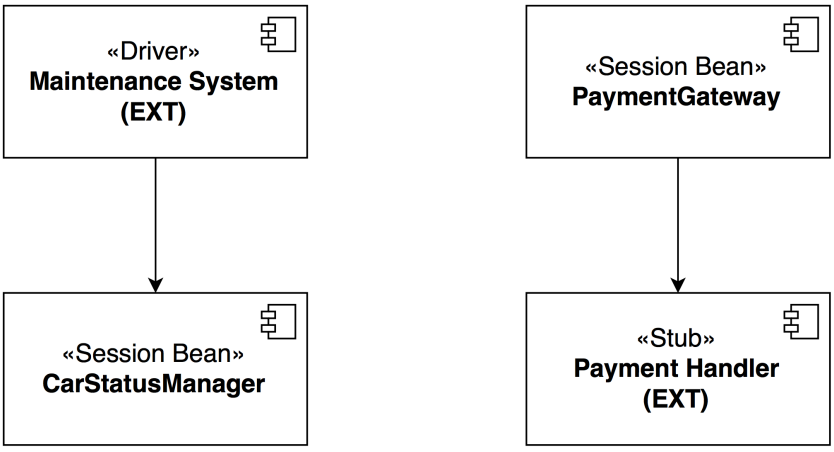


Figure 2.5: Integration of the external systems.

Section 3

Individual Steps and Test Description

The following are the test cases to be carried out. They are directly mapped with Table 2.1 for the integration among components and Table 2.2 for the subsystems integration. Test cases starting with **I** are integration test among components while test cases starting with **SI** concern the integration among subsystems. The adopted structure of the tables refers to the provided inegration test example [4].

3.1 Integration Test Cases I01, I02, I03, I04, I05, I06, I07, I08

The following test cases concern the integration among the Java Entity Beans and the Database Tier running the DBMS. Since the test cases are very similar to each others, they are grouped together as follows:

Test Case Identifier	I01T1
Test Item(s)	(JEB) User → DBMS
Input Specification	Typical queries on table User.
Test Case Identifier	I02T1
Test Item(s)	(JEB) Car → DBMS
Input Specification	Typical queries on table Car.
Test Case Identifier	I03T1
Test Item(s)	(EJB) Reservation → DBMS
Input Specification	Typical queries on table Reservation.
Test Case Identifier	I04T1

Test Item(s)	(EJB) Ride → DBMS
Input Specification	Typical queries on table Ride.
Test Case Identifier	I05T1
Test Item(s)	(EJB) SafeArea → DBMS
Input Specification	Typical queries on table SafeArea.
Test Case Identifier	I06T1
Test Item(s)	(EJB) PowerGridStation → DBMS
Input Specification	Typical queries on table PowerGridStation.
Test Case Identifier	I07T1
Test Item(s)	(EJB) AlternativeChargesSituation → DBMS
Input Specification	Typical queries on table AlternativeChargesSituation.
Test Case Identifier	I08T1
Test Item(s)	(EJB) Payment → DBMS
Input Specification	Typical queries on table Payment.
Output Specification	The queries shall return the correct results.
Environmental Needs	GlassFish server, Test Database.
Test Description	The purpose of these tests is to check the correctness of the queries to the DBMS that the JEBs shall perform and implement. Drivers for the entity beans are used to properly initialize and call their methods before the related Session Beans are fully developed.
Testing Method	Automated with JUnit.

3.2 Integration Test Case I09

Test Case Identifier	I09T1
Test Item(s)	(SB) DiscountProvider → (JEB) AlternativeChargesSituation
Input Specification	Calls from DiscountProvider to methods of the AlternativeChargesSituations entity to manage and update the information about discounts and additional charges accumulated during a rental.
Output Specification	The additional charges or discount information updates must be correctly memorized and made persistent.

Environmental Needs	GlassFish server, Test Database.
Test Description	The purpose of this test is to verify that the additional charges or discount information are correctly managed and updated by the AlternativeChargesSituation entity upon being prompted by the DiscountProvider.
Testing Method	Automated with JUnit.

3.3 Integration Test Case I10

Test Case Identifier	I10T1
Test Item(s)	(SB) CarStatusManager → (JEB) Car
Input Specification	Calls from CarStatusManager to methods of the Car entity to update the car status information according to specific conditions.
Output Specification	The car status information updates must be correctly memorized and made persistent.
Environmental Needs	GlassFish server, Test Database.
Test Description	The purpose of this test is to check that every update to the status attribute of the Car entities performed upon requests from the CarStatusManager is applied correctly.
Testing Method	Automated with JUnit.

