# Design of an IT architecture for the e-portfolio system of IBLC group

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# DESIGN OF AN IT ARCHITECTURE FOR THE E-PORTFOLIO SYSTEM OF IBLC GROUP

**Master Project Report**

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iblc

*Dedicated to my parents*
*Giuseppe and Giovanna*
*and my sister Federica*

*"Siti sempri intra u me cori"*

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# Abstract

This graduation project originates from the need of IBLC Group to develop a system for maintaining electronic portfolios that enables the Knowledge Workers trading business within IBLC community. The purpose of this project is to create an IT architecture that is used for the development of the E-Portfolio system, in order to place it within the business context of IBLC community. The designed architecture is assessed by using the ATAM methodology to evaluate to which extent it fulfils its goals and the associated risks (and trade-offs).

# Executive Summary

This summary gives an overview about the content of this graduation report.

**Research Context**

IBLC Group is a company that manages IBLC community, a community that focuses on the trading of learning products, such as courses, between different parties.

In order to extend its business, IBLC Group needs to develop a software system for maintaining electronic portfolios that enables the Knowledge Workers trading business within IBLC community, the E-Portfolio system. The E-Portfolio system has to interact with Prodis, the system that, in the scope of the business extension, will be responsible to manage IBLC community partners and the learning product trading business.

In order to place the E-Portfolio system within IBLC community business context, the system has to be developed with a system development methodology that produces a validated IT architecture prior to the implementation phase.

*Initial Assignment: "To develop an IT architecture for the E-Portfolio system of IBLC Group"*

**Research Methodology**

The initial assignment is taken as a departure point to formulate the Research Questions that will address the core phases of the project: Analysis, Design and Validation.

The COMET and ATAM methodologies have been applied in this project in order to answer the main Research Questions by producing the main Research Deliverables.

The COMET methodology, which is applied during Analysis and Design phases, has been chosen basically because of two reasons:

- COMET modelling layers fit the Architectural Development Process for the development of software products;
- Familiarity of me with the methodology;

The ATAM methodology, which is applied during the Validation phase, has been chosen because of two reasons:

- The ATAM's conceptual flow fits the models of COMET methodology, especially the Business Domain Models (defining the architecture business drivers).
- It can be performed without the need to build a code-based prototype, which falls outside the scope of this graduation project. Moreover the ATAM methodology is an assessment tool more effective than a prototype-based one.

The development of an IT architecture for the E-Portfolio system focuses on the business logic and on specific functionalities of the system. The Graphical User Interface, the Platform Specific Model

and aspects general for all the software systems, such as login mechanism and tool for the system administration, are not within the scope of the research.

**Orientation**

The Orientation phase answers the following Research Question:

*RQ1 What are initial objectives and scope of the E-Portfolio system?*

The Orientation phase is considered as an introductory phase needed to prepare scope and context for the project and for the E-Portfolio system. In this phase, differently than expected, there was scarce documentation about the organization and the business of IBLC Group. Therefore the planned tasks of collecting information from existing documentation turned in a task of investigation of the organizational structure and business of IBLC Group in order to create the documentation needed to define scope and context.

The results of this phase are a wide overview of the Prodis system and several findings about the E-Portfolio system functionality that had to be better investigated during further phases of the project.

**Business Model**

The Business Model is a COMET work product, applied during the Analysis phase in order to answer the following Research Question:

*RQ2 What are the processes involved in the E-Portfolio system and the main actors using the system?*

The Business Model describes the context of the E-Portfolio system by giving an overview of its stakeholders in a Context Diagram, and by specifying the high level activities of the Knowledge Workers trading business. The E-Portfolio system should support the activities for the Individual partners of IBLC group to place their electronic professional portfolios within IBLC community and to retrieve the electronic professional portfolios of others.

The goals each stakeholder achieves by using and implementing the E-Portfolio system are captured and hierarchically structured in the Goal Model. Goal model and high level activities of the Knowledge Workers trading business are used to create the Business Process and Role Models, which define business processes the E-Portfolio system has to support and the roles involved in their activities. The creation of an electronic professional portfolio by an Individual partner and the access by third parties to the information stored in it, are the core processes of the system.

From the E-Portfolio system's Business Process and Role Models, the resources relevant for the KW trading business are identified and captured by the Resource Model. These resources are the actors of IBLC community involved in the KW trading business and the objects these actors use when involved in the business.

**Requirements Model**

The Requirements Model is a COMET work product, applied during the Analysis phase in order to answer the following Research Question:

*RQ3 What are the requirements of the E-Portfolio system for the KW trading business within IBLC community?*

The Requirements Model has been created according to the guidelines and techniques prescribed by COMET. The only exception refers to the development of a system prototype, which has been omitted in this project for reasons of time.

The Requirements Model expresses requirements of the stakeholders identified in the Business Model, towards the E-Portfolio system. Activities and roles of the Business Process and Role Models provide the basis for the formulation of the requirements. The functional requirements are captured and expressed by the means of use cases and the quality requirements global for the whole system by the Non-functional requirements work product. Given the interactive nature of the E-Portfolio system, the Use Case Model presents a large amount of use cases. Each use case is detailed by the Use Case Scenario Model.

The use cases themselves provide the input for the Reference Architecture Analysis. During the Reference Architecture Analysis the use cases of the E-Portfolio system are grouped within subsystems according to specific criteria, such as common actors. These subsystems grouping is needed to identify the initial components of the E-Portfolio system, in order to bridge between the Business Domain Model and the Architecture Model. The subsystems are also used for defining the versioning of the system.

**Design**

During the Design phase it is designed the solution for the problem space defined by the Business Domain Model, namely Business and Requirements Model of COMET. The Design phase answers the following Research Question:

*RQ4 How can the E-Portfolio system requirements be expressed in a software architecture?*

During this phase the Architecture Model of COMET has been applied. The design focused on a subset of E-Portfolio system structure needed for the realization of the main functionalities of the system, the Core Model. The design also partially accounts the External Model, which defines the structure of the E-Portfolio system when interacting with Prodis and external systems.

The only viewpoint used during the architecture definition has been the Functional Viewpoint. The main functionalities of the system are expressed by the components grouping the use cases linked to the Business Goal.

The Component Structure Model defines the static structure of the E-Portfolio system. According to COMET the prominent architectural style used for the Component Structure Model is the Boundary- Control-Entity (BCE) pattern. The main control components identified are the
EP Services that manages the handling of portfolios, the Verification Services that provides functionalities for the verification of the information stored in the portfolios, the Authorization

Services that manage the access to specific portfolios and the Registration Services that offer functionalities for the registration to the E-Portfolio system.

The Component Interaction Model defines the dynamic structure of the system. The interaction between components is based on the Use Case Scenario Model for each use case.

The Interface and Information Model specify respectively the interfaces offered by the components and the information that is passed through the operations of each of the identified interfaces. Each Information Model is a refined subset of the Resource Model.

The Architecture Model produced in this project is to be taken as a blueprint of the system and the interfaces need to be further specified for detailed operations of the components.

**Validation**

The ATAM is a methodology applied during the Validation phase in order to answer the following Research Question:

*RQ5 To what extent does the E-Portfolio system candidate architecture fulfils its objectives?*

ATAM basically prescribes a presentation concerning architecture business drivers and architectural styles used to design the candidate architecture, during which are held two brainstorming sessions. The methodology aims on finding those trade-offs between quality requirements, that are connected to specific architectural solutions applied during the design.

The results of the assessment showed a strong focus by the assessment participants towards the security attribute of the E-Portfolio system. This is motivated because of the privacy-critical information stored in a professional portfolio. The security measures of the E-Portfolio system are in a trade-off with the maintainability of the system itself. This trade-off has been solved in favour of the maintainability because the security measures, even though they are not as described in the quality requirements, have been considered satisfactory enough to preserve the privacy of the end-users as indicated by the Goal Model.

**Conclusions**

The research answered the main Research Questions by producing the corresponding Research Deliverables. The candidate architecture produced by applying COMET and validated with ATAM is suitable for the implementation of the E-Portfolio system.

The Business Process and Roles Model of COMET did not have a core importance in this project because of the interactive nature and highly automated nature of the E-Portfolio system. On the other hand, the Use Case Model presents a large amount of use cases, because the system is designed mainly to fulfill the goals of the end-users (use case fulfillment).

The Architecture Model created for the E-Portfolio system is not suitable for automated code generation. The Architecture Model produced in this project is to be taken as a blueprint of the system and they need to be further specified for detailed operations of the components.

The ATAM methodology indicated some weak areas of the architecture that have to be taken under control. The ATAM assessment might have given more results if the assessment participants would have been more familiar with the methodology.

In order to prevent, for further projects, time consuming tasks of investigation of the organizational structure and business of IBLC Group. it is strongly suggested to IBLC Group to improve and formalize the documentation already existing within the company.

In order to diminish the risk of lack of user acceptance of the E-Portfolio system, it is recommended to create a system prototype and use it as a tool to elicit GUI's requirements, which definition was outside the scope of this project. For the same reason it is suggested to complement the ATAM assessment with a prototype based assessment.

# Table of Contents

# 1. Introduction

This chapter provides an overview about IBLC Group, the company where this graduation project is carried out, and its business environment. The business environment provides the context for the initial assignment which outlines the problem for this graduation project.

The first part of this chapter presents IBLC Group's business environment. *Section 1.1* presents IBLC Group's strategy, organization and IBLC community. Then in *section 1.2* the context for the initial problem of this graduation project is given.

The chapter is concluded with the description of the initial assignment for this graduation project in *section 1.3*.

## *1.1 Company Description: IBLC Group*

This graduation project is carried out at IBLC (International Business Learning Community) Group. IBLC Group business focuses on the management of IBLC community, a community dedicated for companies, institutions and soon individuals, interested in providing and/or acquiring knowledge structured in a variety of forms, such as courses and manpower skills.

This graduation project is in the scope of the development of the E-Portfolio product for IBLC Group. The product will be part of the new IT-enabled products and services range that IBLC Group is currently developing for IBLC community.

The following subsections present a bird-eye overview of the business environment of IBLC Group. First, IBLC Group business strategy and IBLC community's key role for the achievement of IBLC Group strategic goals are presented. Following, the internal organization of IBLC Group is shown and a brief description of how each organizational entity makes the strategy operative by contributing to the management of IBLC community.

The presentation goes on with the description of IBLC community. The description focuses on the IT-enabled community business, together with related services and products provided by IBLC Group.

### 1.1.1 Strategy

Mission and vision statements are commonly used tools for companies to define the business strategy and the long-term business goals. Within IBLC Group, when this project is initiated, the vision was not documented and the mission statement, although appearing on the company's website, rather than a proper statement looked more like a motto. Consequently strategic goals were pretty vague and their achievement could not be analytically proved. In order to overtake these shortfalls, I gathered information in order to properly formulate both mission and vision statements. Mission and vision statements shown in this section are formulated by using as source of information the General Manager. As IBLC Group's founder and owner, he is in a position where he has a wide sight of the company business strategy and he provided information about the opportunities IBLC Group aims to catch and which goals it wants to achieve by making its business operative. The complete IBLC Group's vision statement can be found in *Appendix A.*

#### 1.1.1.1 Vision Statement

In the context of the European Union (EU) Lifelong learning program [1], organizations, institutions, governments and potential Knowledge Workers (KWs) are starting to cooperate within Human Resources (HR) Networks. These HR Networks are communities used to effectively share and exchange knowledge and labour market related information between the involved parties in order to implement the lifelong learning strategy.

A great added value to support the HR network infrastructure is given by the Human Resources Information Systems (HRIS), which rely on information technologies. They allow potentially everybody to have access to the HR networks to use and offer both knowledge and information.

IBLC Group strongly believe in this vision and in order to catch the opportunities offered by the knowledge-based economy founded, within The Netherlands, its own nationwide HR network, IBLC community. IBLC community business is enabled by a custom made HRIS which belongs to IBLC Group IT infrastructure. IBLC Group goal is to expand IBLC Community beyond the Dutch borders in order to act as a platform to support the development of the EU as a powerful knowledge-based economical system.

#### 1.1.1.2 Mission Statement

IBLC Group mission is *"Deploying people smarter"*. IBLC Group in order to perform its mission, manages IBLC Community, a professional HR network supported by an HRIS based on Web 2.0[1] technology and Wikinomics[2] principles, in order to guarantee the exchange of semantic and trusted information within the community, to be used for recruitment, development and deployment of KWs.

### 1.1.2 Organization Structure

To effectively identify both organizational resources involved in the project and communication policies within the organization, a general description of IBLC Group organizational structure is presented. IBLC Group's documentation uses an organogram to describe its organization structure. However the organogram, besides depicting the organizational functions and hierarchy, does not show other relevant aspects for this project such as the responsibility for each involved function. To gather the mentioned information I performed an investigation based on interviews with IBLC Group General Manager and its employees. The General Manager provided information about the tasks performed by each function in ideal conditions, while each employee gave more insight on pragmatic aspects mainly concerning the decision making process, communication between functions and cross-functional responsibilities. The organogram and the results of the investigation, which define the responsibility for each function, are shown in following subsection.

#### 1.1.2.1 Organogram and Organizational Functions

IBLC Group besides being the founder and managing entity of IBLC community is considered also as one of its members. IBLC Group performs its mission by making its organization resources,

[1] The second generation of the World Wide Web, especially the movement away from static webpages to dynamic and shareable content and social networking.

[2] The theory and practice of harnessing the power of mass collaboration.

through its IT infrastructure, available for IBLC community, in order to enable the exchange of trusted and semantic information in the scope of trading knowledge sources structured, such as courses or unstructured such as KWs, between different parties. IBLC Group has a functional oriented organization structure. The organizational structure is depicted in a visual form by the organogram in *Figure 1*. The boxes represent the organizational functions.

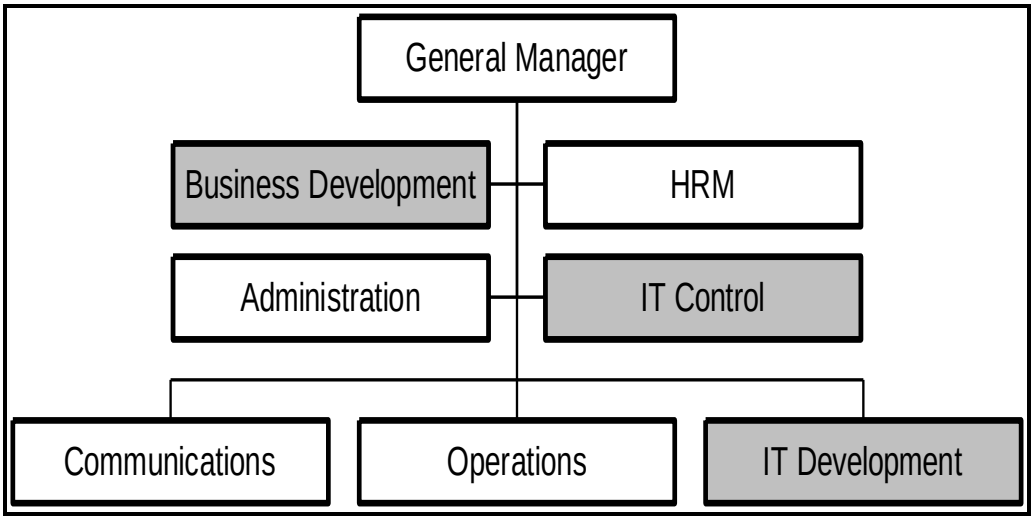


***Figure 1: IBLC Company Organization Structure***

Strategic and tactical decisions at IBLC Group are taken by the General Manager. This function is supported by four staff functions, Administration, Business Development, Human Resources Management (HRM) and Information Technology (IT) control functions. The General Manager is in charge of all the staff functions, with the exception of IT control that is managed in cooperation with the IT Manager.

Communications, Operations and IT Development are considered as departmental functions because they have a key importance for IBLC community. However, given the small size of the company and the sole location, there are no explicitly marked departmental boundaries.

The functions relevant for this graduation project are Business Development, IT Development and IT Control.

- The *Business Development* is in charge of searching new business opportunities for IBLC Group and to develop and implement solutions to make use of these opportunities. IBLC Group business mainly relies on IT, hence the Business Development often cooperates with the IT Development department to proper implement the solutions.

- *IT Development* analyzes, evaluates, develops and implements new IT solutions to enable and support IBLC community business. The function's actors are the General Manager and the IT Manager.

- The HRIS of IBLC community is managed by *IT Control*. This function's responsibility is to manage the access to IBLC community, issue privileges to community members and maintain the IT infrastructure of IBLC Group.

### 1.1.3 The Business Community

This section describes IBLC community, the HR network managed by IBLC Group. The information presented in this section are related to the as-is situation of IBLC community, namely when this graduation project is initiated.

The two subsections describe respectively IBLC community business potentiality and the product and service range currently offered by IBLC Group.

#### 1.1.3.1 IBLC Community Description

IBLC community is an IT-supported HR network opened to any party which is interested in offering or acquiring knowledge. The knowledge is not directly exchanged throughout the community. From this perspective IBLC community is not to be considered a pure HR network. The actual business purpose of IBLC community is to enable the exchange of trusted and semantic information between different parties, the community partners, to support and make faster and more reliable the trade of knowledge, offered by knowledge sources, such as courses, and Knowledge Workers (KWs). That means the information exchanged within IBLC community is not the knowledge itself but can be seen as meta-knowledge, information about the knowledge a knowledge source or a KW can offer. For instance, the meta-knowledge in the case of a course might be its description and background requirements, while in the case of a KW it might be his/her Professional Portfolio.

IBLC community business partners are providers and consumers of meta-knowledge. The providers of meta-knowledge are the business partners that provide meta-knowledge with the purpose of offering knowledge. The consumers are the business partners that are interested in consuming meta-knowledge with the purpose of acquiring knowledge. The partners do not have a specific role; that means a partner can act as consumer, by consuming meta-knowledge, as well acting as provider, by providing meta-knowledge. The community acts on a push basis. That means that the providers push their knowledge sources to the market.

IBLC community business is currently enabled by an HRIS, CWPro belonging to IBLC Group IT infrastructure. CWPro enables just the exchange of meta-knowledge about structured knowledge repositories, namely the Learning Products (LPs). As LP is defined any structured knowledge source, such as courses and books. However, IBLC community business is restricted to the LPs that rely on the professor-scholar model, such as courses, trainings or seminars. The information available for every LP does not concern just the meta-knowledge. The meta-knowledge, in the scope of the trading of LPs between partners, is enriched with information such as price and issuing schedule. The union of meta-knowledge and this set of information is called LP information.

IBLC community business partners at the moment are just organizations, i.e. companies and institutes, and CWPro enables just Business to Business (B2B) transactions. From the community viewpoint an organization partner is considered as a sole entity. That means the community is not aware of the organization members interacting with the community. The organization partners are allowed to provide and consume LP information.

Most of the companies belonging to IBLC community act within the Dutch market in different sectors and areas of specialization. The number of partners currently amount to about 200. The community in its nationwide market branch is unique; therefore IBLC Group has no direct competitors within the Dutch borders.

Within IBLC community partners we can distinguish between business and other partners. The business partners are those actively involved in the exchange of meta-knowledge. The other partners, although not directly involved in the exchange of meta-knowledge, contribute to IBLC community business. The main types of other partners and their role within IBLC community are the following:

- Technology Partners: Provide the technology needed for IBLC community IT infrastructure.
- Industry Partners: Non-governmental bureaus to which many companies partners belong, such as PAEPON and VETRON. These bureaus certify the quality of LPs offered by their members.
- Other HR networks.
- Government NGO: These partners, such as Kennisnet and standardization bureaus, offer information validation and consultancy services to IBLC Group.

### 1.1.3.2 IBLC Community Products and Services

IBLC Group, through its IT infrastructure, currently provides a range of products and services available for IBLC community partners. IBLC Group makes profit by allowing IBLC community partners to make use of this services and products as well as CWPro usage. The products are actually extra services that are considered products for commercial reasons. In this report a distinction is made between basic and extra services, rather than services and products. The basic services are those essential in order for the partners to make business within the community. The extra services are those designed by IBLC Group to add quality to IBLC community business.

***Basic Services***

The community partners, depending on their role, are entitled to make use of the basic services in *Table 1*. Most of the listed basic services are supported by CWPro.

| Service | Community Role | CWPro | Description |
|---|---|---|---|
| *Brokering* | Consumer and Provider | Partially | IBLC Group creates the connection between provider and consumer that want to do business with each other. It mediates both parties during every business transaction. |
| *Publishing* | Provider | Yes | The provider publishes its LP information in the community. A set of LP information from the same provider is called LP assortment. The LP assortments are visible and available for purchasing to all the community partners. |
| *Selecting* | Consumer | Yes | The consumer selects a set of LP information, according to certain criteria, among the ones available within the community. A set of LP information selected by a specific consumer is called LP selection. A consumer might have more than one LP selection. |
| *Searching* | Consumer | Yes | The consumer looks for the LP information within one of its LP selection. |
| *Booking* | Consumer, Provider(involved) | Yes | The consumer can attempt to purchase LPs. IBLC Group is responsible to route the request to the provider and forward back the response to the consumer. |
| *Payment* | Consumer and Provider | No | The payment process for purchased LPs might be performed thru the community. The consumer performs the payment to IBLC Group which delivers the amount to the provider. |

***Table 1: IBLC Community Basic Services (as-is)***

***Extra Services (Products)***

Currently IBLC Group provides just one extra service, the Course Catalogue. This product has been designed specifically for the LP consumers. The Course Catalog product basically concerns on the

development by IBLC Group of a Web portal, with customized "look and feel" and functionalities, for a specific LP consumer to make business within IBLC community through CWPro.

## 1.2 Initial Problem Context

This section gives an overview about the context of the initial problem of this graduation project. This graduation project is in the scope of the development of the E-Portfolio product for IBLC Group. The E-Portfolio product will be part of the new IT infrastructure that IBLC Group is currently developing to enable IBLC community's business extension.

The business extension is discussed in *section 1.2.1*. *Section 1.2.3*, introduces the topic of this graduation project, the E-Portfolio product. A brief description of the Millenials phenomenon, which triggered the business extension, can be found in *Appendix A*.

### 1.2.1 The Business Extension

The business extension has been conceived to further enable IBLC community potentiality. At the moment, IBLC community potentiality is partially enabled, focusing just on the LP trading business between organization partners.

A research performed by Business Development department of IBLC Group about the Millenials phenomenon [2] brought to the conclusion that this phenomenon offers opportunities that IBLC Group must catch in order to pursue its business strategy.

IBLC community with its networking structure and its large set of consolidate partners can be used to satisfy the requirements of the Millenials in terms of career perspective and knowledge development. On the other hand, the Millenials can be used by the community organization partners as potential candidates for both fulfilling vacant job positions and purchasing LPs.

Hence, the Business Development department identified two main business goals for the implementation of the business extension:

1. *Open IBLC community, which was open just to organization, to individuals, considered within the community as KW.*

2. *Enable the KWs trading business.*

The Millenials are basically KWs. For IBLC community business a KW is seen as a source of knowledge. According to the European Lifelong learning philosophy [1], every individual can be considered as a potential KW. In this scope, in order to catch the opportunities offered by the Millenials phenomena, IBLC Group decided to open IBLC community business to individuals.

The current organization-oriented business of IBLC community, focusing on the LP trading, does not allow access and interaction with individuals. An individual-opened community business, enabled by a proper IT-infrastructure with new individual-oriented services, will better serve the needs of the Millenials, in the scope of the development of qualitative KWs. With the presence of the individual partners, IBLC Group IT infrastructure is therefore required to enable, within IBLC community, Business to Consumer (B2C) and Consumer to Consumer (C2C) transactions as well as the already enabled B2B transactions.

The new individual-opened community business is conceived as an extension of the one already existing. The current community HRIS, CWPro, has been successful in terms of creating a network of consolidate partners for IBLC community. Therefore IBLC Group did not feel the need to create a new IT infrastructure from scratch, but to keep the one already existing and extending it with individual-oriented functionalities.

The development of the new IT infrastructure is divided into several projects. Each project is dedicated either to the reengineering of existing business processes or to the development of new ones in order to issue a new range of products and services.

In order to define and adapt the new IT infrastructure to the business requirements needed to achieve the first business extension goal, a new HRIS enabling IBLC community business, Prodis, is currently under development. Prodis will be incrementally built over the functionalities already offered by the currently operating community HRIS, CWPro. At the same time, Prodis will also enhance the quality of the community business already enabled by CWPro.

The second business extension goal is driven by the exchange of meta-knowledge about KWs, besides the already supported exchange of LP information, within IBLC community. Considering that for privacy reasons just a KW, namely an individual, is allowed to share his/her meta-knowledge within IBLC community, the first goal achievement is needed for the successful achievement of the second one. The second business extension goal achievement is discussed in the next subsection.

### 1.2.2 The E-Portfolio Product

The E-Portfolio product is an extra service issued to IBLC community by an information system to be developed for IBLC Group IT infrastructure, the E-Portfolio system. The development of the E-Portfolio system is in the scope of the achievement of the second business extension goal:

*Enable the KWs trading business.*

Indeed, its main required business functionality, according to the second business goal driver, is to give to the KWs, namely the individual partners of IBLC community, the opportunity to provide their own meta-knowledge, namely their Electronic Professional Portfolios (EPs), to IBLC community and make this meta-knowledge available for its partners. The individual partner that provides the EP is called EP owner. The E-Portfolio system, besides implementing its main business functionalities, has to provide services that enhance the quality of the KWs trading business.

As already mentioned, the first goal achievement, driven by the Prodis system, is needed for the successful achievement of the second one. Consequently, the E-Portfolio system operating environment is the to-be IT infrastructure of IBLC Group, namely when Prodis will be operating. According to that, although the E-Portfolio and Prodis systems are considered as separate systems, the former needs the latter to realize its required functionalities.

This graduation project is centered on the development of the E-Portfolio system rather than product. As E-Portfolio product it is considered the marketable part of the system, namely the service offered to IBLC community business partners.

## 1.3 Initial Assignment Formulation

The initial assignment for this graduation project has been given by the General Manager of IBLC Group. IT Development is the department under which this graduation project is performed. The initial assignment is recognized as a starting point to address the activities for this graduation project.

The subject of this graduation project is the development of the E-Portfolio system, an information system belonging to IBLC Group IT infrastructure, responsible of issuing the E-Portfolio product. The E-Portfolio system's main required business functionality, which drives the second business extension goal achievement, is to give to the KWs, namely the individual partners of IBLC community, the opportunity to provide their own meta-knowledge, namely their Electronic Professional Portfolios (EPs), to IBLC community and make this meta-knowledge available for its partners. The E-Portfolio system, besides realizing its main business functionality, has to satisfy properties that enhance the quality of the KWs trading business. Its unsuccessful development may hinder the achievement of the second business extension goal. Hence, the E-Portfolio system can be classified as *business critical information system*.

The achievement of the first business extension goal is driven by the Prodis system, whose development is linked to other IT infrastructure development projects. Consequently, the E-Portfolio system operating environment is the to-be IT infrastructure of IBLC Group, namely when Prodis will be operating.

When this project is initiated the E-Portfolio product is just a concept and its development has not started yet. In this scope, the main concern of IBLC Group General Manager is about diminishing the risks involved in the E-Portfolio system development:

- Identification and implementation of E-Portfolio system required functionalities and qualities;
- Place the E-Portfolio system within IBLC Group to-be IT infrastructure;
- Successful integration with Prodis, especially in the scope of the first business goal extension. This concern is especially emphasized because of the current under development status of Prodis.

In order to cope with these concerns, IBLC Group General Manager wants the E-Portfolio system to be developed with a system development methodology that produces a validated architecture prior to the implementation phase. The system architecture development is required to define and adapt the to-be IT infrastructure of IBLC Community to the business requirements and qualities of the E-Portfolio system.

Given the fact that the E-Portfolio system has to rely on IT, the initial assignment of this graduation project is as follows:

**Initial Assignment**: *"To develop an IT architecture for the E-Portfolio system of IBLC Group"*

# 2. Research Methodology

This chapter describes the research methodology adopted to achieve the objectives of this graduation project. A preliminary research methodology is created during the initiation phase, based on the initial assignment description. The final version of the research methodology is created during the Orientation phase.

The initial assignment as given by IBLC Group General Manager, described in *section 1.3*, provides elements useful to formulate the initial set of research questions and identify relevant literature for this graduation project. Literature and research questions address the project approach whose activities are mapped in a skeleton of the project plan.

The preliminary research methodology is refined after the Orientation phase described in *chapter 3*. The information gathered during the Orientation phase provides more insight on the scope and objectives of this graduation project. The refinements have led to the research methodology as presented in this chapter.

## 2.1 Project Processes

This graduation project is based on the suggested phases of a design-based graduation project, especially in the field of IT system development. These phases are Orientation, Analysis, Design, Validation and eventually Implementation. The Orientation phase aim on having an overview of the general environment where the project is performed. During the Analysis phase the problem space of the graduation project is defined. The Design phase attempts to find a solution space for the problems defined in the Analysis phase. The Validation phase assesses the quality of the design solutions. The validated design is eventually implemented. The research activities to be performed during these phases are addressed by the assignment around which this graduation project evolves.

The subject of this graduation project is the development of the E-Portfolio system, an information system to be designed for IBLC Group IT infrastructure. An information system is a special case of work system. A work system is a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers [3]. In the case of the E-Portfolio system, processes and activities are devoted to processing information in order to drive the achievement of the second business extension goal of IBLC Group:

*Enable the KWs trading business.*

The unsuccessful development of the E-Portfolio system may hinder the achievement of the second business extension goal. Therefore, the E-Portfolio system can be classified as a *business critical information system*.

According to the System Life Cycle Model (SLCM) [7], the life cycle of any system can be basically divided into 2 phases:

- Development;
- Operations and Maintenance.

This graduation project lies within the Development phase of the SLCM. In the specific for information systems, the Software Development Process (SDP) is basically composed by the *Requirements Analysis*, *Design* and *Implementation* phases.

The initial assignment is to develop an IT architecture for the E-Portfolio system for IBLC Group. Within any SDP, the architecture forms the bridge between requirements analysis and design activities, performing the trade-offs necessary to satisfy the demands of both [5].

The Architecture Development Process (ADP), core process of this graduation project, according to [5] is divided into the activities *Initial Scope and Context Definition*, *Stakeholders Engagement*, *Capturing Stakeholders Concerns* and the actual *Architecture Definition*. The first three activities are supporting activities for the Architecture Definition activity. The Architecture Definition activity produces the system architecture and an Architectural Description (AD) which documents the architecture.

The solution architecture produced by the ADP has to be assessed from a quality perspective. As mentioned by [6], it is not possible to say which one of the candidate architectures is best for a given system, yet an architecture that meets system stakeholders' needs, is to be considered qualitative. Consequently the ADP is followed by an assessment phase, centred on the system stakeholders, whose goal is to validate the system architecture produced by the ADP.

In this graduation project, therefore, I potentially have three instantiated processes evolving. The process concerning this graduation project, both core and supporting activities, the SDP and the ADP. Two of the processes, SDP and ADP, are hierarchically connected. That means the ADP process is a sub-process of the SDP. The ADP process, according to the initial assignment, is mapped within the core activities of this graduation project. Here I have two different dimensions to be taken into account. One is regarding the project core activities, namely the E-Portfolio system architecture development for IBLC Group, and one regarding the project supporting activities. These project's activities are addressed by the research questions and mapped according to the project approach as discussed in *section 2.6*.

## 2.2 Theory Background

The research methodology for the core phases of this graduation project, namely Analysis, Design and Validation, is supported by already existing and tested scientifically-based methodologies in the field of architecture development for information systems.

IBLC Group does not adopt any standard architectural framework for the SDP. The architecture development methodology supporting the ADP activities is therefore not constrained by any IBLC Group directive. The chosen methodologies are COMET [9] and ATAM [14]. The motivations underneath the choice of these methodologies and how they suit within the graduation project phases is hereby discussed.

The COMET methodology is applied to the ADP activities. The methodology has been chosen because of the following two reasons:

- COMET modelling layers fit the ADP for the development of software products;
- Familiarity of me with the methodology;

The Business Domain Models of COMET (Business and Requirements Models) are models used to define the problem space for the ADP. Guidelines and deliverables related to the development of the Business Domain Models of COMET, which contribute to the Analysis phase of this graduation project, fit the supporting activities of the ADP and part of the architecture definition phase. The Architecture Model of COMET is composed by a set of models that define the solution space and contributes to the AD. Guidelines and deliverables related to the development of the Architecture Models contribute to the actual Architecture Definition phase of the ADP, namely the Design phase of this graduation project.

The ATAM methodology is used to assess the candidate solution architecture produced during the design phase. The ATAM methodology has been chosen for the following reasons:

- The ATAM's conceptual flow fits the models of COMET methodology, especially the Business Domain Models (defining the architecture business drivers).

- It can be performed without the need to build a code-based prototype, which falls outside the scope of this graduation project (see next section). Moreover the ATAM methodology is an assessment tool more effective than a prototype-based one [5, 6, 14].

The architecture assessment with the ATAM methodology occurs within the Validation phase of this graduation project.

A detailed description of how the two above mentioned methodologies are mapped within the graduation project is given in the *section 2.6*.

## 2.3 Project's Scope and Constraints

IBLC Group does not use any standard or formalized either SDP or ADP. When this graduation project is initiated there is not any E-Portfolio system SDP activity carrying on. The only starting point for the E-Portfolio system Architecture Definition activity is the business idea of the General Manager and some of his concerns. The ADP for the E-Portfolio system is within the scope of this graduation project and other SDP activities, whether preceding or succeeding the ADP, fall outside.

This scope restriction does not jeopardize the successful execution of the project. The architecture definition in the SDP bridges between requirements analysis and design. According to [5], even though the architecture definition has elements from requirements analysis, it is considered as a separate activity. That basically means the supporting activities in the ADP can catch the system requirements but cannot extensively fulfil all the qualitative aspects of a proper requirements analysis activity.

As stated in *chapter 3*, the existing documentation does not extensively cover the E-Portfolio system operating environment, namely the to-be IT infrastructure of IBLC Group when the first business extension goal has been achieved. Specifically, the Prodis interfaces needed for the E-Portfolio system to fulfil its requirements, are not properly documented and not stable. As a result, building a code-based E-Portfolio system prototype presents a level of complexity which is not within the scope of this graduation project. That motivates the choice to perform a paper-based IT architecture assessment.

The COMET methodology is divided in Platform Independent Models (PIM) and Platform Specific Models (PSM). This graduation project focuses on the business logic of the E-Portfolio system architecture, as shown in *chapter 4*. Moreover, although IBLC Group prefers the system to be developed with .NET technologies, the suggested practices about an IT architecture require the system architecture not to be constrained by any specific platform or technology [5]. Hence, activities related to fill the PSM are not within the scope of this graduation project.

The successful development of the E-Portfolio product, as stated by the initial assignment in *chapter 1* is constrained by the successful development of the Prodis system. During the ADP for the E-Portfolio system it is assumed that the Prodis system is operating according to its complete set of specifications.

## 2.4 Research Questions

The research questions are formulated in order to achieve the assignment goals of this graduation project. Initially the research questions are formulated based on the initial assignment goal and are eventually refined with elements provided by the Orientation phase as shown in *chapter 3*.

Each research question addresses and it is answered by a specific research activity placed within a specific phase of this graduation project as shown in *section 3.6 "Project Approach"* of this graduation report.

Hereby follows the list of research questions for this graduation project:

*RQ1* What are initial objectives and scope of the E-Portfolio system?

*RQ2* What are the processes involved in the E-Portfolio system and the main actors using the system?

*RQ3* What are the requirements of the E-Portfolio system for the KW trading business within IBLC community?

*RQ4* How can the E-Portfolio system requirements be expressed in a software architecture?

*RQ5* To what extent does the E-Portfolio system candidate architecture fulfils its objectives?

## 2.5 Research Deliverables

The main deliverables produced during this graduation project are as follows:

*D1* Business Domain (business and requirements) Models of COMET

*D2* Architecture Models of COMET

*D3* Architectural Description (Functional viewpoint)

*D4* ATAM report and recommendations

Each deliverable is produced by a specific research activity as shown in the next section.

## 2.6 Project Approach

The research activities related to the two evolving processes of this graduation project, the ADP for the E-Portfolio system and the one related to the graduation project itself, are mapped within the project's phases in order to answer the research questions listed in *section 2.4* and produce the deliverables listed in *section 2.5*.

The deliverables of the research activities are shown into the Research Model of *Figure 2*.

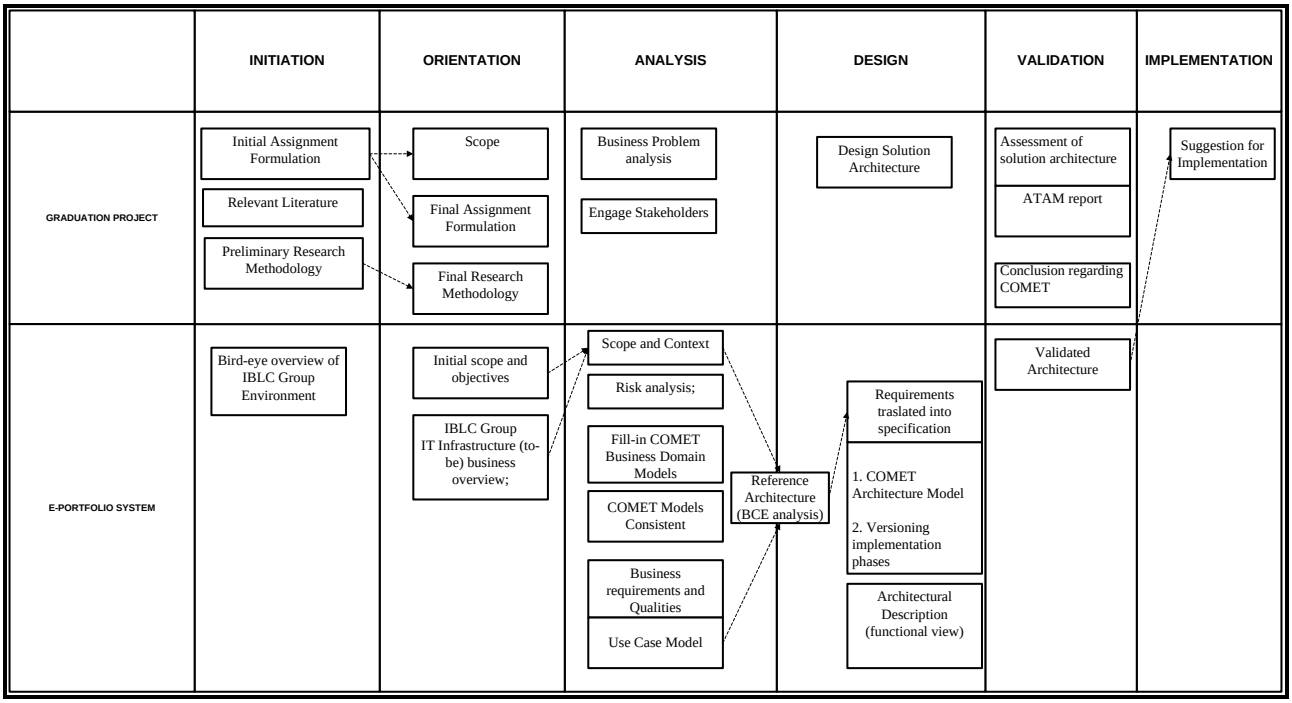


***Figure 2: Research Model***

The research model shows in the columns the 5 phases suggested by the guidelines for the execution of a design-based graduation project as stated in *section 2.1*. The rows represent the two evolving processes of this graduation project.

Given the fact that every project has its own set of intrinsic factors, such as domain, scope, environment and context, that makes it unique, I found it opportune to slightly modify the structure suggested by the guidelines in order to make the research model more suitable for this graduation project. The Orientation phase is not the initial phase of the project but has been preceded by an Initiation phase. This choice has been taken to cope with shortfalls on the existing documentation within IBLC Group.

The actual ADP is initiated in the Analysis phase. The ADP suggested by [5], in order to be initiated requires information about the enterprise IT architecture, initial scope and context for the system (sufficiently firm), initial system stakeholders and concerns and organizational structure and strategy.

After the initiation phase two of the required inputs were not available. The enterprise IT architecture, in this case referring to IBLC Group to-be IT infrastructure, was not sufficiently documented, and needed to be better investigated. Consequently, the initial scope and context for the system, in this case the E-Portfolio system, did not take into account the interaction between the

system and the IT to-be infrastructure of IBLC Group, the system's operating environment. The Orientation phase copes with this lack of information in order to initiate the ADP activities.

The COMET methodology models fulfill the outputs required by the ADP activities. Therefore, as shown in the research model, in this graduation project the activities of the ADP are performed with methods and techniques suggested by COMET and their output are the COMET models. The Analysis phase produces the COMET Business Domain (business and requirements) models. According to the model driven approach [9], the COMET Business Domain Models are translated, using the Reference Architecture Analysis based on the initial system specifications, into the initial candidate architecture during the Design phase. The Design phase produces the candidate architecture expressed through the COMET architecture models, which also contribute to the Functional viewpoint of the AD [9]. The candidate architecture is then assessed during the Validation phase, using the ATAM methodology. The validation phase produces the assessed solution architecture and the final system specifications.

The project phases hereby presented are based on methods, techniques and literature that are detailed in the referring chapters of this graduation report. Following are briefly described the research activities performed in each phase of this graduation project and the graduation chapters where the results are presented:

### 1. Initiation Phase

The results of this phase are presented in *chapter 1* and contribute to *chapter 2.*

The Initiation phase is the starting point of this graduation project. The research activities performed in this phase aim on gathering information about the environment where the graduation project is performed and define the initial problem. The initial problem is used to look for relevant literature and to set-up a preliminary research methodology. The techniques used in this phase are informal interviews with the General Manager, the only project stakeholder identified at this phase.

The research activities are as follows:

- The initial activity of this phase is to define the environment for this graduation project. IBLC Group General Manager, who is the problem owner, provides a bird-eye overview of IBLC Group organization and business, especially in the scope of IBLC community business extension.

- The initial problem is defined based on the concerns of IBLC Group General Manager. According to the initial problem the initial assignment of this graduation project is formulated.

- Relevant literature on the field of system architecture definition and assessment is identified and studied.

- A preliminary research methodology is created based on the initial assignment and literature. Research questions and their related activities and deliverables are formulated. The project approach is detailed for the Orientation and Analysis phases.

## 2. Orientation Phase

This phase answer question *RQ1*. The results of this phase are presented in *chapter 3* and contribute to *chapter 2*.

The Orientation phase represents a bridge between the Initiation and the Analysis phases, where the ADP is initiated. The picture provided by the initial problem is not enough to initiate the ADP activities. The research activities performed in this phase aims on providing the missing elements needed to initiate the ADP. These elements are a high level overview of the to-be IBLC Group IT infrastructure and some more first-cut concerns on the E-Portfolio system. This information leads to the formulation of the final assignment. The final assignment is used to finalize the research methodology. Findings from the Orientation phase are further investigated in the Analysis phase. The techniques used in this phase are analysis of the existing documentation and interviews with General Manager and IT Manager.

- The initial activity of this phase is the initial problem refinement process. Existing documentation about to-be IT infrastructure is analysed and shortfalls are solved with information gathered by interviews with the General Manager and IT Manager. This information is used to define Prodis and how it uses the related resources of the IT infrastructure to implement its required functionalities.

- The information gathered in the previous step is cross-checked with the initial problem and the findings are used to clearly define objectives and scope for the E-Portfolio system. An initial E-Portfolio system versioning is defined.

- The final assignment is formulated according to E-Portfolio initial scope and objectives.

- The research methodology is finalized according to the final assignment. Research questions, and their related activities and deliverables are updated. The project approach is defined for the complete phases of the graduation project.

## 3. Analysis Phase

This phase answers questions *RQ2* and *RQ3*. The results of this phase are presented in *chapter 4*.

The Analysis phase concerns the supporting activities of the ADP and part of the Architecture Definition. The Analysis aims on gathering information to create a complete business problem space for this graduation project. Information about the E-Portfolio system business context, business processes and resources, risk analysis and business requirements are gathered and used to fill in the business and requirements models of the COMET methodology. A Reference Architecture for the system is analyzed using the BCE pattern, as a bridge for the Design phase. The techniques used in this phase are interviews and the ones suggested by the COMET methodology.

- A business analysis of the E-Portfolio system is performed. The main techniques to gather data are use case technique, workshops and interviews. The information gathered at each iteration of the business analysis is used to progressively create the business domain for the E-Portfolio system. The information gathered during the business analysis are used to fill-in the COMET business models.

- The risks associated to the E-Portfolio system development are identified and analyzed during the business analysis. New identified system stakeholders are engaged to bring new concerns about the risk involved in the E-Portfolio system development.

- The first concerns of the system stakeholders captured by the use cases and their scenarios are used to define system boundaries and fill in the COMET requirements model.

- The consistency between COMET requirements and business models is checked.

- The COMET Business Domain Models are analyzed through the reference architecture analysis, in order to create the initial draft of the Component Structure Model.

**4. Design Phase**

This phase answers question *RQ4*. The results of this phase are presented in *chapter 5*.

In this phase the actual architecture definition for the E-Portfolio system is performed. The COMET Business Domain Models, especially the Reference Architecture, provide the system business context and requirements that are translated into system specifications captured by the candidate IT architecture. The candidate IT architecture is documented by the Architecture model of the COMET methodology.

- The E-Portfolio system components are designed, according to the reference architecture and perspectives addressed by non-functional requirements. The components interaction which defines their dynamic behavior is extracted from the Use Case Scenario model of COMET.

- Derive the interfaces of the E-Portfolio system components and their Information model, derived from the Resource model.

- Fill in the COMET architectural models and document the Functional viewpoint of the architecture in the AD.

**5. Validation Phase**

This phase answers question *RQ5*. The results of this phase are presented in *chapter 6*.

In this phase the solution architecture is assessed by using the ATAM methodology. The COMET models express the solution architecture and its business drivers to be used in the assessment process. During the assessment presentation two brainstorming sessions among the presentation attendant are held, where architecture quality attributes are elicited and discussed. The candidate architecture is than validated against these quality attributes in order to identify shortfalls and suggest improvements.

**6. Implementation Phase**

The implementation phase is not addressed by any research question because it is not within the scope of this graduation project. However suggestions for the implementation in terms of versioning

and future development of components that do not belong to the main set of models are presented in *chapter 7*. In this chapter are also presented the overall conclusion about this graduation project.

# 3. Orientation and Final Assignment

This chapter presents the information gathered during the Orientation phase. This information contributed to the formulation of the final assignment, presented at the end of this chapter, and to refine the research methodology and the project structure as presented in *chapter 2*.

In this chapter the following research question is answered:

RQ1 *What are initial objectives and scope of the E-Portfolio system?*

The initial problem refinement process, which aims on providing information to answer *RQ1*, is described in *section 3.1*. In the following sections the results of the process are presented. In *section 3.2* a high level overview of Prodis. Then in *section 3.3* findings about the E-Portfolio system.

The final assignment of this graduation project is presented in *section 3.4*. Starting from the initial assignment, the final assignment is further specified with information gathered from the refinement process and relevant literature.