3.4 Integration Test Case I11

Test Case Identifier	I11T1
Test Item(s)	(SB) UserManager → (JEB) User
Input Specification	Calls from UserManager to methods of the User entity to update user account and profile information according to user requests.
Output Specification	The target information must be updated correctly and the change must be made persistent.
Environmental Needs	GlassFish server.

Test Description	The purpose of this test is to check that every modification requested by a user to his/her personal information is performed correctly.
Testing Method	Automated with JUnit.

Test Case Identifier	I11T2
Test Item(s)	(SB) UserManager → (JEB) User, (SB) NotificationManager
Input Specification	Calls from UserManager to the methods of the User entity to manage user information (i.e. generate user credentials) when this operation requires a confirmation e-mail; calls to the methods of NotificationManager in order to generate and send said e-mails.
Output Specification	The target information must be updated and the change made persistent, and a notification e-mail must be sent to the corresponding user.
Environmental Needs	GlassFish server, mocked e-mail sender and receiver.
Test Description	The purpose of this test is to check that every modification requested by a user that implies an e-mail notification is performed correctly and said e-mail is sent without issues. The message must be simulated through a mock e-mail address manager which simulates the user behaviour as needed.
Testing Method	Automated with JUnit and Mockito.

3.5 Integration Test Case I12

Test Case Identifier	I12T1
Test Item(s)	(SB) PaymentGateway → (SB) DiscountProvider
Input Specification	Call from PaymentGateway to the methods of DiscountProvider to trigger the retrieval of the lists of alternative charges situations.
Output Specification	The lists of situations are returned correctly.
Environmental Needs	GlassFish server.

Test Description	The purpose of this test is to ensure that every time the PaymentGateway requests the discount or additional charges situations relative to a ride, the DiscountProvider indicates all of them correctly in list form.
Testing Method	Automated with JUnit.

Test Case Identifier	I12T2
Test Item(s)	(SB) PaymentGateway → (JEB) Payment, (SB) UserManager, (SB) NotificationManager
Input Specification	Method calls from PaymentGateway to the Payment entities to create and memorized them in a persistent way, to the NotificationManager in order to generate the necessary confirmation/error e-mails, and to the UserManager in case of failed payments that cause a user account to be locked.
Output Specification	All simulated payments must be correctly registered and memorized using methods provided by the Payment entity; in case the simulated payment is successful, a confirmation e-mail must be sent without issues; in case it fails, an error e-mail must be sent without issues and the UserManager must be contacted with a request of account locking.
Environmental Needs	GlassFish server, mocked e-mail sender and receiver.
Test Description	The purpose of this test is to ensure a proper behaviour of the system in every possible case concerning payments for the services of *PowerEnJoy*, in terms of registering payments, notifying success or failure and eventually requesting account locking.
Testing Method	Automated with JUnit and Mockito.

3.6 Integration Test Case I13

Test Case Identifier	I13T1
Test Item(s)	(SB) RideManager → (JEB) Ride, (SB) CarStatusManager

Input Specification	Calls from RideManager to methods of Ride entities to update the ride status attribute at the beginning and end of the ride, and to methods of CarStatusManager to request updates to the status of cars according to the conditions at the end of rides.
Output Specification	The updates to the Ride entities must be correctly performed and made persistent in memory, and the status update request for cars must be performed correctly based on the final conditions of rides.
Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to ensure a correct behaviour of the system in managing the rides and the consequent status variations of cars through the CarStatusManager.
Testing Method	Automated with JUnit.

Test Case Identifier	I13T2
Test Item(s)	(SB) RideManager → (SB) PaymentGateway, (SB) DiscountProvider
Input Specification	Calls from RideManager to methods of PaymentGateway to communicate standard charges and prompt final charges computation, and to methods of DiscountProvider to request registration of detected alternative payment situations.
Output Specification	Every simulated detection of an alternative charges situation must result in an adequate method call to the DiscountProvider; the prompt to the final charges computation must be performed correctly in correspondence with the end of the ride.
Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to verify the correctness of the active behaviour of the RideManager in terms of registering alternative payment situations and prompting the computation of final ride charges, through the indicated components.
Testing Method	Automated with JUnit.

3.7 Integration Test Case I14

Test Case Identifier	I14T1
Test Item(s)	(SB) ReservationManager → (JEB) Car, (JEB) Reservation, (SB) CarStatusManager
Input Specification	Usual calls to the methods of the Car and Reservation entities from the ReservationManager to search for available cars and generate valid reservations; calls to the methods of CarStatusManager to request updates to the status of cars.
Output Specification	Update to cars and reservation must be performed correctly and the changes made persistent. The requests of car status modification must be performed correctly in relation to the context in which they happen.
Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to verify that the ReservationManager behaves correctly during the car reservation process, with respect to showing available cars, generating and managing reservations and requesting car status updates to support reservation activities.
Testing Method	Automated with JUnit.