The chapter is closed with some conclusions about the Orientation phase.

## *3.1 Initial Problem Refinement Process*

As stated by [5], during the ADP, scope and objectives of a system might be subject to slight modifications. On the other hand, before initiating the ADP, scope and objectives of the system, as well as its first-cut context, should be firm enough in order to reduce the risk of major changes during the ADP.

The initial problem for this graduation project, as presented in *chapter 1*, does not detail enough the relationships between the E-Portfolio system, whose development is in the scope of this graduation project, and its operating environment, the to-be IT infrastructure of IBLC Group. This lack of details hinders the clear definition of scope and objectives of the E-Portfolio system.

The initial problem refinement process's goal is to reduce the risk to having major changes on the objectives and scope for the E-Portfolio system, during the ADP. The process pursues its goal by providing more detail on the relationship between the E-Portfolio system and its operating environment.

The process information sources are the E-Portfolio system stakeholders already identified at this stage, IBLC Group General Manager and IT Manager, and the documentation already existing within IBLC Group.

Starting from the initial problem, the process consists of two main activities. These activities are performed sequentially and iteratively. Given the high granularity of the information required at this stage of the project, the process iterates twice. The two main activities of the refinement process are:

1. Analyze the existing documentation and gather initial concerns from the stakeholders already identified at this stage. The goal is to create a business level overview of the to-be IT infrastructure of IBLC Group. Specifically it is defined the Prodis HRIS and how it uses

the resources made available by the IT infrastructure to enable IBLC community business. During this task some stakeholders' concern about the E-Portfolio system are gathered.

2. Cross-check the information already available about the E-Portfolio system, with the information gathered at step 1. The findings will give more insight on the relationships between the system and its operating environment, providing more detailed scope and objectives.

The two stakeholders get actively involved in the refinement process. They provide information useful to bridge between the required IBLC community business functionalities and their Prodis implementation. They also provide support in order to understand the documentation and solve any related shortfall. The techniques used in order to gather information are mainly informal interviews. During these interviews, in line with the suggested practices of communication with stakeholders [5], I took particular care of the following:

- Clarify with both General Manager and IT Manager the concept of IT architecture, in order to share a common viewpoint during the process.

- Communication tasks performed on the same level of the stakeholders' background knowledge in order not to have misunderstanding that might influence quality and correctness of the gathered information.

The following subsection discusses the existing documentation used during the refinement process. Then the results obtained from the process are shown in the two following sections. First, an high level overview of Prodis in *section 3.2*. Then, in *section 3.3*, some findings about the E-Portfolio system that contributed for the refinement of its scope and objectives.

A list of the existing documentation used during the refinement process and a complete overview of Prodis can be found in *Appendix B*.

## 3.2 The Prodis HRIS

This section presents a high level overview of the Prodis system. The Prodis system is part of the to-be IT infrastructure of IBLC community, the environment where the E-Portfolio system is going to operate. The main assumptions underneath this overview, applied also for further phases of this graduation project, is that the first business goal is successfully achieved and Prodis will be implemented as presented in the existing documentation of IBLC Group.

The Prodis HRIS is a system, currently under development, that will be responsible for the management of IBLC community partners and to enable the LP trading business. The Prodis system will enable the IT infrastructure Business to Consumer (B2C) and Consumer to Consumer (C2C) transactions as well as B2B transactions, already enabled by CWPro.

Relatively to the LP trading business, the meta-knowledge exchanged within IBLC community is the LP information. The Prodis system has to conform to a set of business rules that constrain IBLC community business partners' behavior relatively to the LP trading business, of as shown in *Table 2*. IBLC community business partners are distinguished in two types: individual and organizations.

| | Consumer | Provider |
|---|---|---|
| **Organization** | LP information | LP information |
| **Individual (KW)** | LP information | / |

***Table 2: IBLC Community Business Rules (LP trading business)***

The individual partners are just allowed to consume LP information and cannot provide LP information within IBLC community. Hence, the individual provider role in the LP trading business does not exist. The organization partners have the right to both provide and consume LP information.

Taking into account the LP trading business and the business rules in *Table 2* above, the business roles within IBLC Community are as shown in *Table 3*.

| Individual (KW) | Organization |
|---|---|
| LP Individual Consumer | LP Organization Consumer;<br>LP Provider |

***Table 3: IBLC Community Roles (LP trading business)***

An organization partner is considered by the IT infrastructure as a sole entity with no visibility for the members of the organization. That means, an organization partner's member that makes business with IBLC community on behalf of the organization, is not accounted as individual partner.

The basic services enabled by Prodis, as presented in *Table 4*, take into account IBLC community roles as shown in *Table* 3 above. Prodis, similarly to CWPro, does not enable the issuing of all the IT infrastructure services as presented in the *chapter 1*. The *Brokering* service is partially supported. The *Payment* service will be supported in the future but its development has not been planned yet. These two services, therefore, are not taken into consideration in this overview.

| Service | Community Role | Description |
|---|---|---|
| *Publishing* | LP Provider | The LP provider upload its LPs information in the community. A set of LP information from the same provider is called *LP assortment*. The LP assortments are visible and available for purchasing to all the community partners. |
| *Selecting* | LP Organization Consumer | The LP organization consumer selects a set of LP information, according to certain criteria, among the ones available within the community and deliver it to the organization consumer. A set of LP information selected by a specific consumer is called *LP selection*. An organization consumer might have more than one LP selection. |
| *Searching* | LP Organization Consumer,<br>LP Individual Consumer | The LP consumer looks for the LP information within one of its LP selections. In the case of individual consumer, the LP selection is whole set of LP assortments of IBLC Community. |
| *Booking* | LP Organization Consumer,<br>LP Individual Consumer,<br>LP Provider(involved) | The consumer can attempt to purchase LPs. IBLC Group is responsible to route the request to the LP provider and forward back the response to the LP consumer. |

***Table 4: Prodis supported basic services***

In order to make use of the services listed in *Table 4*, an individual or organization has to be partner of IBLC community. To become partner of IBLC Community, and have the right to use IBLC Group IT infrastructure, a party has to register to Prodis. To register, the party has to provide data to IBLC community called *account information*. These data differ between organization and individual partners. The account data are information about the partner, such as name (individual or organization), surname (individual), business sector (organization) and so on. The registration assigns a *unique account* to every partner, to be uniquely identified within IBLC community.

The organizations, in order to register to IBLC community, have to stipulate a paper-based contract directly with IBLC Group General Manager. That involves a meeting arrangement between the two parties. For the individual partners this procedure is neither feasible nor user friendly. IBLC Group would like the individual consumers to register to IBLC community through a Web Interface, instead. In both cases the account information of the new IBLC community partner are then stored in Prodis.

Prodis issues each basic service by executing the associated business process of the IT infrastructure. The LP individual consumer has the right to use IBLC community infrastructure and its other services, relatively to his/her role, through a Web Interface.

## 3.3 Findings about the E-Portfolio system

This section presents some findings about the E-Portfolio system. The findings contribute to better define scope and objectives of the E-Portfolio system and point out aspects that are further investigated during the Analysis phase.

The Prodis HRIS is responsible for the management of IBLC community partners and enables the LP trading business. Based on this statement, the reasons why the E-Portfolio system has to interact with Prodis, already identified at this stage, are as follows:

- The usage of the E-Portfolio system is offered only to IBLC community partners. This verification is done through communication with the Prodis system.

- IBLC Group requires, in order to attract individual partners, the E-Portfolio system to implement features for social networking and EPs reliability verification and make these features available for IBLC community partners. Some information needed to implement these features is stored in Prodis system.

- The E-Portfolio system should associate the IBLC community LP trading booking history of an individual partner to his/her EP. The LP trading booking history is stored in the Prodis system.

According to the above listed points, the Prodis system has to be considered as system stakeholder as well.

Another finding is about the business criticality of the E-Portfolio system. The extra services are those designed by IBLC Group to add quality to IBLC community business. The E-Portfolio product, although linked to the achievement of the second business extension goal, is considered an extra service of IBLC community because of the following reason:

- The exchange of EPs is mainly seen as a supporting business to enable the pull basis for the LPs trading, considered as main business of IBLC community.

Moreover, the E-Portfolio product is seen by IBLC Group as a mean to sensibly extend the partners' network of IBLC community and, in a future perspective, the first step towards the opening of IBLC community to the recruitment business.

The final finding is about the E-Portfolio system versioning. The General Manager because of both practical and marketing reasons wants the E-Portfolio system not to be operational only when all its required functionalities and qualities are implemented. The E-Portfolio system implementation phase, during its execution, should release several operational versions of the system. The versions along with their features are identified during the Analysis phase.

From these findings emerge the following aspects that will be further investigated in the second part of the analysis phase.

- Identify the social-networking functionalities the E-Portfolio system should offer.
- Define business reasons and logic underneath the booking history association mechanism.
- Define whether an individual partner can choose to be involved just on one type of IBLC community business, either LP trading or KW trading, or not. In the former case related business rules have to be formulated and applied.
- Similarly to Prodis for the LP trading business, the E-Portfolio should conform to a set of business rules, yet to be defined, related to the EP trading.
- The boundaries of the E-Portfolio system as well as complete insight of its interaction with Prodis are not yet clearly defined. There is the need to understand which, among Prodis IT infrastructure processes and the related resources are directly involved for the implementation of E-Portfolio functionalities and qualities.
- There are not enough elements to identify risks linked to the E-Portfolio system development and consequently, contingency plans to control them. Risks involved with the development of the E-Portfolio system have to be identified, assessed and associated to effective contingency plans.
- Define the amount of versions of the E-Portfolio systems and the features for each version.

## 3.4 Final Assignment Formulation

The final assignment is a specification of the initial assignment, as given by IBLC Group General Manager, based on information collected from the refinement process and relevant literature. Even though this information adds more context to the assignment, its goal basically remains as stated in the initial assignment. The final assignment points out the directions along which further activities of this graduation project evolves.

In order to cope with the concerns presented in the initial assignment and with the findings discovered during the Orientation phase, the E-Portfolio system development process will include

an ADP. This ADP produces a validated IT architecture prior to the implementation phase. The ADP will be based on the COMET methodology. The methodology produces models related to the candidate IT architecture which comprises the first two versions of the E-Portfolio system but details main functionalities and qualities. The E-Portfolio system candidate architecture validation will be paper-based and uses the ATAM methodology.

A detailed requirements analysis and the implementation phase of the development process fall outside the scope of this graduation project. According to this, the final assignment for this graduation project is formulated as follows:

**Final Assignment**: *"Use the COMET methodology to develop an IT architecture for the E-Portfolio system that interacts with Prodis"*

The final assignment is accompanied by the following goal:

**Accompanying Goal:** *"Evaluate the practicality of COMET and ATAM methodologies for the development of a small-sized business critical information system"*

## 3.5 Conclusions on the Orientation phase

The Orientation phase successfully led to the formulation of the final assignment of this graduation project. The refinement process answered to *RQ1*. The final assignment is used to refine further activities of the initial research methodology addressed by the initial assignment, as presented in *chapter 2*.

The findings about the E-Portfolio system are taken into consideration during the analysis phase where the ADP is initiated, as presented in *chapter 4*.

# 4. Analysis

This chapter presents the information gathered during the Analysis phase. This information is used to create a complete business domain for the E-Portfolio system by using the COMET Business Domain Model, namely business and requirements set of models. The most important models are also presented in this chapter.

In this chapter are answered the following research questions:

*RQ2 What are the processes involved in the E-Portfolio system and the main actors using the system?*

*RQ3 What are the requirements of the E-Portfolio system for the KW trading business within IBLC community?*

In the analysis phase the E-Portfolio system ADP is initiated. This part covers the ADP supporting activities and part of Architecture Definition activity (Reference Architecture Analysis), which is fully covered in the Design phase. The ADP inputs are provided by the information gathered during the Orientation phase. The information already available about the business context of the E-Portfolio system, stakeholders, scope, first-cut context and objectives are completed and formalized by applying the COMET methodology.

The information concerning the business context of the E-Portfolio system are represented through the business models of COMET. The requirements model is used to express the business requirement and define the boundaries of the E-Portfolio system. The information stored in the models describe the business domain of the E-Portfolio system that it is going to be used as reference during the design phase for the architecture definition task described in *chapter 5*.

The deliverables of the analysis phase are the COMET Domain Models, namely the Business and Requirements models.

## *4.1 Context Statement*

The purpose of the Context Statement is to define the scope of the E-Portfolio system and place it within its business context. The E-Portfolio system is required by IBLC Group in order to support the KW trading business within IBLC community. The E-Portfolio system is part of the to-be IT infrastructure provided by IBLC Group for the management of IBLC community. The to-be IT infrastructure will be operative in the business extension context. There is only another system operating in the to-be IT infrastructure, the Prodis system.

The Context Statement for the E-Portfolio system is composed of two parts.

- An UML Context diagram showing the stakeholders which have interest in the development and usage of the E-Portfolio system, in *section 4.1.1*;

- The definition of the KW trading business within IBLC community and how the E-Portfolio system supports it. An UML activity diagram is used to place the system within the higher general KW trading business process of IBLC community, in *section 4.1.2*.

- The definition of the EP used within IBLC community, which contains elements that influences the E-Portfolio system context.

### 4.1.1 E-Portfolio system stakeholders

The context diagram of *Figure 3*, gives an overview of the stakeholders interested in the development of the E-Portfolio system. The system stakeholders shown in the context diagram are involved on either the E-Portfolio system development or its usage once it will be operational within IBLC community.

The stakeholders shown in *Figure 3* have different reasons to use the E-Portfolio system. EP providers and EP consumers are the business stakeholders, namely those that use the system to get involved in the KW trading business (see *section 4.1.2*). These stakeholders interact with the front office side of the system. The other stakeholders are responsible for the development of the E-Portfolio system and, once it will be operational, manage and maintain the system. The stakeholders responsible to manage and maintain the system interact with the back office side of the E-Portfolio system.

IBLC Group considers IBLC community as the marketplace where the KW trading business occurs. That means, only IBLC community partners can be potentially involved in the KW trading business. The IBLC community partners involved in the KW trading business, namely E-Portfolio system business stakeholders, might also be involved in the other business of IBLC community, the LP trading. In particular the EP organization consumers are always involved in the LP trading business. For the individual partners, both EP providers and consumers, such involvement is optional and they can just be involved as LP consumers.

For these reasons, the definition of the E-Portfolio system stakeholders, although focusing on the KW trading business, takes under consideration aspects correlated with the LP trading business within the wider context of IBLC community business.

The organization partners, as shown in the context diagram of *Figure 3* through the *Uses Through* relationship, can use the E-Portfolio system only through Prodis. This choice is motivated by the willing of IBLC Group, as it currently happens with CWPro, to keep the contract-based registration procedure to IBLC community, and therefore to Prodis, for the organizations. This constraint hinders the possibility for the organizations to register directly to the E-Portfolio system. On the other hand, by registering to Prodis the organizations gain the right to use the E-Portfolio system. The reasons underneath this choice are as follows:

- Maintain the already tested and successfully working way of interaction of organization partners with IBLC Community.

- The organization partners, in terms of reliability and LPs quality, are of critical importance for IBLC community business. The traditional way of registration gives to IBLC Group transparency and control on the choice of the organization partners in order to prevent poor qualitative LPs and improper consumers' behaviour, such as missing payments or fake booking transactions.

- IBLC Group, in order to make profit, wants the organization partners to pay to access the information stored in a specific EP. The billing system is part of Prodis and therefore the purchase of a specific set of EPs has to be managed by Prodis.

The individual partners can use the E-Portfolio system directly. In order to meet the business constraint that only IBLC community partner can use the E-Portfolio system, the registration procedure differs depending on whether the individual is already an IBLC community partner, i.e. already registered to Prodis, or not.

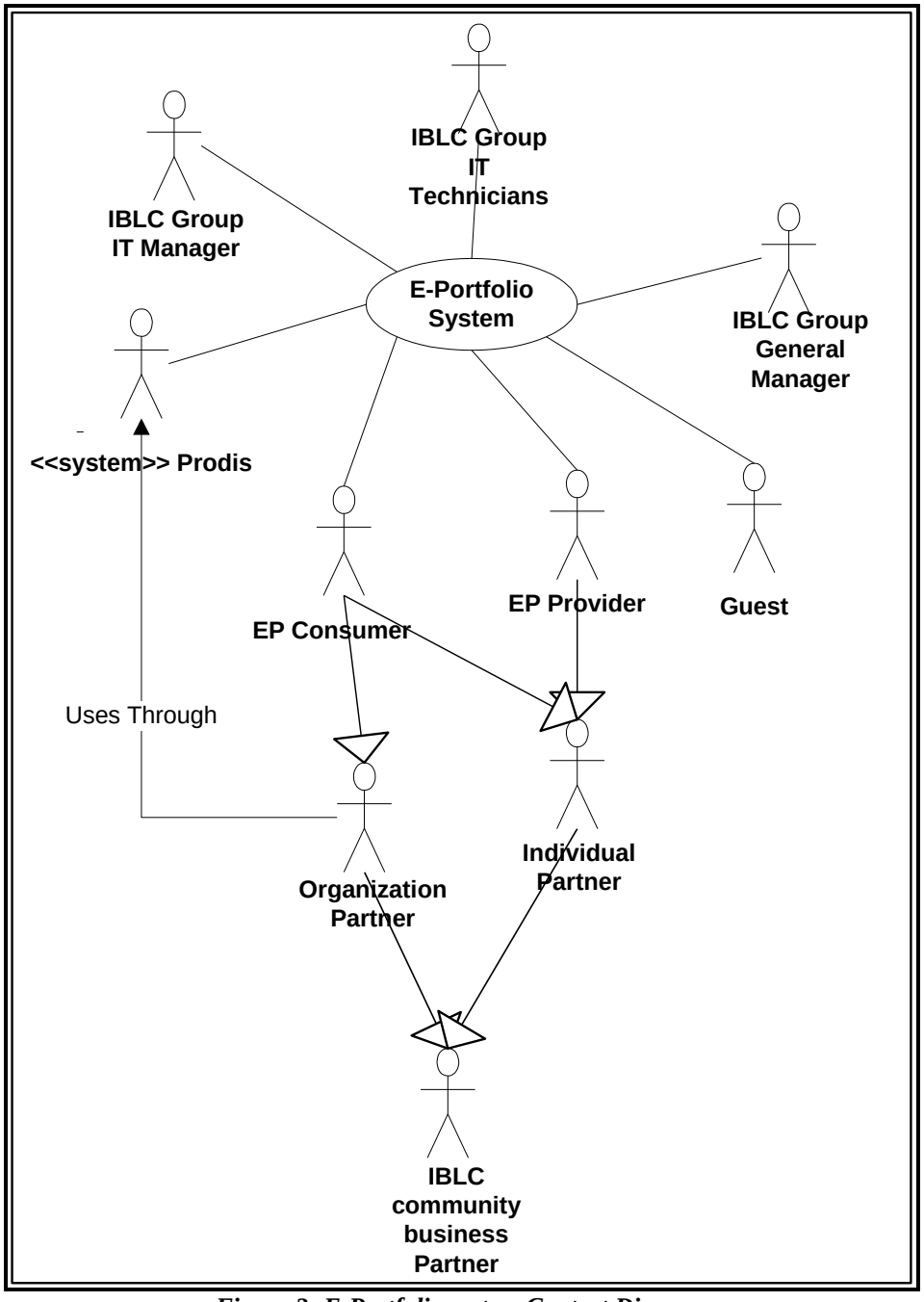


*Figure 3: E-Portfolio system Context Diagram*

Among the stakeholders shown in *Figure 3*, just the IT manager, General Manager and IT technicians of IBLC Group are steadily available as source of information during this graduation project. The stakeholders groups directly involved in the KW trading business and final users of the E-Portfolio system, namely EP consumers, EP providers and guests, are difficult to reach and their concerns towards the E-Portfolio are provided by two sources:

- A market survey commissioned by IBLC Group in the scope of the KW trading business.
- The business concerns of the idea owner of the E-Portfolio system, namely IBLC Group General Manager.

A detailed description of the E-Portfolio system stakeholders can be found in *Appendix C*.

### 4.1.2 The KW Trading business

This section discusses the KW trading business within IBLC community. The KW trading business is the IBLC community business that IBLC Group wants the E-Portfolio system to support.

IBLC community is the market where the KW trading business occurs. In the KW trading business the offer side is represented by the KWs, the demand side is represented by the parties that look for KWs. Parties on both sides are IBLC community partners. A KW, because of his/her status of human being, cannot be traded in the literal sense of the word. The actual good that represent the offer side of the KW trading business is the knowledge a KW can offer. The demand side "purchases" this knowledge in exchange for "goods" that provide an added value for the KW. These "goods" varies depending on the demand actor. The demand actor can be either an organization or a KW.

The KWs in the offer side, offer themselves in the KW trading business for basically two reasons:

- Effectively develop their knowledge (through purchasing LPs)
- Effectively deploy their knowledge (through finding a job position)

These two reasons are correlated. Indeed a KW by deploying their knowledge, for instance by fulfilling a job position, also develops it through informal learning.

Organizations and KWs demand other KWs in the KW trading business to use their knowledge. Within IBLC community, the knowledge is used by the organizations for the following reasons:

- Fulfil a job position with the right person.
- Perform the LP trading business in a pull perspective, by proposing to KWs a set of LPs matching their knowledge requirements.

In both cases the organizations offer, as added value for the KW, a knowledge development opportunity, respectively informal and non-formal. In the first case they also offer a knowledge deployment opportunity.

The KWs, on the demand side, use the knowledge of a KW, on the offer side, for the following reasons:

- Receive tutoring about a specific professional topic.
- Offer tutoring about a specific professional topic.

In the first case the KWs on the demand side, as added value for the KW, offer a knowledge deployment opportunity, in the second case a knowledge development opportunity.

Within IBLC community, the knowledge a KW offers is described by his/her EP. A KW on the offer side is therefore called EP provider, while the demand side is called EP consumer. The EP consumer within IBLC community can be either an individual, namely a KW, or an organization.

The E-Portfolio system required by IBLC Group is placed within its IT infrastructure in order to enable the exchange of EPs in the scope of the KW trading business within IBLC community. The operational aspects of the E-Portfolio system are placed within the higher KW trading business process as modelled in the activity diagram of *Figure 4*. The process embraces the wider context of IBLC community, taking into account the correlation with the LP trading business and, in a future perspective, also the recruitment business.

According to *Table 5*, the individual partners, namely the KWs, are entitled to both provide and consume EPs while the organization partners are just allowed to consume EPs. The organization provider role in the EPs business does not exist.

| | **Consumer (role)** | **Provider (role)** |
|---|---|---|
| **Organization** | LPs information<br>EPs | LPs information |
| **Individual (KW)** | LPs information<br>EPs | EPs |

***Table 5: IBLC Community Business Rules (LPs and KWs trading businesses)***

Taking into account both LP and KW trading businesses and the business rules in *Table 5* above, the business roles within IBLC Community are as shown in *Table 6*.

| | **Individual (KW)** | **Organization** |
|---|---|---|
| **KW business** | EP Provider;<br>EP Individual Consumer | EP Organization Consumer |
| **LP business** | LP Individual Consumer | LP Organization Consumer;<br>LP Provider |

***Table 6: IBLC Community Roles (LPs and KWs trading businesses)***

It is necessary to underline that an individual partner of IBLC community does not necessarily have to be involved in the KW trading business.

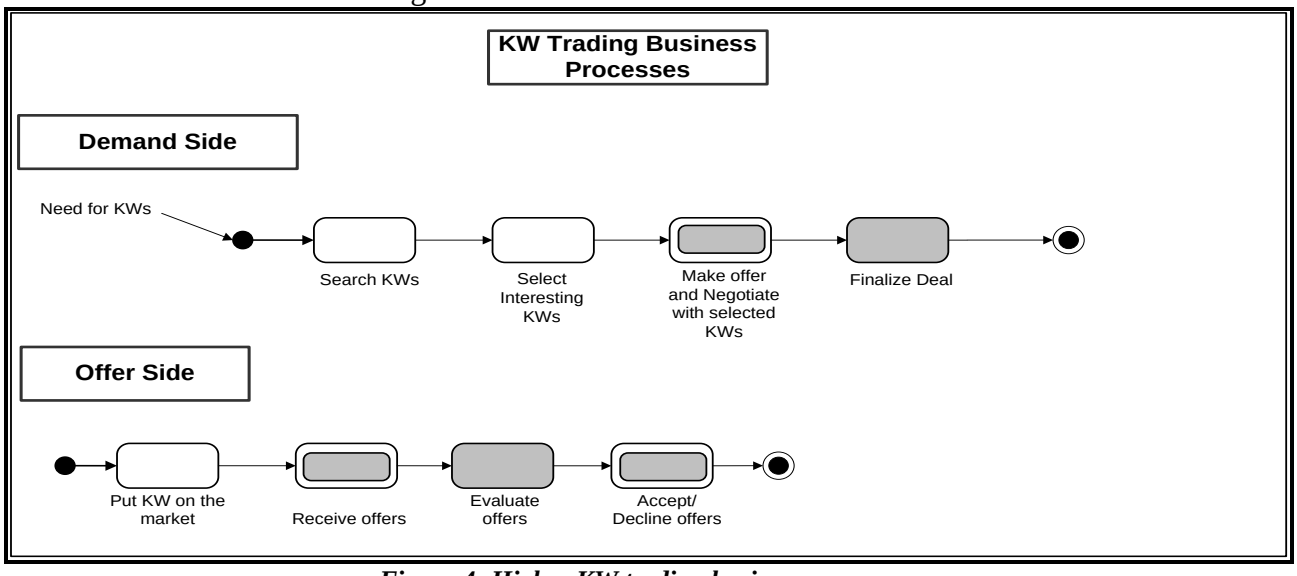


***Figure 4: Higher KW trading business processes***

The E-Portfolio system, through the EPs as described in *section 4.1.3*, is responsible to make demand and offer of KWs met within IBLC community. The system is not aware of the reasons why the business partners get involved within the KW trading business.

In *Figure 4* are shown the activities, both for offer and demand side, of the higher KW trading business process and how the E-Portfolio system fit within the process. The activities within the E-Portfolio system's scope are coloured in white, those external to the system are coloured in grey. The activities with a grey core, as following explained, are partially enabled by the E-Portfolio system.

The partially enabled activities are those in the Consumer Side *Make offer and Negotiate with selected KWs* and those in the Providers Side *Receive offers* and *Accept/Decline offers* activities. These activities are partially enabled in the sense that the E-Portfolio system realizes them as simple communication between users, for instance through e-mails, without taking them into account as actual business transactions.

The only exception is when the need for KWs by an EP organization consumer is in the context of the LP trading business. In this case the partially enabled activities and the *Finalize Deal* activity correspond to activities of the LP booking process performed by Prodis. The successful purchase of an LP (*Finalize Deal*) is considered within the KW trading business as a knowledge development activity (not to be confused with a process' activity) of the involved KWs. Therefore, in this case the Prodis system has to notify and update the E-Portfolio system about the successful LP booking. Consequently, the EP organization consumer might be also an LP provider in the LP trading business and the EP provider a potential LP individual consumer. This is better described in the *Offer LP* process, which can be found in *Appendix C*.

The recruitment business is not yet enabled by IBLC community. Any recruitment business transaction happens outside the boundaries of IBLC community. However, the recruitment business is considered as a trigger for the organization partners to use the E-Portfolio system.

How the E-Portfolio system enables the activities of the higher KW trading business process within its scope and the role of the EPs within this context is shown in *section 4.3*, where the E-Portfolio system main business processes and resources are modelled and described.

### 4.1.3 IBLC Electronic Professional Portfolio (EP)

Within IBLC community the EP is considered as meta-knowledge about a KW, namely an individual partner.

The meta-knowledge contained in an EP may vary. IBLC Group, in order to keep the EPs semantic, i.e. professionally meaningful, easy to retrieve and to control the reliability of the information stored in it, wants each EP to have a predefined structure. An EP is composed by a set of personal information, professional information and a list of skills. The personal information of the EP, such as name, surname and date of birth, are the account information of the individual partner. The account information uniquely identifies an individual within IBLC community and is needed for the Prodis' registration. The professional information might refer to study or working career.

The professional information is composed by a set of activities. An activity can be for instance a study program or a job position. In order to have a complete overview on the activity, the activity name has to be accompanied by information fields about the entity issuing the activity, the period

the activity was performed and eventually qualification awarded and marks. The information might be complemented by a description of the activity and assessments, made by others or the individual him/herself. Each activity might also have sub-activities.

In *Table 7*, to make things clearer, are shown two examples of activities. The first one concerns the study career, the other the job career of a given individual:

| **Career** | **Activity** | | | | **Issued by** |
|---|---|---|---|---|---|
| | **Name** | **Period** | **Qualification Awarded and Marks** | **Description** | |
| **Study Career** | Business Information Systems Master Program | 2007-2009 | Master of Science with a certain mark on a scale of ten | *Master Description (Content, objectives…)* | Technical University of Eindhoven |
| **Job Career** | Software Engineer Position | 2004 – 2009 | Senior Software Architect | *Position description (Duties, responsibilities…)* | IBLC Group |

***Table 7: EP's activities examples***

In the study career case the sub activities can be the courses taken during a master program. In the job career case the projects undertaken during the permanence in a specific job position.

The assessment on a specific activity can be done, for instance, by the entity that issued the activity. In the study career activity case it can be the master program coordinator, in the job career activity case it can be the supervisor of the job position.

For planned activities, the activity format is the same. Of course certain fields might not contain information. For instance the period can be omitted or it has to relate to future planned dates.

IBLC Group wants to have the same format of the professional information contained in a EP to the booking transaction of the LP trading business. Every professional information contained in a EP is considered as an LP booking transaction. Therefore every activity in the EP is going to be stored with the format shown in *Table 8*.

| **EP owner** | **Activity** | **Issued by** |
|---|---|---|
| LP individual consumer | LP information | LP provider |

***Table 8: IBLC Community professional information format***

LP information and LP provider concerning activities stored in a EP are not necessarily linked to entities within IBLC community. That means the *Issued by* field might be an organization not partner of IBLC community and the *Activity* field a product not registered within the community.

To each EP it is associated the IBLC score, a score computed based on update frequency, completeness and amount of verified information.

## 4.2 Goal Model

The Goal Model is the first model concerning the business operations. Its purpose is to agree with E-Portfolio system's stakeholders a hierarchy model of business goals that will be met by implementing and using the E-Portfolio system. The goals listed here refer to the E-Portfolio system applied to the wider context of IBLC community, hence the system operating within the to-be IT infrastructure of IBLC Group and interacting with Prodis.

An initial list of business goals have been obtained through several brainstorming sessions with the IT Manager. This list, in cooperation with the IT Manager, has been refined in order to find any correlation and hierarchical connection between the goals. The final result is the Goal Model shown in *Figure 5.* In the Goal Model are also shown the business processes needed to achieve the goals.

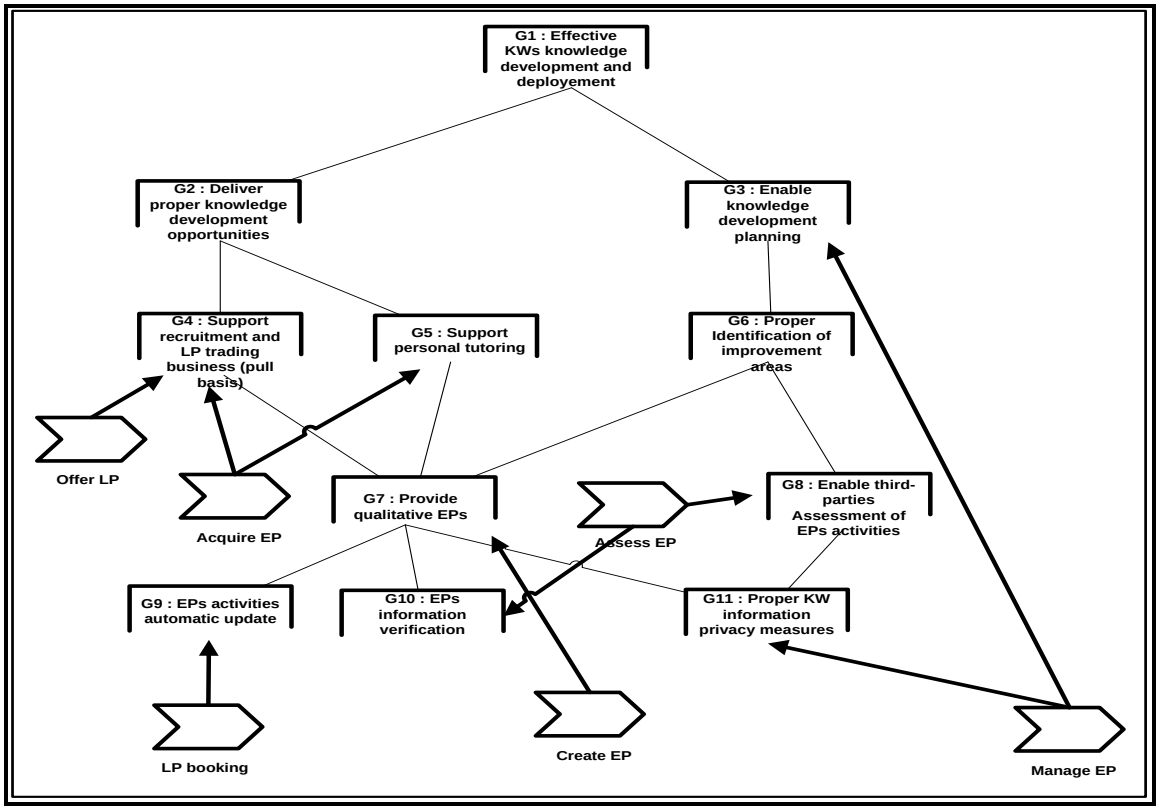


***Figure 5: E-Portfolio system Goal Model***

A detailed description of the E-Portfolio system business goals can be found in *Appendix C.*

## 4.3 Community Model

The Community Model is a container for that part of the Business model that details the business processes and business resources that are relevant to the E-Portfolio system.

The Community Model of COMET methodology consists of two sets of models.

- The Business Process and Roles Model, in *section 4.3.1* uses UML Activity diagrams to describe business processes and roles of the domain which are relevant to the E-Portfolio system.

- The Resource Model, in *section 4.3.2* uses UML Class diagrams to define the concepts of the KW trading business relevant to the E-Portfolio system and the relationships between them.

All the models presented in these sections and in *Appendix C* have been already refined according to the Work Analysis Refinement Modelling (WARM) of COMET methodology.

### 4.3.1 Business Process and Roles Model

The Business Process and Roles model defines:

- the business processes of the domain which are relevant to the E-Portfolio system, and which will enable the goals to be met;

- the roles of the resources that perform those processes.

In this section are presented the main business processes that detail the higher KW trading business processes according to the business goals described in the *Goal Model* in *section 4.2*. The other processes can be found in *Appendix C*. The processes make explicit the E-Portfolio system business stakeholders' activities concerning the higher KW trading processes.

The business processes are placed within the to-be IT infrastructure that IBLC Group offers for the management of IBLC community. According to the business context presented in *section 4.1* above, the E-Portfolio business processes embrace also the activities correlated within the wider context of IBLC community business and the LP trading business. This correlated business activities are within the scope of the Prodis system, whose detailed analysis is outside the scope of this graduation project. Moreover the under development status of Prodis, makes it difficult to detail both activities and the actors performing them.

According to that, I made a set of assumptions in order to diminish the risk that any change occurring in the Prodis system will also affect the E-Portfolio system business processes. These assumptions keep the E-Portfolio business processes execution independent from the actual details concerning correlated activities of the Prodis system.

These assumptions are following listed:

- The actor performing activities outside the boundaries of the E-Portfolio system are not specified. All these activities have Prodis as actor. This choice holds unless an E-Portfolio system stakeholder triggers or performs these activities.

- The activities outside the boundaries of the E-Portfolio system are not detailed, but the information flow conforms and is consistent with the functionality requested to Prodis and its correlation with the E-Portfolio system.

In the activity diagrams used to model the processes, the activities outside the boundary of the E-Portfolio system are coloured in red, those within its boundaries are shadowed.

As already introduced in *section 4.1.3*, within IBLC community the knowledge a KW can offer is described by its EP. The E-Portfolio system, by using the EPs, is responsible to match demand and offer of KWs within IBLC community.

A KW that does not own an EP is not considered to be in the market by the E-Portfolio system, because his/her knowledge is not described and consequently cannot match the demand. The *Put KW on the market* activity of the higher KW trading process is basically the E-Portfolio system high-level business process where a KW, namely an individual partner, creates and manages his/her own EP.

The offer side activities of the higher KW trading process *Search KWs* and *Select Interesting KWs* are basically the high level business processes of the E-Portfolio system specific for the EP consumers, where a KW or an organization matches its knowledge requirements against a specific set of EPs. The *EP consumers specific process* is not further divided into specific for EP individual consumers and EP organization consumers, because there is not distinction between them at business level.

The *Put KW on the market* and *EP consumer specific process* correspond, respectively, to the activities on the Offer and Demand side of the higher KW trading business process within the E-Portfolio system scope. Together with the *Registration process* are the main business processes of the E-Portfolio system.

In *section 4.3.1.1* the *Registration* process to the E-Portfolio system is described. Then in *section 4.3.1.2* and *4.3.1.3* respectively the *Put KW on the market* and *EP consumer specific process* are described. Their structured activities are detailed in *Appendix C*.

Some of the higher KW trading business process activities is partially enabled by the E-Portfolio system. That means they happen through general communication, such as e-mails, between the two parties involved, namely EP providers and EP consumers. A general communication, for instance through e-mails exchange, is not recognized as a structured business task therefore it is not detailed at business level. Both job position and tutoring proposals are considered as general communications. In the case the offer is related to a set of LPs, the business processes need to be detailed. These processes, whose importance is considered as secondary, can be found in *Appendix C*.

#### 4.3.1.1 E-Portfolio system Registration

The first step to get involved in the KW trading business is to register to the E-Portfolio system. The organization partners do not need registration in the E-Portfolio system, because they act through Prodis. Without registration a user is considered by the E-Portfolio system as Guest. A Guest user is entitled to use the E-Portfolio system just to a search for EPs but can neither access nor create them. A Guest user can be either partner of IBLC community or not.

In the case s/he is a partner of IBLC community s/he already takes part in the LP trading business (in the role of LP individual consumer) and s/he can register with his/her IBLC community account. In the other case, through registration, a Guest user of the E-Portfolio system becomes individual partner of IBLC community as well, even if s/he is not interested in getting involved in the LP trading business.

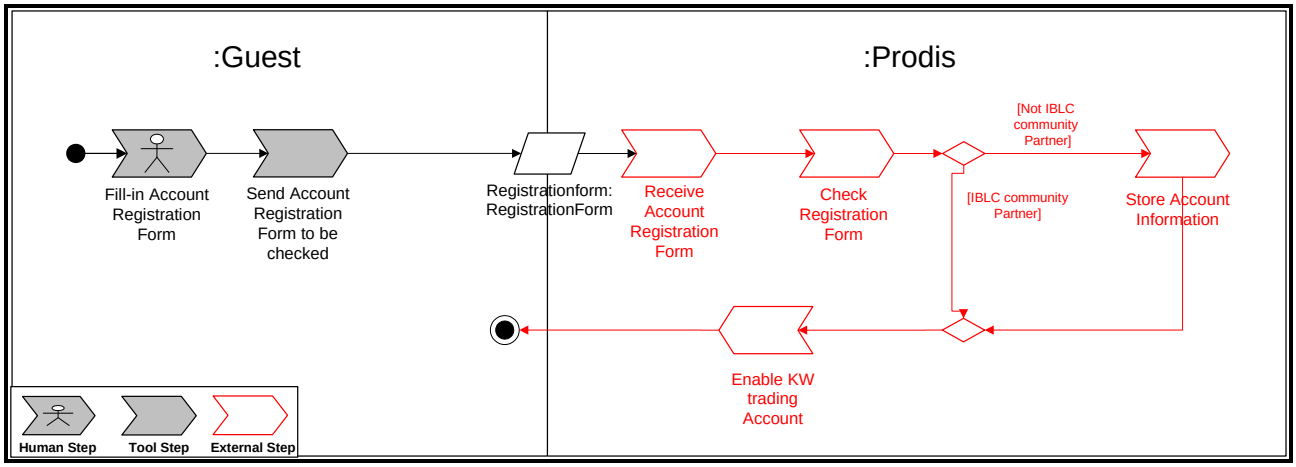


***Figure 6: E-Portfolio registration process***

In the activity diagram of *Figure 6* it is shown the registration process. The process is triggered by a Guest that wants to register to the E-Portfolio system. The registration form is sent to Prodis. Prodis checks whether the Guest is already partner of IBLC community or not. In the former case the Prodis system gets the IBLC community account formation and send them to the E-Portfolio system. Otherwise Prodis stores the registration form and consequently the Guest becomes an IBLC community partner. The business reasons underneath storing/sending the account information in Prodis is that Prodis manages the access to IBLC community. After processing the Registration Form, Prodis enables the KW trading account for the Guest within IBLC community.

With KW trading account enabled the Guest becomes an E-Portfolio system individual user and can use the system according to the *Put KW on the market* and *EP individual consumer specific process*. These processes are discussed in the following sections.

#### 4.3.1.2 Put KW on the market

The *Put KW on the market* process corresponds to the higher Provider side KW trading business activity *Put KW on the market*. An individual user of the E-Portfolio system by creating its EP becomes an EP provider. It is also referred to the EP provider as the owner of a specific EP. The EP represents the knowledge a KW can offer within the KW trading business. In *Figure 7* it is shown the activity diagram concerning the Put KW on the market process.

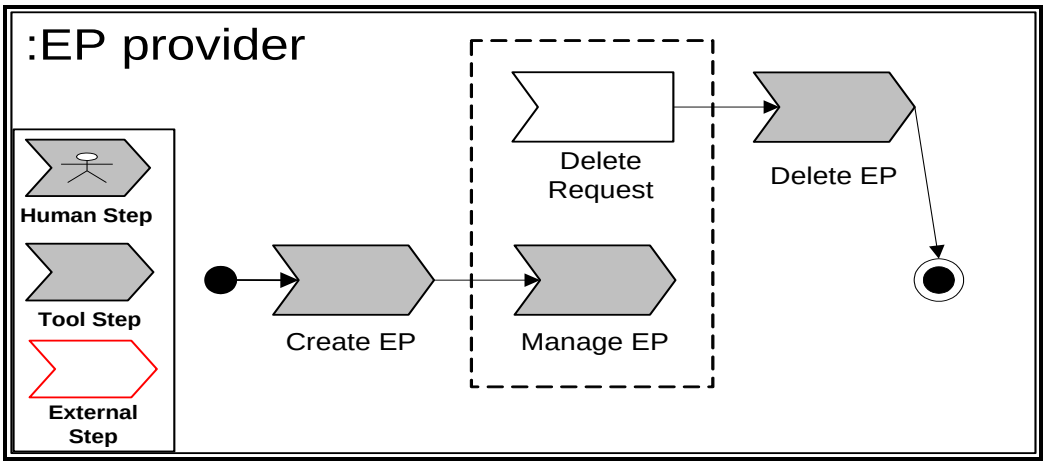


***Figure 7: Put KW on the market process***

Once an EP provider creates his/her EP s/he can manage it, in the *Manage EP* process, by modifying the EP information or changing authorization and privacy measures. At any point after the EP is created, the EP provider can decide to remove him/herself from the KW trading business by deleting his/her EP. This is modelled by placing the *Manage EP* process within an interruptible activity region (UML 2) together with the event *Delete Request*. When the event is triggered the *Manage EP* process is interrupted and the *Delete EP* is executed. The *Delete EP* process removes the EP from the E-Portfolio system. The individual user is then not recognized anymore as an EP provider but his/her activities and account information are not removed from IBLC community.

When an EP provider creates or modify his/her EP, s/he can also add planned activities that s/he plans to attend in the future. These planned activities have to conform to the IBLC Group EP predefined format.

The *Delete EP* is a not structured business process therefore it is not going to be detailed at business level.

#### 4.3.1.3 EP consumer specific process

The *EP consumer specific process* correspond to the higher KW trading business Consumer side *Find KWs* and *Select interesting KWs*.

An EP consumer, either individual or organization, triggers the *EP consumer specific process* when it needs a set of KWs. The E-Portfolio system is not aware of the reasons why the EP consumer needs a specific set of KWs.

In *Figure 8* is shown the activity diagram concerning the *EP consumer specific process*.

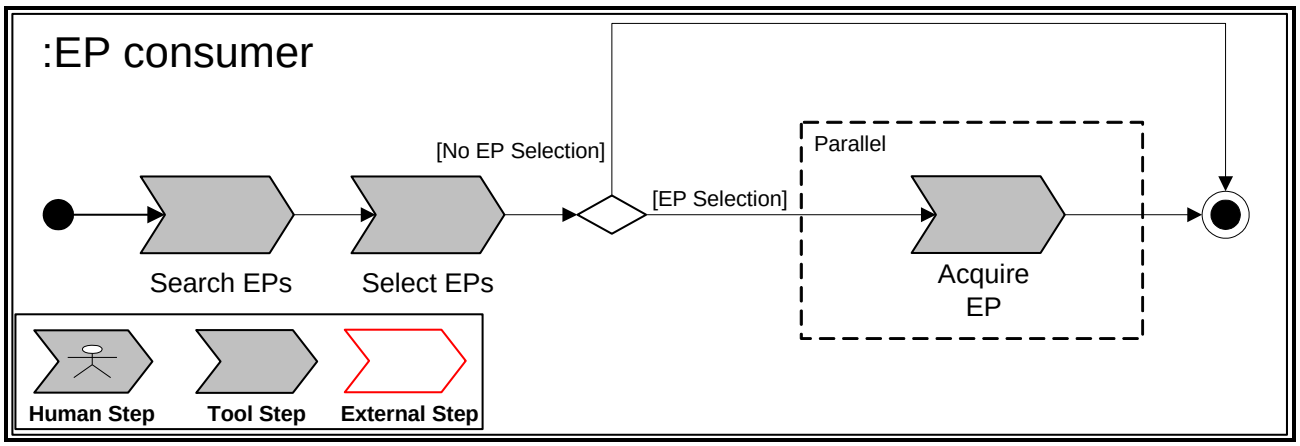


***Figure 8: EP consumer specific process***

The process is triggered when the EP consumer wants to search for KWs whose EPs match specific criteria with the *Search EPs* process. From this set of matching EPs s/he can make a further selection in the *Select EPs* process. If there is not any EP selection made by the EP consumer the process ends. Otherwise, the process proceeds with the access to the information stored in the EP in the *Acquire EP* process. *Acquire EP* is executed in parallel for every EP in the EP selection. This is modelled by placing the *Acquire EP* process within a *parallel expansion region* (UML 2). The parallel expansion region, given as input a collection of elements of the same type, executes the activities inside it in parallel for each element of the collection. After the EP is acquired the EP consumer specific process ends.

Both *Search EPs* and *Select EPs* are not structured business tasks therefore they are not going to be detailed at business level.