3.8 Integration Test Case I15

Test Case Identifier	I15T1
Test Item(s)	(SB) SecurityAuthenticator → (JEB) User, (SB) RideManager
Input Specification	Usual calls to the methods of the User entity in order to match user authentication information with a provided set of test inputs; calls to methods of the RideManager to request the creation of new rides.
Output Specification	The match between authentication information and values in the database is carried out correctly; if the procedure is successful, the new Ride tuple is created without issues.

Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to check that the authentication process needed to start rides is performed correctly and all the required controls are carried out, as well as to ensure that every valid ride is memorized and made persistent upon its beginning.
Testing Method	Automated with JUnit.

Test Case Identifier	I15T1
Test Item(s)	(SB) SecurityAuthenticator → (JEB) Reservation
Input Specification	Usual calls to the methods of the Reservation entity in order to match users and reservations upon unlock attempts.
Output Specification	The calls to the Reservation entity return and are matched correctly by the SecurityAuthenticator in order to decide whether allowing or preventing the car unlock process.
Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to verify that whenever a user wants to unlock a car there actually is a reservation corresponding to his/her account and to the specific car of the case.
Testing Method	Automated with JUnit.

3.9 Integration Test Case I16

Test Case Identifier	I16T1
Test Item(s)	(SB) MapManager → (JEB) Car, (JEB) SafeArea, (JEB) PowerGridStation
Input Specification	Usual calls from MapManager to the Car, SafeArea and PowerGridStation entities, in order to locate cars, power plugs and boundaries of the Safe Area based on input sets of coordinates.
Output Specification	The calls return correctly lists of values to be provided to other components needing such information.

Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to verify that the MapManager calls to the database return results correctly with respect to the input coordinates and the actual positions of cars, power plugs and boundaries of the Safe Area.
Testing Method	Automated with JUnit.

3.10 Integration Test Cases I17, I18, I19, I20

The following test cases concern the integration among the JEE Containers and the related Session Beans. Since the test cases are very similar to each others, they are grouped together as follows:

Test Case Identifier	I17T1
Test Item(s)	(EJB Container) UserManagementContainer → (SB) UserManager
Input Specification	Requests for the UserManager Session Bean.
Test Case Identifier	I18T1
Test Item(s)	(EJB Container) UtilitiesContainer → (SB) MapManager, (SB) NotificationManager
Input Specification	Requests for the MapManager and NotificationManager Session Beans.
Test Case Identifier	I19T1
Test Item(s)	(EJB Container) ChargesManagementContainer → (SB) DiscountProvider, (SB) PaymentGateway
Input Specification	Requests for the DiscountProvider and the PaymentGateway Session Beans.
Test Case Identifier	I20T1
Test Item(s)	(EJB Container) RideManagementContainer → (SB) RideManager, (SB) ReservationManager, (SB) SecurityAuthenticator, (SB) CarStatusManager
Input Specification	Requests for the Session Beans provided by the RideManagement Container.
Output Specification	The Session Beans must be correctly assigned. Moreover the concurrency among multiple requests must be properly managed.

Environmental Needs	GlassFish server
Test Description	Multiple requests for one specific Session Bean have to be simultaneously carried out in order to avoid concurrency troubles during the system usage.
Testing Method	Automated with Arquillian and JUnit.

3.11 Integration Test Case I21

Test Case Identifier	I21T1
Test Item(s)	ApplicationController → UIManager, GPSManager, ConnectivityUnit, DataProcessingUnit
Input Specification	Typical requests of functions offered by a specific component of the On-Board Application are processed by the controller.
Output Specification	The controller contacts the appropriate component and the functionality is offered.
Environmental Needs	Basic components to integrate with must be fully developed.
Test Description	The purpose of this test is to check if the ApplicationController is able to make all the components communicate together.
Testing Method	Automated with a proper C/C++ testing environment.

3.12 Integration Test Case I22

Test Case Identifier	I22T1
Test Item(s)	ApplicationController → UIManager, GPSManager
Input Specification	Typical requests of functions offered by a specific component of the Mibile Application are processed by the controller.
Output Specification	The controller contacts the appropriate component and the functionality is offered.
Environmental Needs	Basic components to integrate with must be fully developed.

Test Description	The purpose of this test is to check if the ApplicationController is able to make all the components communicate together.
Testing Method	Automated with JUnit.