### 4.3.2 Resource Model

The Resource Model is an information model that identifies and defines the concepts of the KW trading business relevant to the E-Portfolio system and the relationships between them. These concepts are the actors of IBLC community involved in the KW trading business and the objects these actors use when involved in the business. According to the business context of the E-Portfolio system, there are also concepts concerning the wider context of IBLC community.

The Resource Model for the E-Portfolio system is shown in the class diagram of *Figure 9*.

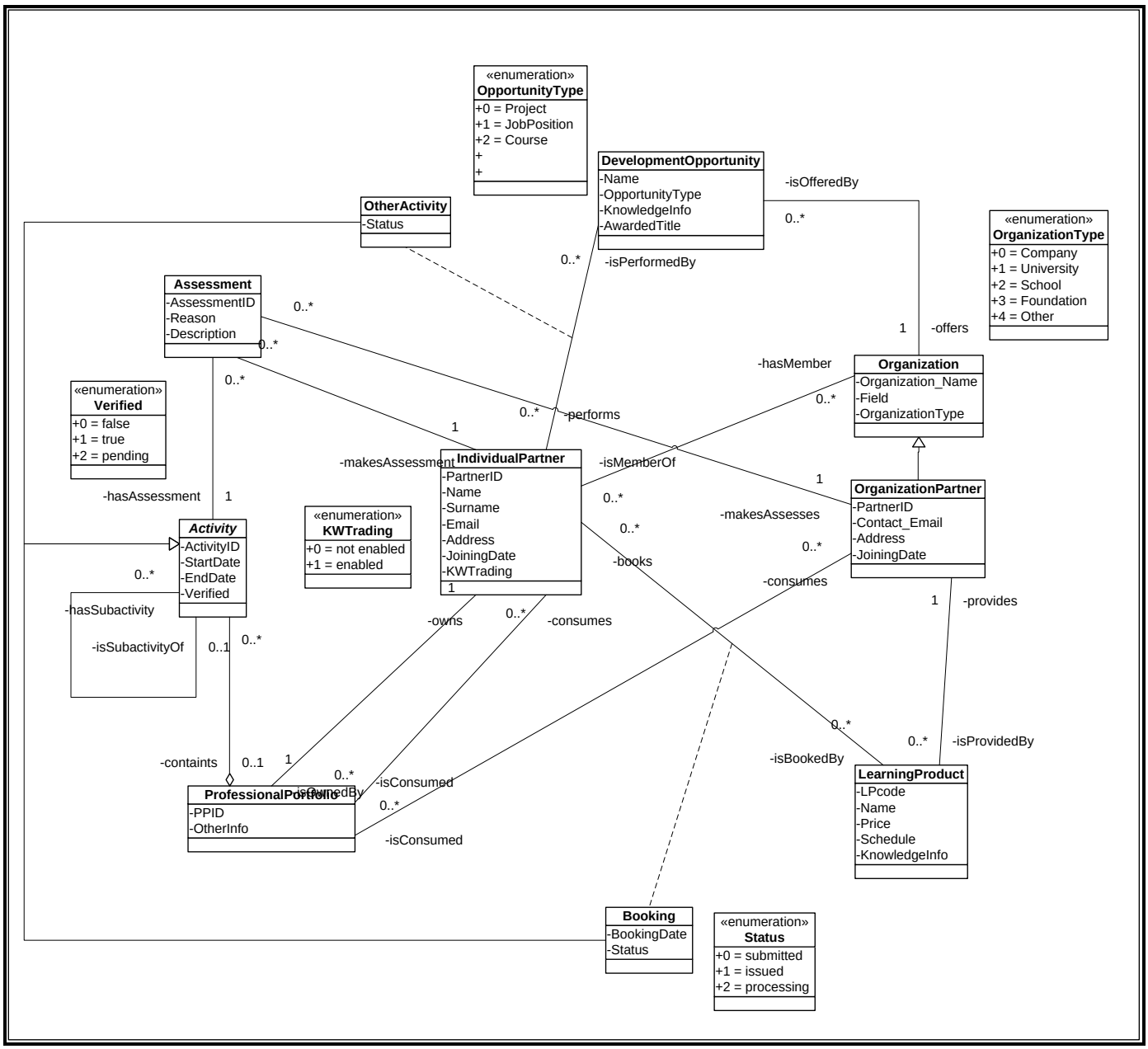


***Figure 9: Resource Model for the E-Portfolio system***

All the actors involved in the KW trading business are IBLC community partners, Individual and Organization partners. The account information for every partner are those that identify the partner within IBLC community (the attributes in the classes *IndividualPartner* and *OrganizationPartner*).

The Organization partners are not necessarily involved in the KW Trading business but they don't need registration. The Individual partners have to be registered to the E-Portfolio system (attribute *KWTrading* in the I*ndividualPartner* class set to "enabled").

An EP can be owned at the most by an Individual partner and an Individual partner can own at the most one EP (class *ProfessionalPortfolio)*. An EP contains information about activities (abstract class *Activity*) and *other professional information* (attribute *OtherInfo*) related to his/her owner. Of course an activity is contained in an EP just if the Individual partner that performed the activity is the same Individual partner that owns the EP. Moreover, in case an EP is deleted, the activities are kept in the system (shared aggregation relationship between *ProfessionalPortfolio* and *Activity* classes). Each activity can be either an LP booking transaction (class *Booking*) or another activity related to the career of the PP Provider (class *OtherActivity*). An activity can also contain sub-activities.

As other activity (class *OtherActivity)* it is meant any development opportunity an Individual partner performed during his/her professional career, such as projects, courses, job positions and such. The *OtherActivity* class associates an Individual partner with the development opportunity (class *DevelopmentOpportunity*) offered by an organization. In the case the organization is an IBLC community partner, the truthfulness of the activity can also be verified. An instance of the *OtherActivity* class can be created just if an instance of the *ProfessionalPortfolio* class, that contains the activity, already exists.

As LP booking transaction it is meant the purchase by an Individual partner of an LP within IBLC community. Just the Organization partners can provide LPs. The *Booking* class associates an Individual partner with the purchased LP (class *LearningProduct*). A booking can be added as activity just if the LP is successfully issued (attribute *Status* in the *Booking* class set to "issued"). All LP booking transactions added to the EP as activities are already verified (attribute *Verified* in the *Activity* class set to "true").

Each activity can be assessed. The assessment (class *Assessment*) can be done by the Individual partner that performed the activity (self-assessment) or by another registered partner of IBLC community, upon invitation sent by the EP owner.

## 4.4 Use Case Model

The Use Case Model is part of the Requirements Model of the COMET methodology. According to the methodology, in this project the functional requirements of the E-Portfolio system are captured by using the use case approach. The use cases describe the specific flow of actions upon a specific request made by an E-Portfolio system's actor to achieve a specific goal.

The Use Case Model of COMET methodology consists of two parts.

- The System Boundary Model, in *section 4.4.1*, uses an UML Use Case diagram to identify the high level use cases of the E-Portfolio system, together with actors and goals, and consequently to define the boundaries of the system.

- The Use Case Scenario Model, in *section 4.4.2* is used to describe each high level use case in detail and express their flow of actions according to specific scenarios.

### 4.4.1 System Boundary Model

The System Boundary Model defines the high level use cases of the E-Portfolio system and the boundaries of the system itself. The System Boundary Model is derived from the Business Model.
The first step is to identify the actors which actually use the system. In this scope the Context Statement of *section 4.1* above, provides already a description of the system stakeholders and identifies those that use the system in order to receive added value. Of course the E-Portfolio system stakeholders involved just on its development, the IT technicians, are not considered as system users.

The activities and their related roles of the Business Process and Roles Model of *section 4.3.1* provides the starting point to define the initial use cases for each actor. Once the initial use cases are defined and modelled in the initial draft of the System Boundary Model, the model itself is used to further detail existing use cases and elicit new ones from the available E-Portfolio system stakeholders, namely IBLC Group General Manager and IT Manager. The System Boundary Model presented in *Figure 10* is the final version of the model, namely with all the major use cases identified in order to cover the concerns of the E-Portfolio system stakeholders.

Because of the difficulties in reaching other stakeholders involved as actors in the E-Portfolio system, the use cases for all the actors are not based upon the concerns expressed by the actual actors of the system. The use cases are based instead on the concerns regarding the services the two stakeholders mentioned above, expect the E-Portfolio system to offer to the other actors.

The business stakeholders, namely EP providers, EP individual consumers and EP organization consumers, are the end-users, namely those that use the front-office part of the system. The other stakeholders use the back office part of the system.

The Prodis system uses the E-Portfolio system in two different ways:

- *Direct*: the E-Portfolio system is used by the Prodis actor.

- *On behalf of a EP organization consumer*: the Prodis system makes aware the E-Portfolio system of the EP organization consumer which is using it. Therefore it is the Organization actor actually using the E-Portfolio system through Prodis.

In this latter case, the *Organization* actor cannot make use of all the EP consumer functionalities the E-Portfolio system offers instead to the Individual actor. For instance, the Organization actor differently than the Individual actor, has to pay to have access to a set of EPs. Because the billing system is managed by Prodis, for control reasons the Organization actor cannot have a catalogue of EP owners in the E-Portfolio system. Therefore the use case related to the EP Catalogue management (*UC34: Manage EP Catalogue*) is not available for the Organization partner.

Among the E-Portfolio system stakeholders there are those that, although having different interests towards its development, have the same goals and/or reasons to use the system. That is the case of the IT Manager and the General Manager. These stakeholders use the system just for administration purposes. Therefore they are identified as a unique actor, the *Administrator* actor.

The EP provider and EP individual consumer stakeholders in some cases might be the same individual partner. An individual partner uses the E-Portfolio system as EP individual consumer and, as soon as s/he creates his/her EP, uses it as an EP provider as well. Therefore both stakeholders are identified as a unique actor, the *Individual* actor.

The only E-Portfolio system actor which is not also a system stakeholder is the *External System* actor. This actor represents any external system with the capability of exporting/importing EPs from/to IBLC Community.

The System Boundary Model for the E-Portfolio system is described, according to COMET methodology, by using an UML Use Case Diagram. In the System Boundary Model of *Figure 10* just the high level use cases are shown in order to make the model more understandable by the system stakeholders.

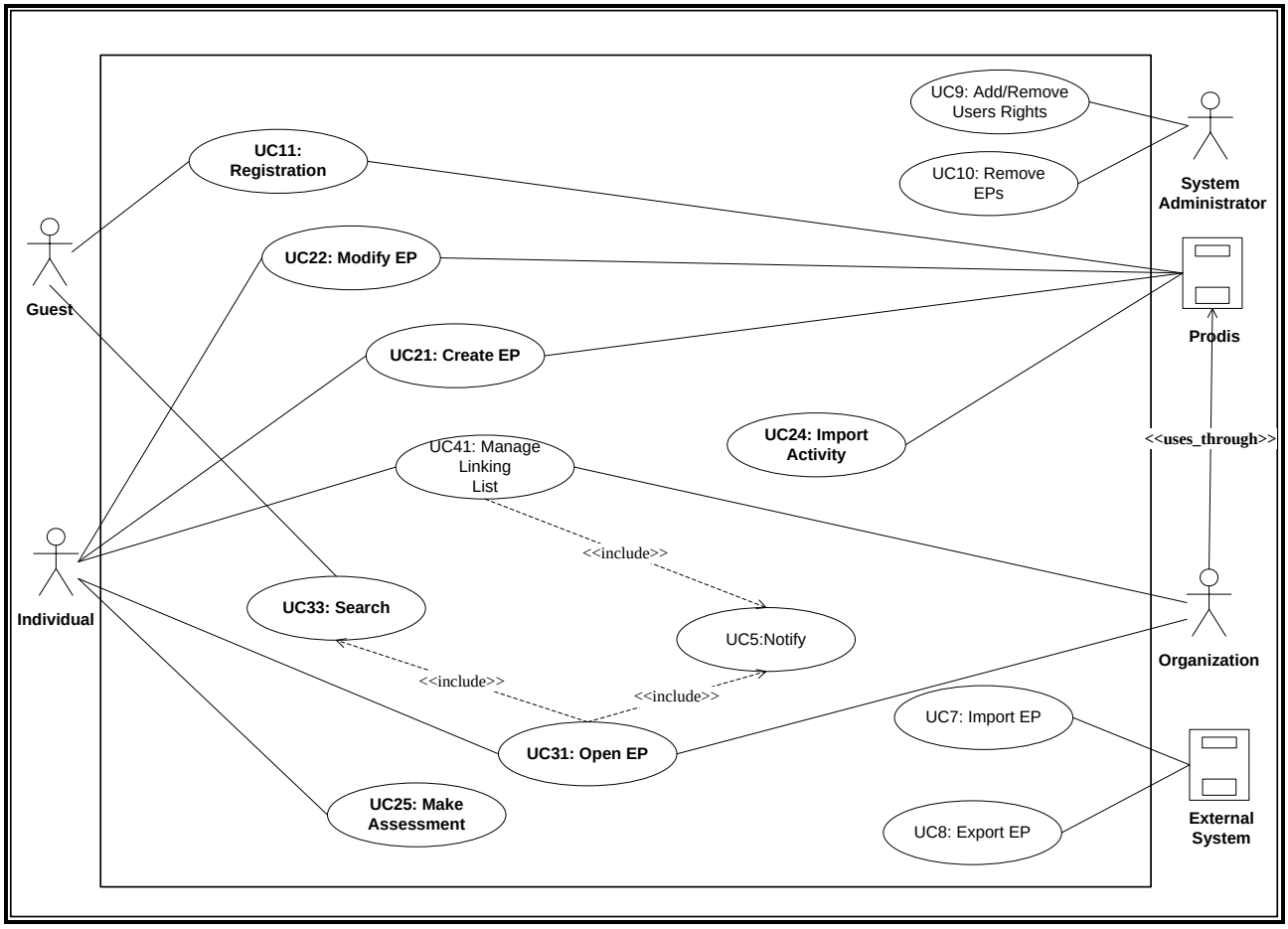


***Figure 10: System Boundary Model for the E-Portfolio system***

The relationships stereotyped with *«include»* in the System Boundary Model of *Figure 10*, indicate that the behavior of the pointed use case is included in at least one scenario of the pointing use case.

The use cases have different priorities. The use cases with the highest priority have to be realized by the first version of the E-Portfolio system. These use cases are those shown in bold in *Figure 10*.

The prioritization of the use cases is made according to the system stakeholders and the goals they fulfil. The identified use cases for the E-Portfolio system are divided in those that are directly linked to the business goals identified in the Goal Model of *section 4.2*, defining the main functionalities

of the system, and those whose goals are not linked to those of the Goal Model, that define extra functionalities IBLC Group wants the E-Portfolio system to exhibit. Indeed, the use cases that define the main functionalities of the system have higher priority than those defining the extra functionalities. The only exceptions are the *UC11:Registration* and *UC33: Search* use cases that, although not linked to any business goal identified in the Goal Model of *section 4.2*, define main functionalities of the E-Portfolio system.

In order to better understand the meaning of the main use cases they are briefly described, along with their corresponding goals, in *Table 10*. A detailed description of each E-Portfolio system use case, along with the identified scenarios, according to the COMET template, can be found in *Appendix D*. The use cases are presented according to the subsystem grouping made during the Reference Architecture Analysis as presented in *section 4.6*.

The use cases do not detail the interaction of the actors with the E-Portfolio system graphical user interface (GUI), focusing instead on its business functionalities. The graphical part of the E-Portfolio system Web Interface is not going to be developed by IBLC Group. An external company, Yiller.com, which belongs to IBLC community, is responsible for the development of the graphical interface as well as for the commercialization of the E-Portfolio product.

### 4.4.2 Use Case Scenario Model

The Use Case Scenario Model describes the flow of users' actions, related to the use cases identified and modelled in the System Boundary Model. The COMET methodology uses a use case template as the baseline for developing the Use Case Scenario Model.

Each use case is covered by a set of main scenarios where the related actors are most likely to be involved with. Modelling all the possible use cases' scenarios would make the model too cumbersome for the stakeholders to understand and might constrain the flexibility of the system's design phase [5].

In *Table 9* is shown the use case scenario according to COMET template, used for the main scenario of the Registration use case. The main scenario refers to the case when a Guest actor is already an IBLC community partner.

| ***UC 11*** | ***Registration*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Involve Guest in the KW trading business | |
| **Actors** | Guest (initiating), Prodis (involved) | |
| **Pre-conditions** | Guest not already registered in the E-Portfolio system but already IBLC Community partner | |
| **Post-conditions** | Guest registered as E-Portfolio system Individual actor | |
| **Description** | Step | Action |
| | 1 | Fill-in the registration form with IBLC community identification data |
| | 2 | Submit the registration form |
| | 3 | Receive registration to E-Portfolio system confirmation (KW trading account enabled). The identification data for E-Portfolio system are the same as IBLC community |

***Table 9: Registration use case Main Scenario***

In the use case scenario the actor's flow of actions refers to the E-Portfolio system as a *black box*. That means the actors' interactions with the system, including system responses, are as perceived from outside the boundaries of the system without dealing with its internals. Qualitative aspects of the E-Portfolio system specific for certain use cases are discussed in textual form for each scenario in order to be taken into account during the Reference Architecture Analysis, described in *section 4.6*. Other qualitative aspects, global for the whole system, are discussed in *section 4.5*.

| Identifier | Name | Goal(s) | Description |
|---|---|---|---|
| **MAIN FUNCTIONALITIES** | | | |
| *UC11* | *Registration* | To involve Guest in the KW trading business | Leads to the registration of a Guest user to the E-Portfolio system as Individual, in order to get involved in the KW trading business. |
| *UC21* | *Create EP* | G7: Provide qualitative EPs;<br>G3 : Enable knowledge development planning;<br>G11 : Proper KW professional information privacy measures | Leads to the successful creation of an EP by an Individual actor in order to put him/herself within the KW trading market as EP provider. |
| *UC22* | *Modify EP* | Keep the EP up-to-date;<br>G7: Provide qualitative EPs;<br>G3 : Enable knowledge development planning;<br>G11 : Proper KW professional information privacy | Leads to modification made to an EP by its owner |
| *UC33* | *Search* | Retrieve E-Portfolio users | Leads to the retrieval of E-Portfolio system users or EPs according to a set of criteria chosen by a requesting party (Individual, Organization or Guest) |
| *UC31* | *Open EP* | Access information stored on a third party EP;<br>G4 : Support recruitment and LP trading business (pull basis);<br>G5 : Support personal tutoring; | Leads to the delivery of the information stored in a set of EPs to E-Portfolio system users different than their owners |
| *UC25* | *Make Assessment* | G8 : Enable third-parties Assessment of KWs | Leads to the assessment of a specific set of activities belonging to an EP made by E-Portfolio system users different than its owner |
| *UC24* | *Import Activity* | G9 : EPs automatic update | Leads to the add of an LP booking transaction made by an Individual actor, in the scope of the LP trading business, to his/her PP as activity |
| **EXTRA FUNCTIONALITIES** | | | |
| *UC41* | *Manage Linking List* | Create link with other E-Portfolio system users | Leads to the creation/removal of a professional link between two E-Portfolio users. |
| *UC34* | *Manage EP Catalogue* | Save interesting EP owners | Leads to the add/removal of a set of EP owners to/from the PP Catalogue belonging to an Individual actor |

***Table 10: Main Use Cases of the E-Portfolio system***

## 4.5 Non-functional Requirements

This section introduces the non-functional requirements global for the E-Portfolio system not embraced by the Use Case Model. The non-functional requirements for the E-Portfolio system are identified and formulated according to [12].

### 4.5.1 Security

The E-Portfolio system has to be secured from unauthorized access performed by both external and internal entities. The EPs contain information that are extremely confidential and their unauthorized access might prejudice the privacy of the individuals that own the EPs. For this reason the E-Portfolio system must protect private information in accordance with the relevant privacy laws as described in IBLC Group's information policy.

| **Publication** |
|---|
| Publishing an EP basically means to make it retrievable by other E-Portfolio system users. If the status of an EP is not published, the Individual actor will not result as EP owner for other users. When an EP is published its content can be matched against search criteria.<br><br>The *other professional information* section of an EP follows the publication of the whole EP. If an EP is published its owner should be able to choose, for each activity, whether to be published or not. A published activity is available to provide a match against search criteria. A not published activity cannot be matched against search criteria. |
| **Authorization** |
| Authorization refers to privileges issued by the EP owner to other E-Portfolio system users to perform operation on the EP. The EP owner has the right to decide which and by whom the information contained in the EPs can be opened and assessed. The authorization can be set for the whole EP or for each of its section.<br><br>Account information and other professional information can just be opened. The activities can be opened, assessed and verified.<br><br>In the case the EP owner, for a specific set of E-Portfolio users, decides that his/her EP cannot be opened, all of the EP sections cannot be opened. If the EP owner, instead, wants to give opening privileges to his/her EP, can specify for each section whether it can be opened or not and in the case of the activities, whether they can be assessed. By default if the EP can be opened, all the three sections can be opened, but the activities cannot be assessed.<br><br>The authorization can be released by the EP owner in two different ways: upon request or a priori. The two ways are not mutually exclusive. That means on the same EP both of them might be applied at the same time.<br><br>If the authorization upon request is applied, every time an EP consumer wants to open an EP, the EP owner is notified and decides whether or not to release the authorization to the requesting party. The authorization upon request is applied by default.<br><br>The EP owner might also issue a priori authorization privileges to a specific set of other E-Portfolio system's users for a specific set of operations. The set of users can be selected one by one or for categories ( i.e. Individual or Organization actors or through linking relationships). |

***Table 11: Privacy and Authorization measures for the E-Portfolio system***

In order to guarantee the confidentiality of the individual actors' information among E-Portfolio system's users, the system should realize a set of authorization measures to prevent not authorized access to both EPs and account information. For the whole EP and/or separately for each section,

the EP owner must be able to set measures to guarantee confidentiality. These measures are divided in authorization and publication and are described as shown in *Table 11*. The confidentiality policy of IBLC Group for E-Portfolio system might be subject to changes during the system's lifecycle, therefore the system has to be able to bear such changes without influencing its functionalities.

### 4.5.2 Usability

In order to guarantee the usability of the E-Portfolio system by potentially every individual user, it has to interface with its human actors through the most commercially diffused Web Browsers: Internet Explorer, Mozilla, Opera and Chrome. Therefore the GUI has to conform to W3C standards.

### 4.5.3 Development Constraint

The E-Portfolio system has to be developed by using .NET technologies, in order to ease the integration with Prodis and to conform to the development team experience.

### 4.5.4 Performance

The performance requirements in order to be firmly determined require a system's operating prototype. As already introduced in *section 2.3* the development of an E-Portfolio system's operating prototype falls outside the scope of this graduation project. Hence, the performance requirements expressed by the E-Portfolio system stakeholder IT Manager are to be considered as the initial set to be to be taken into account during the design phase. These performance requirements are mainly based on the experience of the general manager on similar interactive systems, and will be refined once an operating prototype is available.

The E-Portfolio system does not have to process big batch jobs. The system has to basically fulfill every end-user's request without a reasonable time. The latency for an end-user (Individual and Organization actors) request it has to be about 1-2 seconds. For requests that take more than 10 seconds an indicators has to notice the end users submitting the request. The indicator however is part of the GUI whose development falls outside the scope of this graduation project.

Estimations about the amount of end users, especially the Individual actors, of the E-Portfolio system have not been made yet. However, the IT Manager does not require the system to bear high throughput periods. The amount of requests from the EP consumers, mainly to open EPs, is most likely to occur during Dutch working hours (9 AM – 6 PM) and with a low frequency (10 requests per hour). The amount of request from the EP providers to create an EP has also an estimated low frequency (10 requests per hour max). The request from the EP providers to update an EP has an even lower estimated frequency (10 requests daily).

## *4.6 Reference Architecture Analysis*

The COMET methodology is use-case driven [9]. That means the design of the architecture is driven by the use cases identified during the analysis phase. The Reference Architecture Analysis is performed in order to reduce the gap between the Domain Models, especially the Use Case Model, and the Architecture Model of the COMET methodology.

The use cases identified in the System Boundary Model are grouped into subsystems. As recommended by [9] there should be few relationships between actors and subsystems and use cases and especially use cases that typically are executed in sequence should be provided by one subsystem. The main subsystem grouping criterion used to conform to this recommendations is based on the role of the system end-users and the use cases defining the main functionalities.

In the E-Portfolio system, the end-users are Individual, Organization and Guest actors. Besides the Guest, the Individual and Organization actors are those that initiate most of the use cases. However a subsystem criterion based just on the actors would have grouped most of the use cases under one *God* subsystem. A clear separation of the functionality of the use cases is given by taking into account the roles of the Individual and Organization actors within the KW trading business, EP provider or EP consumer role. Therefore the biggest use case grouping is made between those whose functionality concerns the role of EP Provider, grouped within the EP Provider Portal, and those whose functionality concerns the role of EP Consumer, grouped within the EP Consumer Portal.

For the remaining use cases the subgrouping is based on the common functionalities (Registration Portal, Linking Editor, Administration Portal and External Services) and those that are not initiated by any human actor (EP Provider services and Notification Services).

Because of the users' oriented nature of the use cases, the component of the E-Portfolio system identified during the Reference Architecture Analysis, are mainly tool components. The lack of overview on the internals of the E-Portfolio system, which is however a good practice during the requirement phase [9], does not allow to fully identify components belonging to the business service and resource service tiers of the 4+2 reference architecture of COMET methodology [9].

The Registration Portal, EP Provider Portal, EP Consumer Portal, Linking Editor, Administration Portal, External Services subsystems are modeled as tool components because they interface with human actors. The EP Provider Services and Notification Services instead are modeled as business service components. All the identified tool components are made available to the E-Portfolio system users through a web browser.

The Guest actor can make use of limited functionalities within the E-Portfolio system defined by the *UC11: Registration* and *UC33: Search*. The Guest actor is the only E-Portfolio system user that uses the *UC11: Registration*, the only use case grouped within the Registration Portal. The *UC33: Search* is instead a functionality that can be used also by EP consumers hence it is grouped within the EP Consumer Portal.

The Organization actor, as already mentioned, uses the E-Portfolio system through Prodis, a system actor. Therefore the Organization actor, although modeled as a direct user of a tool component, the EP Consumer Portal (*Figure 11*), actually can make just use of the business services related to it. This aspect will be better taken under consideration during the design phase.

The Linking Editor is part of the extra functionality of the E-Portfolio system because it groups use cases whose functionality is not linked with the business goals listed in the Goal Model of *section 4.2*.

The uses cases grouped under EP Provider Services have been identified during the development of the Use Case Model but they do not involve any human actor. Although the name might indicate it

is a service that serves just the EP Provider Portal, it groups use cases that serves the Registration Portal and EP Consumer Portal as well.

In the System Boundary Model of *Figure 11* the use cases are grouped into subsystems according to the Reference Architecture Analysis. Each subsystem represents a coarse grained component of the E-Portfolio system architecture, used as a starting point for the design phase. In *Figure 11* for each subsystem secondary use cases not presented in *Figure 10* are also shown.

In this project the subsystems grouping is also used to define the versioning of the E-Portfolio system. Each version of the E-Portfolio system should realize a specific set of subsystems (components) or specific uses cases grouped within a subsystem.

The first version of the E-Portfolio system should realize part of the use cases defining the main functionalities of the system. These use cases are grouped within the Registration Portal, EP Provider Portal and EP Consumer Portal subsystems. For the design of this version of the E-Portfolio system, given the absence of interaction with Prodis, assumptions on the interaction of Organization actors have to be made. These assumptions are stated in *section 5.4.1.*

The second version should realize the interaction with Prodis and the use cases grouped within the EP Provider Services, Notification Services and Administration Portal.

The third version should realize use cases and functionalities grouped within the Linking Editor.

The fourth version will enable the interaction with External Systems. The development of this version is linked to the realization of standards of communication between the E-Portfolio systems and the External systems willing to exchange information.

In this project the architecture of the E-Portfolio system is designed in detail for the first and part of the second versions of the system.

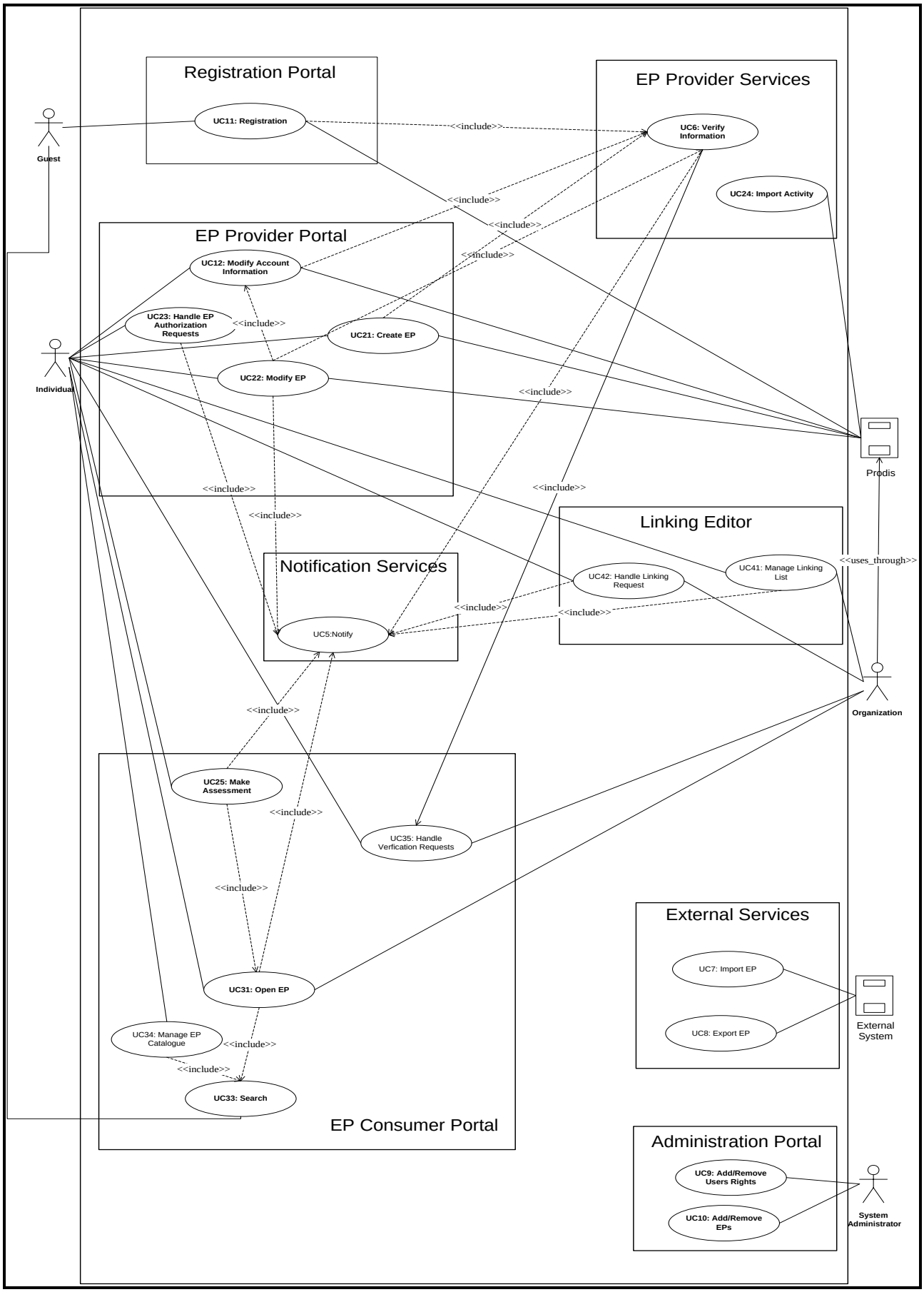


*Figure 11: Boundary Model for the E-Portfolio system (Subsystem Grouping)*

For each version of the E-Portfolio system, along with the subsystems identified during the Reference Architecture Analysis, components from the other layers (4+2 tiers) needed for the realization of the uses cases are designed and developed. The Reference Architecture Analysis produced an UML Component diagram based on the Boundary Control Entity (BCE) pattern for the use case realization. The component diagram, to be used as input for the Design phase, is as shown in *Figure 12*, according to the Component Structure Model prescribed by COMET.

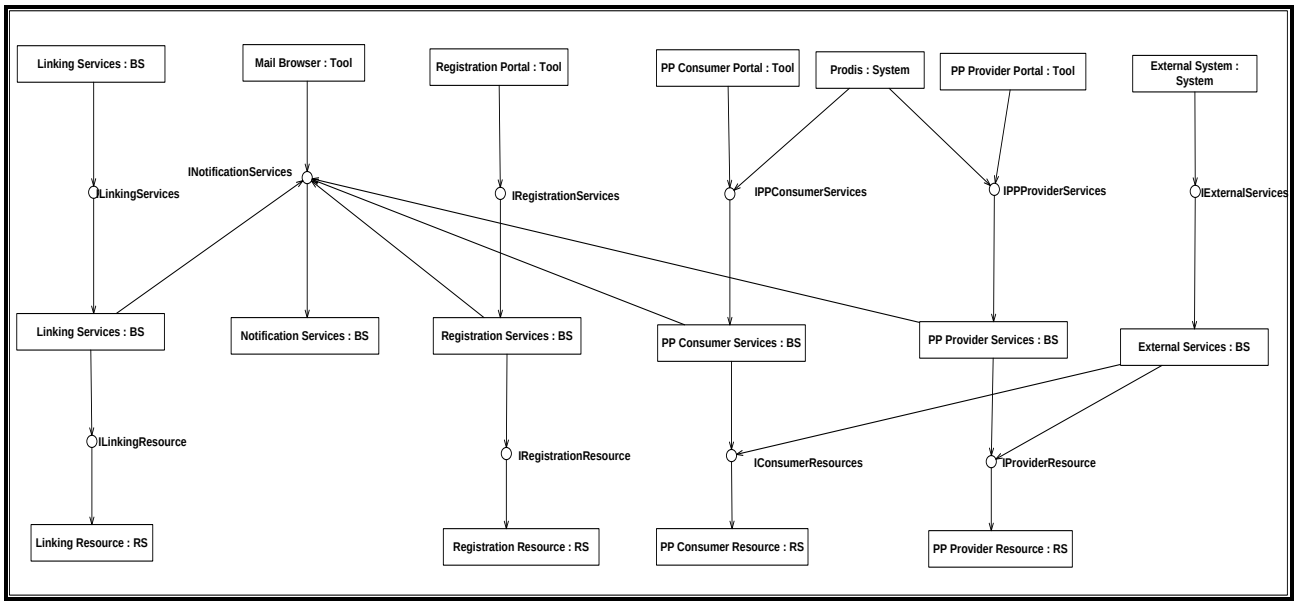


***Figure 12: Component Diagram for the E-Portfolio system (Reference Architecture Analysis)***

# 5. Design

This chapter presents the results of the Design phase. During the Design phase the actual candidate IT architecture for the E-Portfolio system is designed. The IT architecture is described by using the COMET Architecture Model and it is based on the COMET Business Domain Model created during the Analysis phase. Some of the models are presented in this chapter, the others can be found in *Appendix E*.

In this chapter is answered the following research question:

RQ4 *How can the E-Portfolio system requirements be expressed in a software architecture?*

The design phase fully covers the Architecture Definition activity of the ADP for the E-Portfolio system. The architecture is designed by applying the COMET methodology in order to fill the Architecture Model repository describing the candidate architecture for the E-Portfolio system.

The main inputs for the design of the candidate architecture of the E-Portfolio system are the Use Case Model and the Reference Architecture Analysis of COMET. In the chapter are explained and motivated the architectural patterns used and the design decision taken during the Architecture Definition activity.

The deliverables of the design phase are the COMET Architecture Model and the architectural description (AD), limited to the Functional viewpoint [5], of the E-Portfolio system.

## *5.1 COMET Architecture Model*

During the Design phase the components of the candidate architecture for the E-Portfolio system and their related interfaces are designed and described.

The Architecture Model of the COMET methodology [9] consists on a set of models to describe the candidate architecture designed for the E-Portfolio system:

- The *Component Structure Model*, in *section 5.4* describes the high-level components of the E-Portfolio system and their interrelationships by using UML Component diagrams;
- The *Component Interaction Model*, in *section 5.5* describes the interaction between high level components of the E-Portfolio system by using UML Sequence or Collaboration diagrams;
- The *Interface Model*, in *section 5.6* details the E-Portfolio system's component interfaces, i.e. their operations and detailed behaviour, by using UML Class diagrams.
- The *Information Model*, in section 5.6.1 contains the definition of the information that is passed through the operations of each of the identified interfaces, by using UML Class diagrams.

This set of models, which are also part of the architectural description (AD), are the deliverables of the Design phase. As it will be pointed out in the next sections, the Architecture Model is designed

in detail just for a subset of the components identified during the Reference Architecture Analysis in *section 4.6*.

The inputs for the design phase of this graduation project are the Business Domain Models of COMET methodology. The COMET methodology, as already discussed, is use case driven [9], hence the candidate architecture for the E-Portfolio system is designed according to the information captured by the Use Case Model of *section 4.4*. With this approach the candidate architecture for the E-Portfolio system guarantees at least the realization of the use cases identified in the System Boundary Model of *section 4.4.1*.

The gap between the Business Domain Models and the Architecture Model of COMET is reduced during the Reference Architecture Analysis, which provides the initial Component Structure Model as shown in *Figure 12*, and the use cases realizations' responsibility for the Component Interaction Model as in *Figure 11*.

The iterations performed to obtain a candidate architecture for the E-Portfolio system that satisfies the stakeholders requirements, are based on a set of decision and architectural styles adopted in this project to find proper design solutions. The design decisions are made explicit in the sections where the actual Architecture Model is described. The architectural styles used are listed and described in *section 5.3*.

## 5.2 Architectural Description (AD)

The Architecture Model of the COMET methodology documents some aspects listed in the Functional viewpoint belonging to the Viewpoint Catalog presented in [5]. The viewpoints listed in the Viewpoint Catalog compose the Architectural Description for a general software system. The Functional viewpoint is the only viewpoint essential for the AD.

In this graduation project the AD of the E-Portfolio system is limited to the Functional viewpoint. The Functional viewpoint of the E-Portfolio system is documented as follows:

- Functional Capabilities and Internal structure, modeled by the COMET Component Structure Model in *section 5.4* and Component Interaction Model in *section 5.5*;
- External Interfaces, modeled by the COMET Component Interaction Model of *section 5.5* and Component Interface Model of *section 5.6*;
- Design philosophy, expressed through a set of design decisions and architectural patterns applied during the Architecture Definition activity.
- Stakeholders concerns, expressed by the Requirements Model of COMET methodology.

According to that, the guidelines suggested by [5] in order to reduce risks of having a Functional viewpoint with poor quality, are applied to the creation of the Architectural Model of COMET methodology in this project. These guidelines can be found in *Appendix E*.

## 5.3 Applied Architectural Styles

For the Architecture Definition activity it is a good practice to identify and use specific architectural styles [5]. Architectural styles, also called architectural patterns, are patterns that can be used to construct software architectures with specific properties [10]. As stated by [10] a pattern deals with a specific, recurring problem in the design or implementation of a software system.

When using architectural styles [5] it emerges the problem to combine different styles for the design of the candidate architecture. The problems are mainly about keeping coherence of the architecture when too many styles are used and avoid conflicts between them. A rule of thumb proposed by [5] and applied in this project, in order not to incur in any of the above listed problems, is to select a prominent architectural style for the system and to structure the candidate architecture around it. Secondary styles are introduced when needed to solve a specific problem that the prominent style cannot address by itself.

The architectural styles are grouped in categories [10] according to common properties they help to support: *From Mud to Structure*, *Distributed Systems*, *Interactive Systems*, *Adaptable Systems*. The COMET methodology already "forces" the usage of a specific architectural style, by providing the *4+2 tier Reference Architecture* as basis to develop its architectural model. The 4+2 tier Reference Architecture can be categorized under the *From Mud to Structure* category. The 4+2 Reference Architecture is applied already during the Reference Architecture Analysis of this project to create an initial Component Structure Model for the E-Portfolio system based on the requirements expressed by the Use Case Model, as described in *section 4.4*.

Moreover, the 4+2 tiers Reference Architecture's tiers are inspired by the *Boundary Control Entity* (BCE) architectural pattern. The BCE pattern is a pattern that belongs under the *Interactive Systems* category, being a variant of *Model View Controller* (MVC) pattern.

In this project the candidate architecture is designed according to a version of the 4 vertical tiers of the Reference Architecture adapted to the BCE pattern as shown in *Table 12*. The User Service Domain of the Reference Architecture, similarly to the Boundary element of the BCE pattern, is considered as a passive element that does not contain business functionality. This decision has been taken because the GUI of the E-Portfolio system is going to be developed by the community partner Yiller.com, and therefore out of the scope of this project.

| BCE Pattern | 4+2 Reference Architecture |
|---|---|
| **Boundary** | Tool components - User Service Domain (User Interface Tier + User Service Tier) |
| **Control** | Business Service components<br>Other Systems |
| **Entity** | Resource Service components |

***Table 12: Adaptation 4+2 tier Reference Architecture and BCE model***

The other styles applied for the development of the E-Portfolio system are used to satisfy the security quality attribute. In order to secure the system are applied security patterns according to [11]. These patterns are: Single access point, Check-up point, Roles, Session and Limited View. It

is important to notice that these security patterns are used to design components that are common for many systems and not specific to the functionality of E-Portfolio system.

## 5.4 Component Structure Model

The purpose of the Component Structure Model is to understand and describe the components that together build up the E-Portfolio system, the dependencies between the components, the interfaces they offer, and their use/access of other components through their interfaces.

The Component Structure Model should document:

- The software (and hardware) architecture represented by the components that comprise the product. The purpose of a system architecture specification is to subdivide the system into comprehensible units that represent meaningful groupings (according to Reference Architecture Analysis);

- The dependencies between components, and the interfaces realised and required by them.

The Component Structure Model for the E-Portfolio system has been designed starting from the UML Component diagram obtained during the Reference Architecture Analysis as shown in *Figure 12*. Each subsystem identified during the Reference Architecture Analysis corresponds to a component of the initial candidate architecture. The sub-grouping and the UML Component diagram made during the Reference Architecture Analysis also provides the baseline around which the design of the candidate architecture evolves. Although during the design phase some components have been modified, decomposed or joined to other components, the structure obtained from the Reference Architecture Analysis is maintained.

Other inputs for the design of the Component Structure Model are provided by the Component Interaction Model and the Interface Model.

The correspondence between Reference Architecture Analysis subsystems, relatively to tool and business service components, and the components of the Component Structure Model is as shown in *Table 13*. The Component Structure Model for this graduation project is designed in detail for the components highlined in grey in *Table 13*, those needed to realize use cases that define main functionalities for the E-Portfolio system, as listed in *Table 10*.

| Reference Architecture | Component Structure Model |
|---|---|
| EP Provider Portal : Tool | EP Provider Portal : Tool |
| EP Consumer Portal : Tool | EP Consumer Portal : Tool |
| Registration Portal : Tool | Registration Portal : Tool |
| Linking Editor : Tool | Linking Editor : Tool |
| Administration Portal : Tool | Administration Portal : Tool |
| EP Provider Services : BS<br>EP Consumer Services : BS<br>External System Services : BS | Verification Services : BS;<br>EP Services : BS;<br>Authorization Services : BS |
| Registration Services : BS | Registration Services : BS |
| Linking Services : BS | Linking Services : BS |
| Notification Services : BS | Notification Services : BS |

***Table 13: Reference Architecture – Component Structure Model mapping***

In the Component Structure Model for the E-Portfolio system, the tool components, through which the human actors can interact with the system's internal in order to perform a specific use case, are the same as those identified during the analysis phase. During the design phase, with a better overview on the system internal, the business and resource service components identified during the Reference Architecture Analysis are re-designed according to specific design decisions. For instance EP Provider Services, EP Consumer Services and External System Services components had overlapping functionality. They have been restructured into three new components that have no overlap and a better definition of their responsibilities. This decision is better detailed in *section 5.4.1*.

Other design decisions are made explicit and motivated in the sub-sections describing the E-Portfolio system components where they are applied. Additional components, not corresponding to Reference Architecture Analysis subsystems, have been designed to realize non-functional requirements (such as security measures), proper interfacing with external systems and Prodis and aspects not critical for the E-Portfolio system functionality (such as the Notification tool component).

In this graduation project the Component Structure Model of E-Portfolio system is composed by a set of models, each of them showing a specific view on the system. This decision has been made not to overload a single model with too many components and to better address the versioning of the system. The Core Model shows the E-Portfolio system main functional components without detailing the interaction with Prodis and external systems. The External Model shows the E-Portfolio system component structure taking into account the components that need to interact with Prodis and external systems.

During the design of the Component Structure Model, according to each component's responsibilities, the operations offered by the components through their interfaces in order to fulfil specific use cases, are identified for each view and the Component Interaction Model and the Interface Model updated accordingly.

### 5.4.1 Core Model

The Core Model is a view on the Component Structure Model showing the main functional components, together with their interfaces, of the E-Portfolio system. The main functional components are those needed to realize the use cases grouped within the Registration Portal, EP Provider Portal and EP Consumer Portal tool components. The Core Model describes the component structure needed to realize the 1st version of the E-Portfolio system.

In this view, not to limit the functionalities of the E-Portfolio system that require interaction with Prodis, are applied the following assumptions:

1. The Organization actors cannot use the system (because they act through Prodis);

2. The E-Portfolio system does not make the Prodis system aware about updates of new users or the EPs stored;

3. At registration there is no distinction between Guest actors already IBLC community partners or not. At registration the Guest has always to provide account information (*UC11: Registration* - Alternative Scenario);

4. The information verification can be done just if no Organization actor is involved;

5. The users use the E-Portfolio system components according to their roles (E-Portfolio system secured).

The Core Model for the E-Portfolio system is as shown in the UML component diagram of *Figure 13*.

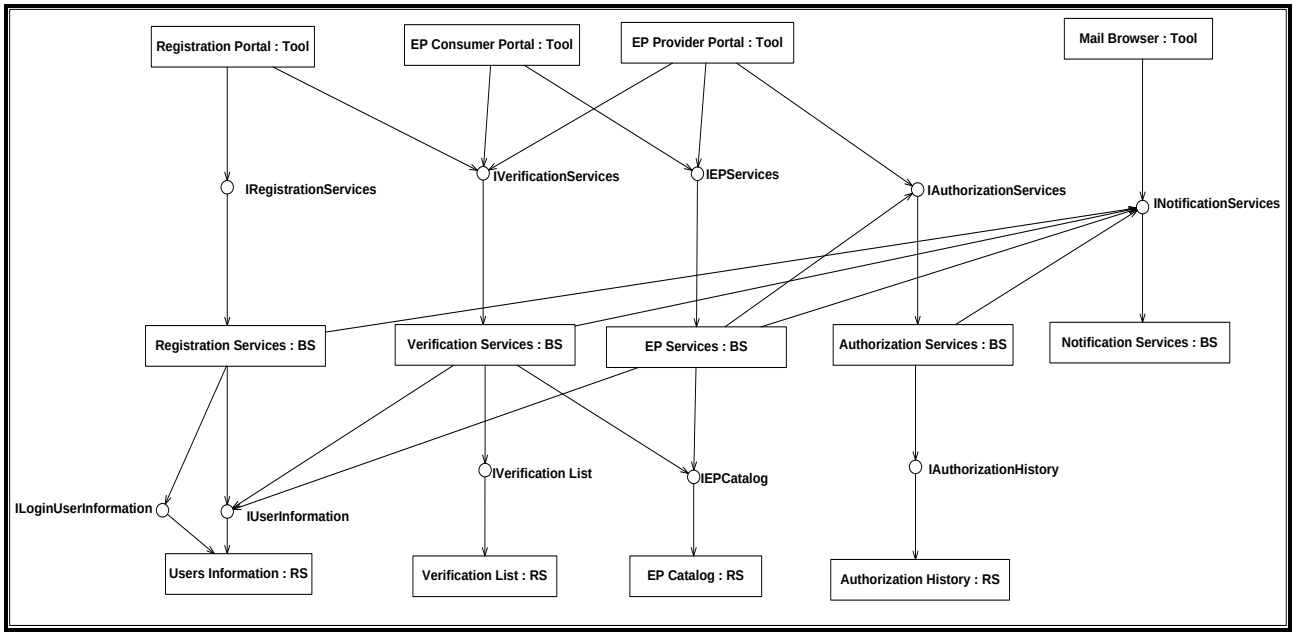


***Figure 13: Core Component Structure Model for the E-Portfolio system***

According to the BCE pattern, the tool components reside on the client side of the E-Portfolio system while the other components reside in the server side of the system. Client and server side communicate over a network.