3.13 Integration Test Case I23

Test Case Identifier	I23T1
Test Item(s)	(SB) WebController → Java Server Pages
Input Specification	The WebController is provided with a typical output to be display on a web page.
Output Specification	Java Server Pages shall display the provided output correctly.
Environmental Needs	GlassFish server, fully developed Application Logic Tier.
Test Description	The test aims to check the robustness of the communication between JSP and the WebController bean.
Testing Method	Automated with JUnit.

3.14 Integration Test Case I24

Test Case Identifier	I24T1
Test Item(s)	(SB) WebController → Java Server Pages
Input Specification	The web application is executed.
Output Specification	The WebContainer instantiates the WebController correctly by injecting it using JSP.
Environmental Needs	GlassFish server.
Test Description	The purpose of this test is to verify that the WebController is correctly injected using JSP during the Web Application session.
Testing Method	Automated with JUnit.

3.15 Integration Test Case SI1

Test Case Identifier	SI1T1
Test Item(s)	Application Logic Tier → Database Tier
Input Specification	Calls to the methods offered by the JPA Entities that are mapped on tables in the Database Tier.
Output Specification	The Database Tier must reply correctly by executing queries on the Test Database. In the case requests are coming from unauthorized sources that are maliciously trying to access the data, they must be blocked.
Environmental Needs	Complete implementation of the JEBs, the Java Persistence API, the Test Database and all of the drivers that call the methods of the JEBs.
Test Description	The replies to the queries coming from the Database Tier will be compared with the expected output results.
Testing Method	Automated with JUnit.

3.16 Integration Test Case SI2

Test Case Identifier	SI2T1
Test Item(s)	Application Logic Tier → (EXT) Maintenance System
Input Specification	Methods invocation to establish a bidirectional communication between the two systems.
Output Specification	The requests and responses are carried out correctly over the established communication.
Environmental Needs	Driver and stub simulating the behaviour of the Maintenance System endpoint to call methods offered by the dedicated RESTful API and to receive intervention requests from the *PowerEnJoy* system over the same API. Application Logic Tier fully developed up to the CarStatusManager functionalities.
Test Description	The RESTful API methods needed to establish a communication between the two systems are called and a series of request/responses is performed and compared with the expected results.
Testing Method	Automated with JUnit and Mockito.

3.17 Integration Test Case SI3

Test Case Identifier	SI3T1
Test Item(s)	Application Logic Tier → (EXT) Payment Handler
Input Specification	Invocations of methods provided by the payment handler API.
Output Specification	The methods are properly invoked with the right parameters.
Environmental Needs	Stub of the Payment Handler endpoint to record dummy transactions and report success/failure. Application Logic Tier fully developed up to the PaymentGateway functionalities.
Test Description	The Application Logic Tier shall correctly invoke methods offered by the Payment Handler endpoint, which is replaced by a proper stub.
Testing Method	Automated with JUnit and Mockito.

3.18 Integration Test Case SI4

Test Case Identifier	SI4T1
Test Item(s)	On-Board Application → Application Logic Tier
Input Specification	Typical RESTful API calls, both correct and intentionally invalid ones, to the Application Logic Tier.
Output Specification	The Application Logic Tier must respond accordingly to the API specification even if the requests are malformed or malicious.
Environmental Needs	Complete implementation of the Application Logic Tier, RESTful API client for the On-Board Application.
Test Description	The clients should make typical API calls to the Application Logic Tier; the responses are then evaluated and checked against the expected output. This test will be supported by an adequate RESTful API client.
Testing Method	Automated with JUnit.

3.19 Integration Test Case SI5

Test Case Identifier	SI5T1
Test Item(s)	Mobile Application → Application Logic Tier
Input Specification	Typical RESTful API calls, both correct and intentionally invalid ones, to the Application Logic Tier.
Output Specification	The Application Logic Tier must respond accordingly to the API specification even if the requests are malformed or malicious.
Environmental Needs	Complete implementation of the Application Logic Tier, RESTful API client for the Mobile Application.
Test Description	The clients should make typical API calls to the Application Logic Tier; the responses are then evaluated and checked against the expected output. This test will be supported by an adequate RESTful API client.
Testing Method	Automated with JUnit.

Test Case Identifier	SI5T2
Test Item(s)	Mobile Application → Application Logic Tier
Input Specification	Multiple and simultaneous requests to the RESTful API of the Application Logic Tier.
Output Specification	The Application Logic Tier shall answer the requests in a reasonable time to the target load.
Environmental Needs	Fully functional and developed Application Logic Tier, Apache JMeter, GlassFish Server.
Test Description	The purpose of this test is to verify if the system complies to the performance requirements as stated in Section 3.3 of the RASD [1].
Testing Method	Automated with Apache JMeter.