The identified tool components are intentionally not decomposed into User Interface and User Service components in order to focus the design on the components that provide the business logic. In all the tool components the User Interface is implemented through a web browser and the User Service does not require any local persistency storage. The User Interface design is outside the scope of this graduation project.

During the Reference Architecture Analysis, relatively to this view have been identified three business services components: Registration Services, EP Provider Services and EP Consumer Services. The design decisions that changed the Reference Architecture to the model of *Figure 13* are the following:

- **The Registration Services** business component has been kept as identified during the Reference Architecture Analysis. The Registration Services offers services for the registration of the Guest actors by offering an interface to the Registration Portal. The Registration Services stores the registration data by using the Users Information resource service. The User Information resource service makes available two interfaces. One interface, *ILoginUserInformation* offers operations on login data just to the Registration Portal, in order to preserve the high confidentiality of this information. The other, *IUserInformation* offers operations on the account information and can also be used by other

components.

- **The EP Consumer Services and EP Provider Services** offered much functionality in common. The components offered handling of EPs or account information, in terms of storage and retrieval, respectively to EP Consumer Portal and EP Provider Portal. However the handling of an EP is performed identically by the two components, differing just in the issuing of authorizations: an EP Provider is always allowed to perform any operation on his/her EP while an EP Consumer has to be authorized by the owner of the EP. The EP Provider and EP Consumer components have therefore been merged into a unique component, the EP Services business service, and the authorization issuing responsibilities relocated in the *Authorization Services* business service component.

- **The Verification Services** business component has been designed upon the merging of the EP Provider Services into the EP Services. The EP Provider Services had the responsibility to provide verifications about EPs or account information of the EP Providers. In order to have a separation of responsibilities and concerns between components, the verification functionalities have been relocated to the Verification Services component. The Verification Services' verification request functionality is available just for the EP Providers, through the EP Provider Portal. The EP Consumers, through the EP Consumer Portal, can just use the operations offered by the Verification Services to confirm/deny the truthfulness of the information. Moreover, the Verification Services receives the EP or account information directly from the EP Provider Portal without going through the EP Services. This choice has been taken because the Verification Services needs just to check the not verified information on the EP or in the account information and requests the verification to the involved parties, without handling the EP or having the need for an authorization to be issued.

Another design candidate solution might have been to create just the EP Services component and delegate the responsibilities of Verification Services and Authorization Services to this component. This solution has been discarded because of several drawbacks. The EP Services would have had a high coupling with the other components, becoming a "God Element". The presence of the "God Element" EP Services would have made the system difficult to maintain, overload the component and hinder the possibility to reuse it. With the chosen design solution, as presented in *Figure 13*, any change in verification or authorization policies by IBLC Group would reflect modification on the related components, without affecting the functionality of the others.

This is particularly the case of the Authorization Services, responsible to issue authorization concerning the EPs. Differently, from the authorization requirements described in *section 4.5.1*, guaranteeing 2 dependent layers of authorization (EP and its sections) with 2 possible allowed operations (open and assess) for each E-Portfolio system actor willing to consume an EP, would have made the design and the E-Portfolio's maintenance tasks too cumbersome. Therefore the authorization requirements and the assessment mechanisms have been modified during the design of the architecture, making them less complex. If in the future IBLC Group would like to change or add more complexity on the authorization measures, this choice will just affect the Authorization Service components.

Responsibilities for each business and resource services shown in *Figure 13* are described in *Table 14*.

### 5.4.2 External Model

The External Model is a view on the Component Structure Model showing those business components of the Core Model, together with their interfaces, which communicate with Prodis and external systems. The External Model describes the component structure to be added to the Core Model in order to realize further versions of the E-Portfolio system. The part about Prodis is to realize the 2nd version; the part about the external system contributes to the 4th version.

In the External Model the first 4 assumptions listed for the Core Model, based on the absence of communication between the E-Portfolio system and Prodis, do not apply. The 5th assumption is reformulated as follows:

1. The Prodis and external systems are allowed to use the E-Portfolio system components according to their privileges (E-Portfolio system secured).

The External Model for the E-Portfolio system is as shown in the UML Component diagram of *Figure 14*. It is important to notice that, though the diagram of *Figure 14* might suggest that in the interaction between Prodis or an external system and the E-Portfolio system, there could be a chance to get stuck in a loop (i.e. Prodis calls an operation offered by IRegistrationServices and Registration Services calls an operation offered by IProdis infinitely), this event cannot occur. The E-Portfolio components might call one operation of Prodis, or external system, per time and the response, if any, is given by the return value and not by calling IProdis, or IExternalSystem, operations. This applies also the other way around, namely when Prodis or an external system calls an operation of an E-Portfolio system component interface. The dynamic structure of the system is made clearer in the Component Interaction Model of *section 5.5*.

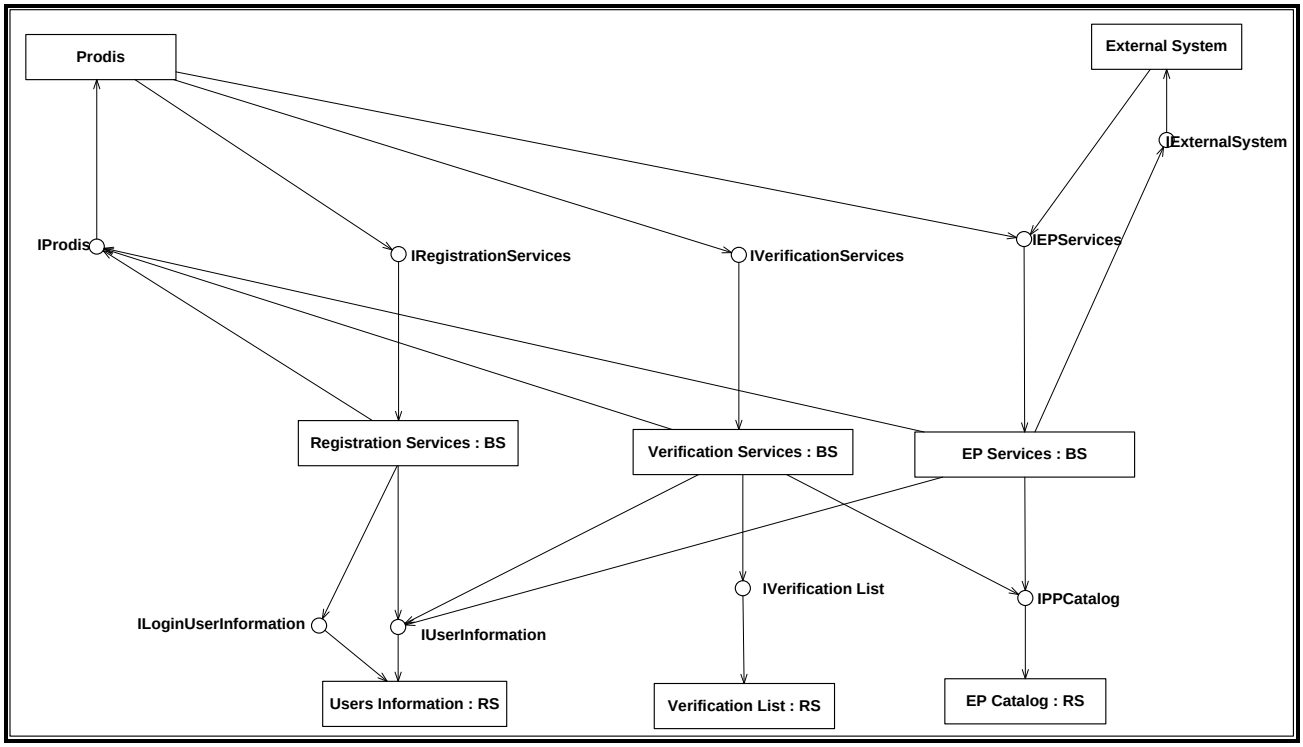


***Figure 14: External Component Structure Model for the E-Portfolio system***

The Prodis system is distinguished by any other external system. As identified in the Use Case Model of *section 4.4*, Prodis uses and offers operations to the E-Portfolio system for the realization

of use cases that differ from any other external system. Therefore the operations that the E-Portfolio system makes available and calls with regards to Prodis are different than those of any other external system.

The communication between the E-Portfolio system and the Prodis system occurs in both ways.
The E-Portfolio system business service components shown in *Figure 14* make available a set of operations, through their interfaces, to Prodis. Similarly the business service components use the interface IProdis that makes available a set of operations for the E-Portfolio system. It is important to underline that the Prodis system is still under development, therefore it is assumed that the IProdis interface and the operations it offers will be realized according to the Prodis system specifications:

The Prodis system uses the interfaces offered by the E-Portfolio system to:

- Allow the Organization actors to use EP Services and Verification Services the same way an Individual actor uses them through the EP Consumer Portal.

- Export to the E-Portfolio system, through the EP Services, LP booking transactions made by an Individual actor, in order to be added to his/her EP as activity (*UC24: Import Activity*).

- Export to the E-Portfolio system, through the Registration Services, account information of new registered Organization partners of IBLC community. This is done to make the E-Portfolio system aware of the Organization partners of IBLC community, in order to authenticate who is using the EP Services and for verification and authorization purposes.

On the other hand the E-Portfolio system components use the IProdis interface to:

- Allow the Registration Services to update the Prodis system with account information of new E-Portfolio system's Individual actors not yet registered to IBLC community (*UC11: Registration* - Alternative Scenario).

- Allow the Registration Services to request account information of IBLC community Individual partners, by providing their IBLC community login data. This is done for the registration of Guest already partner of IBLC community (*UC11: Registration* - Main Scenario).

- Allow the EP Services to update the Prodis system about new EPs or modification on existing ones.

- Allow Verification Services to update the Prodis system about change in information verification status of EPs or account information.

The External System Services business component identified during the Reference Architecture Analysis offered handling of EPs in terms of storage and retrieval for External Systems. As seen in the Core Model, the EP handling functionalities are offered by the EP Services, therefore the External Systems Services have been merged in the EP Services component. Similarly to what happens for a EP Individual Consumer, the issuing of authorization for an external system is responsibility of the Authorization Services component.

The communication between the E-Portfolio system and external systems happens in both ways. As shown in *Figure 14*, the external systems can communicate with the EP Services business service component.

- The external systems use the *IEPServices* to import a specific EP from the E-Portfolio system.

- The EP Services use the *IExternalSystem* to import an EP from an external system.

The import/export of EPs between the E-Portfolio system and external system is based on an authentication policy, yet to be defined by IBLC Group. A robust option is to base the authentication with certificates.

### 5.4.3 Components Description

In this section are described the responsibilities of the business service components identified in the Component Structure Model, both Core Model and External Model. The responsibilities for each business service component are described in *Table 14*.

| E-Portfolio System Component | Responsibility Description |
|---|---|
| ***EP Services*** | • Handle storage and delivery of account information and EPs, or part of them, upon user's request. The storage and delivery requests can be submitted by the EP Provider him/herself and EP Individual consumers through the related tool component and by Prodis (on behalf of EP Organization Consumers) and external systems through the dedicated interfaces. Both storage and delivery requests have to be authorized by the Authorization Services.<br>• Provides search functionality (together with ranking algorithm) for users that want to retrieve both EPs and Individual or Organization users. The search functionality is the only one available for Guest users.<br>• The EPs are stored/retrieved to/from the *EP Catalogue* resource component. The account information is also stored in the *User Information* resource component.<br>• Receives the LP booking transactions from Prodis and add them to the related EPs as activities.<br>• Updates the Prodis system, through its dedicated interface, about new EPs or modification on existing ones. |
| ***Authorization Services*** | • Handle all the authorization requests submitted by the EP Services. The Authorization Services receives the authorization request (i.e. a EP Consumer that wants to open a set of EPs) and checks the *Authorization History* resource service. If the request is authorized, the Authorization Services sends the positive response to the EP Services. Otherwise, unless the authorization is always denied, saves the pending request through the *Authorization History* resource service and sends an authorization request to the EP owner through the *Notification Services* business service.<br>• Upon request submitted through the EP Provider Portal, is responsible to retrieve the authorization list of a specific Individual actor, through the *Authorization History* resource service, and deliver it back to the EP Provider Portal. Based on the response, the component updates the authorization status based on the EP owner response through the *Authorization History* resource service and notifies the parties involved in a pending authorization request. |

| E-Portfolio System Component | Responsibility Description |
|---|---|
| ***Verification Services*** | • Check EPs and account information, submitted by the Individual users through the EP Provider Portal or by an external system, for verification. If there are information not verified that can be verified (i.e. an activity which involves an E-Portfolio system Organization user) the component saves it through the *Verification List* resource service and sends a verification request to the related E-Portfolio system user through the *Notification Services.*<br>• Upon request submitted through the EP Consumer Portal or Prodis, is responsible to retrieve the pending verification request list of a specific user, through the *Verification List* resource service, and deliver it to the EP Consumer Portal or Prodis. Based on E-Portfolio users' response the component updates the verification status of the information through the *Users Information* and *EP Catalog* resource service components. |
| ***Login Services*** | • Guarantees that just authorized users can access the system, specific components and operations. The Login Service is a Single Access Point to the system. Every user present specific credential, login data for human users and certificates for Prodis or external systems. Based on the credential the Login Service business services releases a specific Role and Session with Limited View to the user. The Role and the Session are released to the system users or the external systems, to use the components and operations they are allowed to. The Login Services uses a Check Point to validate the users' login data through the *Users Information* (*ILoginUserInformation* interface) resource service. The Check Point is modelled as a dummy object because the authorization policy of IBLC Group is not established yet. In the case of the Guest actors, not yet registered to the system, it is released a Limited View to use search functionalities of the *EP Services* and the *Registration Services* business service components. |
| ***Registration Services*** | • Register users to the E-Portfolio system and assign them their related role(s). The Registration Services can be accessed by Guests actors through the Registration Portal tool component and by the Prodis system. The component stores the account and login information of the requesting user through the *Users Information* (*ILoginUserInformation* interface) resource service component. To validate the registration, sends registration notifications to the user through the *Notification Services* business service.<br>• The account and login information are provided directly by the user through the Registration Portal or, in the case the user is already an IBLC community partner, by Prodis. In the former case the component also sends the account and login information provided by the use to Prodis (*IProdis* interface). In the latter case the user, through the Registration Portal, provides his/her IBLC community login data. The Registration Services uses these login data to send a request to Prodis (*IProdis* interface) in order to obtain the related account information. In both cases the *KWTrading* attribute (see section 5.6.1) of the registered user is set to "enabled".<br>• Receives from Prodis data about new Organization partners in order to be registered as E-Portfolio system users and stored through the *Users Information* resource service. |
| ***Notification Services*** | • This component responsibility is to deliver notifications to E-Portfolio system's users about requests submitted by *EP Services, Verification Services, Authorization Services, Registration Services, Linking Services* business service components. |

***Table 14: E-Portfolio system business and resource services responsibilities***

*EP Services* and *Verification Services* business services are also responsible to update the *IBLC score* for every EP, based on the amount of verified data and the EP completeness and updating frequency.

The security quality requirement towards the system, as expressed in *section 4.5*, is realized by applying a set of security patterns. All the requests to access the system performed by tool components or external services go through the *Login Services* business service.

## 5.5 Component Interaction Model

The Component Interaction Model offers a dynamic view of the E-Portfolio system, focusing on the collaboration between components for the purpose of offering services. The services the E-Portfolio system has to offer are those needed to fulfill the use cases identified and described in the Use Case Model of *section 4.4*.

Therefore, in this project the Component Interaction Model focuses on describing how the E-Portfolio system components cooperate to realize the use cases identified in the Use Case Model. The realization of each use case is made according to the conceptual scenarios depicted in the Use Case Scenario Model of *section 4.4.2*. This guarantees the preservation of the system structure identified during the Analysis phase.

Besides the Use Case Model the Component Interaction Model needs as input the first version of the Component Structure Model. Through iterations, the Component Iteration Model is refined along with the Component Structure Model, and the components interfaces and their operation identified and documented in the Interface Model. The three set of models have to be indeed consistent with each other.

The interaction between components is described and documented by using UML Sequence Diagrams. Each UML Sequence Diagram describes the realization of a specific use case according to its scenarios. In this project the Component Interaction Model is made for the main use cases belonging to the first two versions of the E-Portfolio system.

The realization of the use cases grouped within the EP Consumer Portal is shown just for the Individual actor. The realization of the same use cases for the Organization actor is easily obtained by replacing the interface of the EP Consumer Portal with the IProdis interface.

According to COMET guidelines [9] and to make the models more readable, the UML Sequence Diagrams do not describe the datatypes of the exchanged messages, with the exception of the return values. A complete specification of the operations and datatypes a component offers through its interface is given in the Interface Model of section 5.6. Moreover, for every diagram it is assumed that the actor has already successfully performed the login procedure and it is recognized by the components according to his/her role and privileges.

The realization of the two use cases identified during the analysis phase as the most important for the E-Portfolio system functionality are presented in this section. The *UC21: Create EP* use case is show in the UML Sequence Diagram of *Figure 15*. The *UC31:Open EP* is shown in *Figure 16*.

UML Sequence Diagrams related to the realization of other use cases can be found in *Appendix E*.

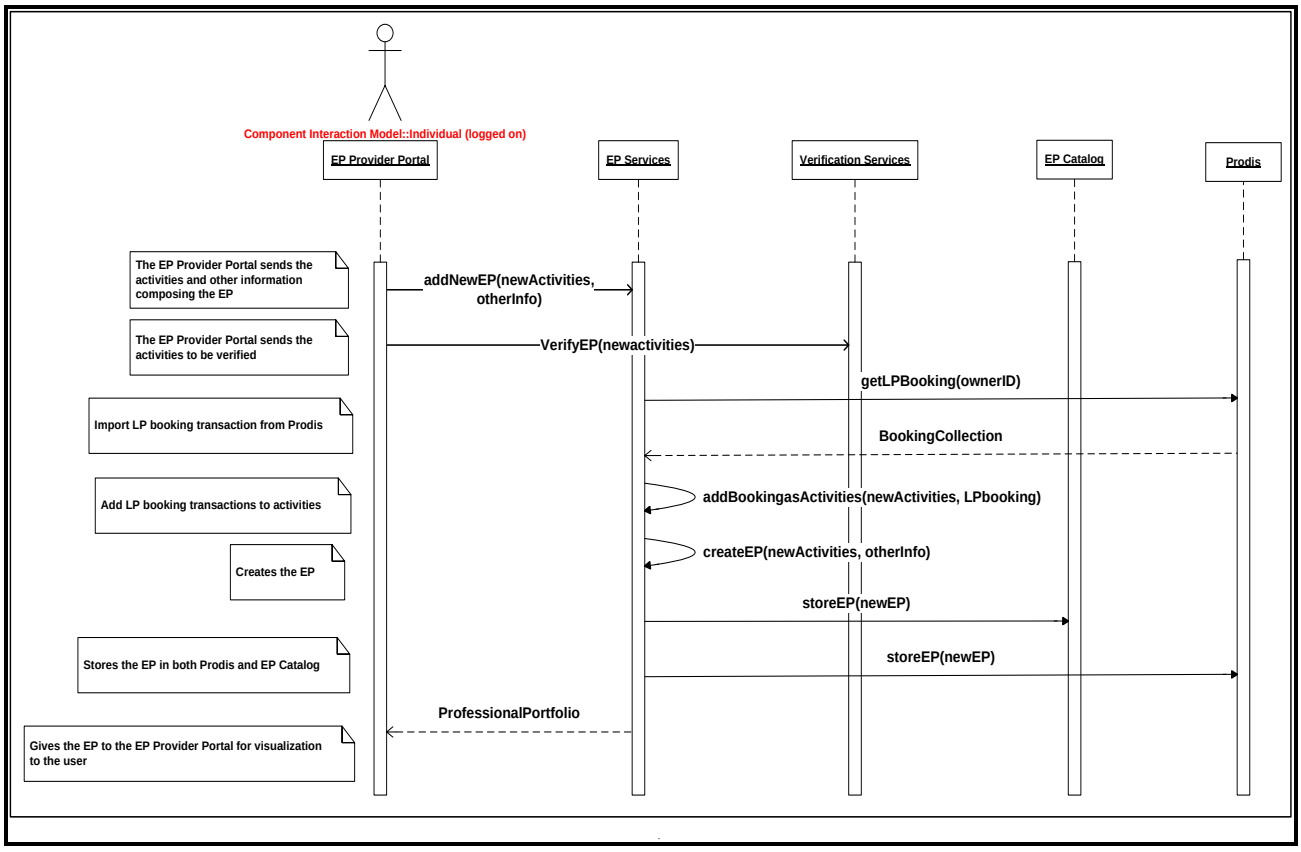


*Figure 15: Component Interaction Model for the UC21: Create EP use case*

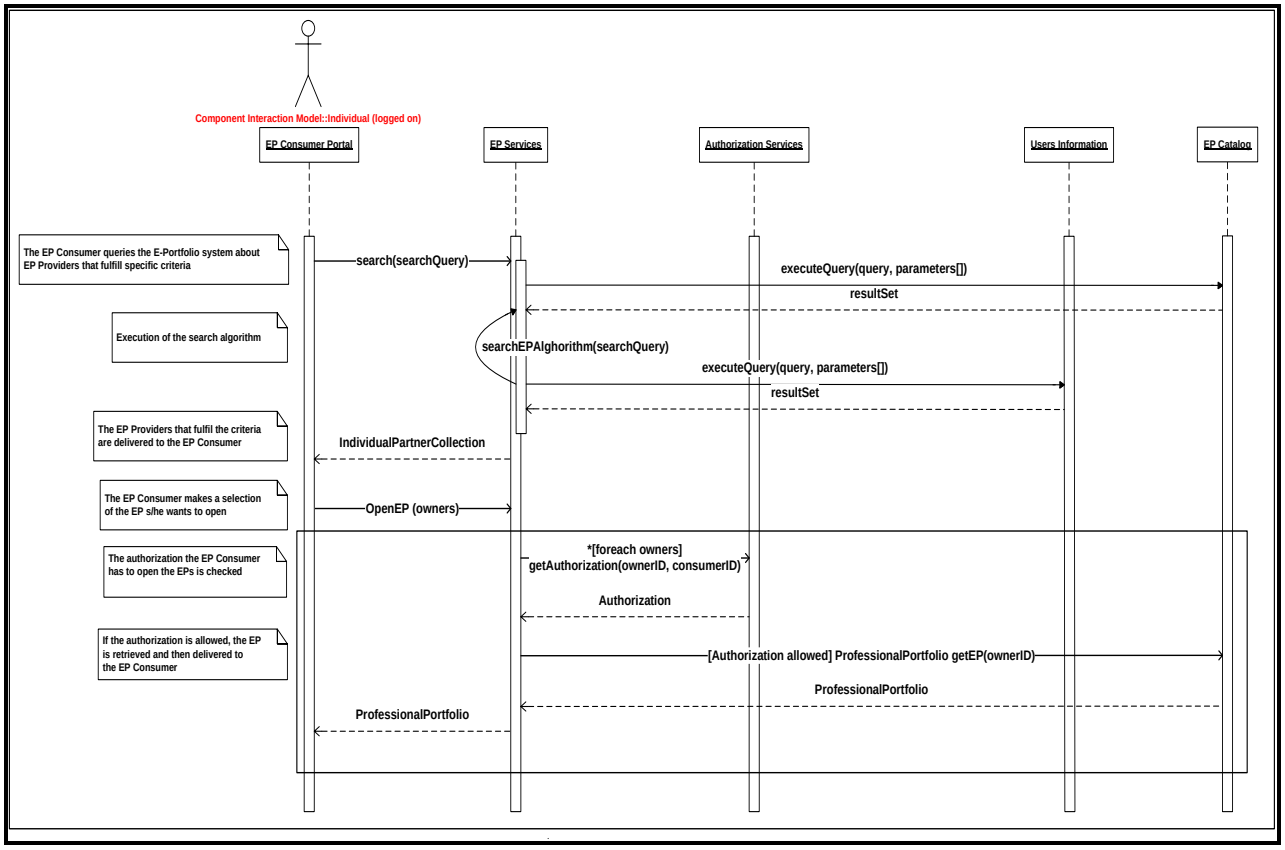


*Figure 16: Component Interaction Model for the UC31: Open EP use case*

In the diagram of *Figure 16* the search algorithm is designed as a black box. That has been decided because IBLC Group, at the time when this project is performed, did not establish yet the parameters upon which a search can be performed and how to calculate the IBLC Score of the EPs that prioritize the results. Moreover a detailed description of the search algorithm is not consistent with the more abstract level of the models designed in this project.