3.20 Integration Test Case SI6

Test Case Identifier	SI6T1
Test Item(s)	Web Tier → Application Logic Tier
Input Specification	Requests for services offered by the Application Logic Tier, both well-formed and invalid or malicious ones.
Output Specification	The web tier must use and interface correctly with the proper RESTful APIs or report an error if the request was not recognized or blocked.
Environmental Needs	GlassFish Server, fully developed Web Tier and Application Logic Tier.
Test Description	This test has to ensure the right translation from HTTPS requests into RESTful API calls, reporting errors when needed.
Testing Method	Automated with JUnit.

Test Case Identifier	SI6T2
Test Item(s)	Web Tier → Application Logic Tier
Input Specification	Multiple and simultaneous requests to the RESTful API of the Application Logic Tier.
Output Specification	The Application Logic Tier shall answer the requests in a reasonable time to the target load.
Environmental Needs	Fully functional and developed Application Logic Tier, Apache JMeter, GlassFish Server.
Test Description	The purpose of this test is to verify if the system complies to the performance requirements as stated in Section 3.3 of the RASD [1].
Testing Method	Automated with Apache JMeter.

3.21 Integration Test Case SI7

Test Case Identifier	SI7T1
Test Item(s)	Web Browser → Web Tier
Input Specification	Typical HTTPS requests from client browser, both well-formed and malformed.
Output Specification	The Web Tier shall display the requested pages if the requests are valid otherwise a generic error message is generated.
Environmental Needs	Fully implemented Web Tier, driver to simulate the behaviour of a client browser.
Test Description	This test aims to emulate HTTPS requests of typical system users.
Testing Method	Automated with JUnit.

Test Case Identifier	SI7T2
Test Item(s)	Web Browser → Web Tier
Input Specification	Concurrent and multiple requests to Web Tier.
Output Specification	The requested web pages are provided in the case of a reasonable load is applied.
Environmental Needs	Fully functional and developed Web Tier, Apache JMeter, GlassFish Server.
Test Description	The purpose of this test is to verify if the system complies to the performance requirements as stated in Section 3.3 of the RASD [1].
Testing Method	Automated with Apache JMeter.

Section 4

Tools and Test Equipment Required

The software tools to be used during the integration testing process are the following:

Apache JMeter: JMeter - `http://jmeter.apache.org/` - is an open source software resource used to test performance both on static and dynamic environments of systems. It will be used to simulate a heavy load on the Web Tier and the Application Logic Tier, to mimic a situation in which many users connect simultaneously to the service. In more detail, the tool will be used to test the compliance with what stated in Section 3.3 of the RASD [1].

JUnit: JUnit - `http://junit.org/` - is a simple framework used to write repeatable tests. It is mainly used to perform unit testing of components (given as a prerequisite for this phase), but it will be coupled with other tools - such as Mockito and Arquillian - in order to better perform integration testing.

Arquillian: Arquillian - `http://arquillian.org/` - is a test framework used to execute test cases against the container in which components are defined. It will be used in order to test the behaviour of containers with respect to the single Java Beans used for the application.

Mockito: Mockito - `http://site.mockito.org/` - Mockito is a clean and simple framework that allows to write stubs and mocks using a simple API. It is used to generate the few stubs we indicated as necessary for the integration of all components and subsystems.

Section 5

Program Stubs and Test Data Required

Appendix A

Appendix

A.1 Software and tools used

- LaTeX, used as typesetting system to build this document.
- draw.io - `https://www.draw.io` - used to draw diagrams and mock-ups.
- GitHub - `https://github.com` - used to manage the different versions of the document and to make the distributed work much easier.
- GitHub Desktop, the GitHub official application that offers a seamless way to contribute to projects.

A.2 Hours of work

The absolute major part of the document was produced in group work. The approximate number of hours of work for each member of the group is the following:

- Giovanni Scotti:
- Marco Trabucchi:

NOTE: indicated hours include the time spent in group work.

Bibliography

[1] AA 2016/2017 Software Engineering 2 - *Requirements Analysis and Specification Document* - Giovanni Scotti, Marco Trabucchi

[2] AA 2016/2017 Software Engineering 2 - *Design Document* - Giovanni Scotti, Marco Trabucchi

[3] AA 2016/2017 Software Engineering 2 - *Project goal, schedule and rules*

[4] SpinGrid Project - *Integration Test Plan*