## 5.6 Interface Model

The Interface Model describes the interfaces offered by the components of the E-Portfolio system. Together with details of how components collaborate (from the Component Interaction Model), the Interface Model describes the contracts for components. This includes the interfaces with their operations and protocols. The details of the information passed through an interface are modeled as part of the Information Model in *sub-section 5.6.1*.

The Interface Model in this project specifies the interfaces, with their operations and protocols, offered by the components of the Component Structure Core Model (with the exception of the Notification Services) and Prodis. The interfaces offered by the Resource Service components of the E-Portfolio system are used just to get/store data and therefore they are not of main importance for the description of the business logic.

In *Table 15* it is shown the description of the interface IEPServices. The IEPServices is involved in most of the UML Sequence Diagrams of the Interaction Model that show the realization of the use cases defining the main functionalities of the E-Portfolio system.

| ***IEPServices*** | ***Description*** |
|---|---|
| **Identification** | IEPServices |
| **Purpose** | Supports the operations of EP Providers, EP Consumers and Prodis for the retrieval and handling of EPs and account information. |
| **Operations** | + addNewEP(In newActivities: [*]Activity, In otherInfo: string): ProfessionalPortfolio<br>+ createEP(In newActivities: [*]Activity, In otherInfo: string): ProfessionalPortfolio<br>+ search(In searchQuery: string): [*]IndividualPartner<br>+ searchEPAlghorithm(In searchQuery: string)<br>+ openEP(In owners: [*]IndividualPartner): ProfessionalPortfolio<br>+ getAccountInfo(In partnerID: string): IndividualPartner<br>+ getMembership(In partnerID: string): Membership<br>+ getEP(In partnerID: string): ProfessionalPortfolio<br>+ addAssessment(In assessments: [*]Assessment)<br>+ addBooking(In ownerID: string, In LPbookings: [*]Booking): ProfessionalPortfolio |
| **Scenarios (link)** | *UC12: Modify Account Information*<br>*UC21: Create EP*<br>*UC22: Modify EP*<br>*UC31: Open EP*<br>*UC33: Search*<br>*UC25: Make Assessment*<br>*UC24: Import Activity* |

***Table 15: Interface Model for the IEPServices***

Every operation offered by an interface is specified in a separate table. The createEP operation of the IEPServices interface is specified as in *Table 16*. This is the only operation specified in this project.

| ***createEP*** | ***Description*** |
|---|---|
| **Name** | createEP |
| **Signature** | + createEP(In newActivities: [*]Activity, In otherInfo: string): ProfessionalPortfolio |
| **Input** | newActivities: [*]Activity, otherInfo: string |
| **Return Value** | ProfessionalPortfolio |
| **Pre-Conditions** | EP not existing |
| **Post-Conditions** | The Individual actor has an EP |

***Table 16: Operation Specification for createEP***

### 5.6.1 Information Model

The Information Model is presented as a set of UML Class Diagrams describing the information model for the associated component of the E-Portfolio system that is visible through the operations of each of the identified interfaces.

The information model in this project is created as a subset of the Resource Model of *section 4.3.2*. Every subset embraces all the classes that are involved in the operations offered by a specific interface. The conceptual UML Class Diagram of the Resource Model, suitable for the analysis phase, is refined for the design phase. The refinement does not affect the information identified at analysis phase and data types and default values are added to the attributes of the classes.

In line with the Interface Model, the Information Model is specified for the interfaces offered by four Business Service Components of the Component Structure Core Model (with the exception of the Notification Services).

In *Figure 17* it is shown the Information Model for the IAuthorizationServices interface. The Information Model for this interface is the one that had the most important modifications during the Design phase with respect to the Resource Model. That is because extra classes needed to be added in order to apply security restriction to the access of EPs by EP Consumers.

To model the role-based access by Individual Partner to an EP, it has been applied the *Association Role Solution* [13]. That means an Individual actor can take both EP Provider and EP Consumer roles. The EP Consumer class, in contrast with [13] has been modeled anyway because both Individual and Organization actors can act as EP Consumer. If an EP Consumer wants to open an EP the attribute *Open_Request* of the class Authorization is set to “true”. If an EP Provider invites an EP Consumer to open his/her EP, the attribute *Invitation_Request* of the class *Authorization* is set to “true”. An EP Consumer has right to open an EP if both attributes are set to “true”.

Once the EP is opened the EP Consumer can also assess its activities. Both EP Provider and EP Consumer can decide not to make public an assessment. In order to be public both attributes *PublicConsumer* and *PublicProvider* of the class *Assessment* have to be set to ‘true’.

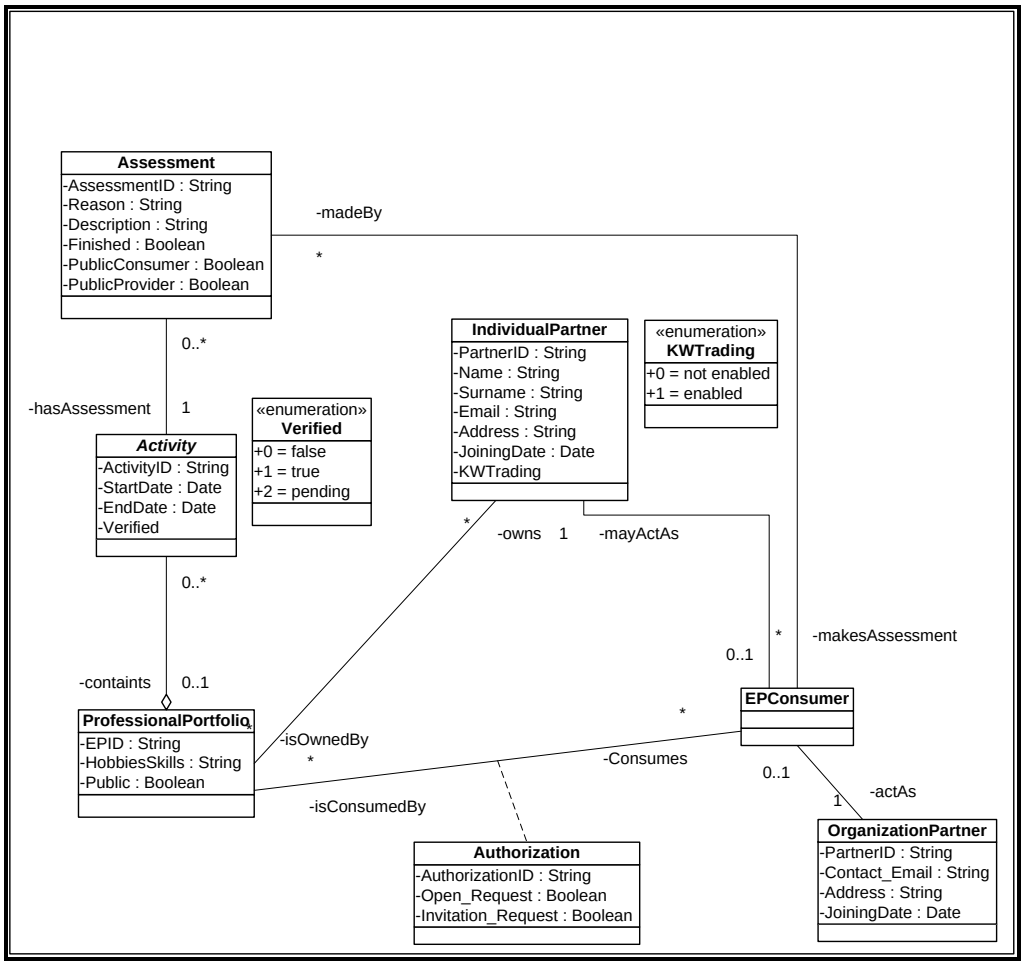


***Figure 17: Information Model for IAuthorizationServices***

# 6. Validation

This chapter presents the results of the Validation phase. The goal of the Validation phase is to assess the candidate architecture for the E-Portfolio system. The evaluation is performed by using the ATAM methodology and it is based on the models created by using the COMET methodology.

In this chapter is answered the following research question:

RQ5 *To what extent does the E-Portfolio system candidate architecture fulfil its objectives?*

The target of the assessment process is the Functional viewpoint of the E-Portfolio system designed during the Architecture Definition phase; components, their interaction and interfaces related to the Core Structure Model of the E-Portfolio system.

The deliverable of the Validation phase is a report that describes the assessment process, its results and recommendations. In this chapter are shown the most important concepts about the assessment process. The full version of this report can be found in *Appendix F*.

## 6.1 Architecture Trade-off Analysis Method (ATAM)

The methodology used for the assessment of the candidate architecture of the E-Portfolio system is ATAM. ATAM stands for Architecture Trade-off Analysis Method. The ATAM gets its name because it not only reveals how well an architecture satisfies particular quality goals (such as performance or modifiability), but it also provides insight into how those quality goals interact with each other, namely how they trade-off against each other [14, 6].

ATAM, in contrast with prototype-based methodologies, does not require the development of a system prototype to perform the assessment. The evaluation of the system is centred on the models produced during the Architecture Definition phase without the need to create a prototype. Moreover, ATAM is proven to be more effective in terms of costs, time and obtained results, than a prototype based methodology [14, 6].

The methodology focuses on the identification of business goals which lead to quality attribute goals that need to be expressed by the architecture. Based upon the quality attribute goals, ATAM is used to analyze how architectural styles aid in the achievement of these goals [14].

ATAM produces analysis commensurate with the level of detail of the architectural specification. Furthermore it need not produce detailed analyses of any measurable quality attribute of a system (such as latency or mean time to failure) to be successful. Instead, success is achieved by identifying *trends* [14].

The ATAM assessment is based on four phases: *Presentation*, *Investigation & Analysis*, *Testing* and *Reporting*. Each phase is composed by a number of steps. In total there are nine steps: three for Presentation, three for Investigation & Analysis, two for Testing and one for Reporting.

The ATAM assessment involves a set of actors. These actors are divided in three different groups: *Evaluation team*, *Project decision makers* and *Architecture stakeholders*. Each of these groups has a different position towards the system and therefore each of them gives a different contribution to the assessment.

ATAM is structured in order to be applied for the assessment of systems of any size and complexity. In the next section it is described how the ATAM has been applied in this project, for the assessment of the candidate architecture for the E-Portfolio system.

## 6.2 Assessment Process

This section describes how the ATAM has been applied to this graduation project. First are introduced the factors that shaped the assessment process. Then in the two subsections are described actors and phases, as prescribed by ATAM, performed in order to assess the candidate architecture of the E-Portfolio system.

The application of the ATAM methodology to this project has been driven by the following factors:

1. The methodology used for the ADP;
2. The viewpoint used for the design of the candidate architecture;
3. The size of the company;
4. The availability of project's stakeholders.

The ATAM-based assessment process is based on a set of predefined phases which involve a set of actors, the assessment participants, in order to produce outputs, the assessment results. Both phases and actors have been tailored for this project but keeping the structure prescribed by the ATAM methodology.

The focus of ATAM on the quality attribute requirements, requires to have a characterization for each quality attribute. In this project the quality attributes have been characterized according to [12] as shown in *section 4.5*. Hence, to preserve consistency, this characterization also applies for the ATAM assessment.

In the following two subsections are described, respectively the assessment participants and the phases of the assessment process. In each section it is first given a brief summary about the ATAM guidelines and then how they have been applied to this project.

### 6.2.1 Assessment Participants

The actors of the assessment process are divided in three different groups: *Evaluation team*, *Project decision makers* and *Architecture stakeholders*.

In this project, given the small size of both company and target system and the overlapping between *Architecture Stakeholders* and *Project decision makers* groups, the actors of the assessment process are divided in two groups: one group accounting the people internal to the project and another accounting people external to the project. The evaluation participants are 4 in total, 2 internal to the project and 2 external. The absence of defined departmental boundaries makes all the actors already acquainted with each other.

The group that accounts people internal to the project is composed by the IT Manager and the General Manager of IBLC Group. Both of them are *Architecture stakeholders* as well as *Project decision makers*.

The group accounting people external to the project is composed by an employee of the Operation function of IBLC Group, which has occasional duties on the IT Development function and therefore familiar with some IT concepts and an employee of the Marketing function which is also cooperating with the General Manager for the Business Development function. This group is considered as the *Evaluation team.*

### 6.2.2 Assessment Phases

The ATAM assessment is based on four phases: Presentation, Investigation & Analysis, Testing and Reporting. The four phases are preceded by an assessment preparation phase, hereby called phase 0.

Phase 0 basically concerns about selecting the evaluation participants, notify them about the details of the meeting (time, place, reasons of the meeting) and get their attendance confirmation.

The first three phases, Presentation, Investigation & Analysis and Testing are the core phases of the assessment process. ATAM prescribes to perform these phases in two different days.

In this project, given the small size of system and evaluation participants group, these phases have been performed in a single day. Therefore they have been merged into a unique phase hereby called *Evaluation phase*. The Evaluation phase consisted in a meeting of the total duration of 2 hours and a half, carried on in a single day. During the meeting a presentation, which gives all the details needed for the evaluation, is held followed by two brainstorming sessions. The Evaluation phase is detailed in *section 6.3*.

In the last phase, Reporting, the results of the Evaluation phase are analysed and re-written in a report by the IT architect and presented to the E-Portfolio system's stakeholders. The results are used to suggest recommendations for the candidate architecture of the E-Portfolio system. The results of the assessment are presented in *section 6.4*.

## *6.3 The Evaluation Phase*

The Evaluation Phase consists on a meeting with the evaluation participants. During the Evaluation phase the architecture, its business drivers and context are presented to the evaluation participants. The evaluation participants, based on the information presented, during the brainstorming sessions investigate and analyse the architecture with respect to its business drivers and provide their feedback. The feedback is then elaborated by the IT architect and used to formulate the results of the assessment phase.

Hereby the list of the Evaluation phase's steps is given and described as they have been applied to this graduation project:

1. **Present the concept of the IT architecture**: The *Evaluation Team* is not familiar with the concept of IT architecture. Hence, a brief presentation concerning the main concepts of IT architecture is given, in order to reduce the risk of misunderstanding the subject of the assessment.

2. **Present the ATAM**: The ATAM methodology and the steps for this project are presented to the evaluation participants.

3. **Present the business drivers:** In this step the context underneath the architecture and the business drivers for the E-Portfolio system are presented to the participants. The COMET Domain Models are used to present the business drivers. The Goal Model of *section 4.2* is used to show a hierarchical representation of the business goals for the E-Portfolio system. The Context Diagram of *section 4.1.1* to present the system stakeholders and their interests towards the system. The Resource Model of *section 4.3.2* to identify the business resources relevant for the system's domain. The Use Case Model of *section 4.4*, relatively to the main use cases, to present the functionality requested by the system's actors. The Non-functional requirements of *section 4.5* to identify the major attribute qualities that shape the architecture. The Use Case Scenarios related to the Use Case Model are not presented in this phase in order not to bias the results of *step 5*.

4. **Present the Architecture (part1):** In this step the candidate architecture is presented to the participants, with a focus on the quality attributes. The static structure of the architecture is presented by using the Component Structure Model of *section 5.4*, where the patterns used to design particular qualities, such as security, are pointed out and motivated. The Component Structure Model used in the presentation is about the part of the architecture fully designed, the Core Model. Each component's responsibility and functionality is explained. The interfaces between the components have been ignored because they increased the difficulty of understanding the relationships between components by three out of four participants.

5. **Generate Quality Attribute Utility Tree (QAUT):** The evaluation participants, based on the information gathered on the first 4 steps, generate a QAUT. The quality attributes are identified, discussed, prioritized and refined. For the high priority attributes it is created a scenario to check whether the candidate architecture supports it or not. Those that are not supported, are discussed in order to assess how they can be supported by the architecture, their difficulty of implementation and the risks associated to their failure to be implemented.

6. **Present the Architecture (part 2):** In this step are presented the main scenarios, and the related quality attributes, the architecture supports. The scenarios are presented by using the COMET Use Case Scenario Model of *section 4.4.2* and their achievement shown by using the relationships between elements in the Component Structure Model. The Interaction Model has not been used because is really complex to be understood by the *Evaluation Team*. The target use cases for the analyses were the *UC21: Create EP* and the *UC31: Open EP*.

7. **Brainstorm and prioritize Scenarios**: In this last step the two use cases presented in the previous step are taken under analysis to discover new scenarios not covered by the architecture, in order to discover pitfalls in both quality and functionality. Eventually the QAUT is updated with new scenarios and quality attributes.

The results of the Evaluation phase, and the related suggested changes in the architecture, are shown in the next section.

## 6.4 Results and Recommendations

The *Evaluation phase* produced a set of results that have been collected and rewritten during the last phase of the Assessment process, the Reporting phase.

The results are summarized by the QAUT as shown in *Figure 18*. The first version of the QAUT is the output of *step 5*, the final version of the QAUT, as shown in Figure 18, is the refined after *step 7*. The QAUT is divided in three sections.

The first section, Quality, refers to the quality attributes, characterized according to [12], identified by the assessment participants. The second section, Refinements, refers to the specification, made during a brainstorming session, of the quality attributes according to how they should be expressed by the candidate architecture of the E-Portfolio system. The third section refers to the scenarios the candidate architecture must support in order to express the quality attribute as listed in the Refinement section.

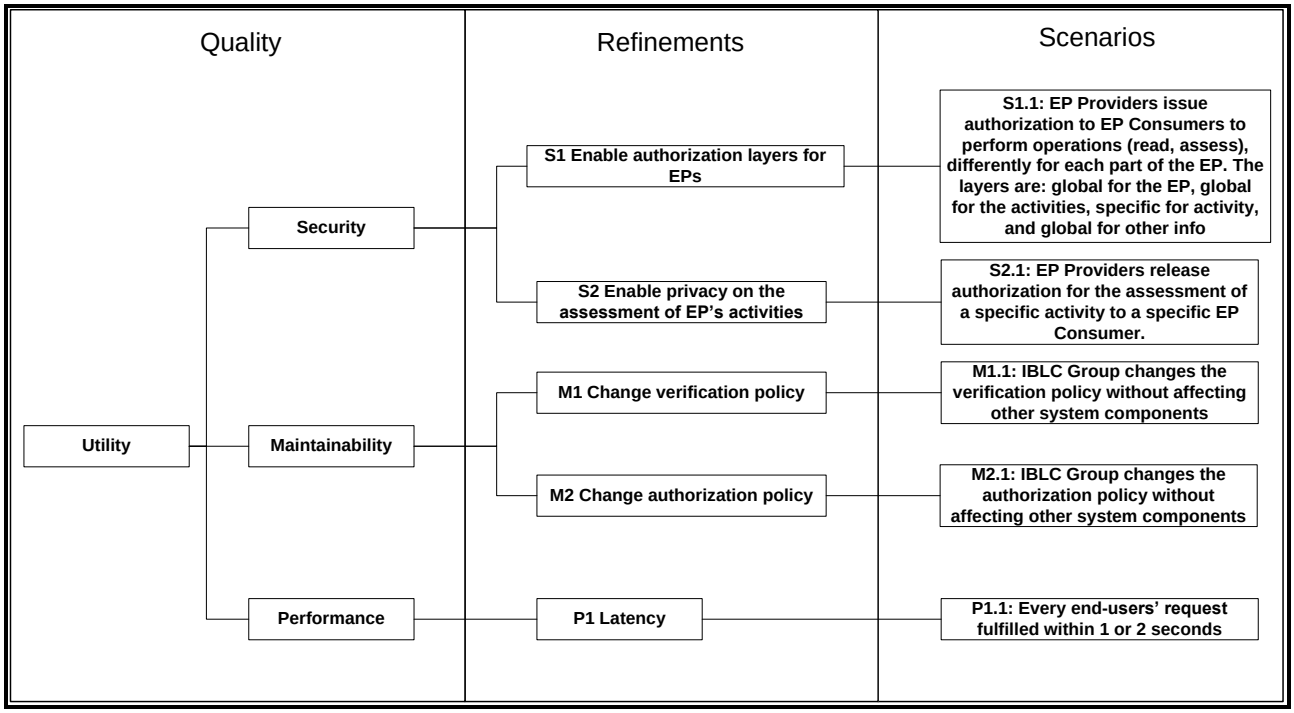


***Figure 18: ATAM Quality Attribute Utility Tree***

The evaluation participants showed a strong focus especially for the security quality attribute of the E-Portfolio system. From an end-user viewpoint the security is considered an important aspect because of the confidential information an EP might contain. Consequently, for IBLC Group, the security of the E-Portfolio system is of utmost importance to push the end-users, especially the EP providers, to use the system in order to achieve the business goals as shown in the Goal Model of *section 4.2*.

The support of each scenario of *Figure 18* by the candidate architecture puts in a trade-off the quality attribute linked to the scenario with the others. Therefore the candidate architecture, by supporting a specific scenario, incurs in a set of risks linked to the trade-off between its quality attributes.

Some trade-offs are linked to the set of design decision taken during the architecture definition activity, creating discrepancies between what is stated in the business drivers and what the candidate architecture expresses instead.

This is the case of *S1.1* and *S2.1* scenarios, which are not supported by the candidate architecture. The trade-off between their quality attributes and the associated risks are presented and described in *Table 17* below. The goals listed in the table refer to the Goal Model in *section 4.2*.

| | |
|---|---|
| *Scenarios* | *S1.1:* EP Providers issue authorization to EP Consumers to perform operations (read, assess), differently for each part of the EP. The layers are: global for the EP, global for the activities, specific for activity, and global for other info.<br><br>*S2.1:* EP Providers release authorization for the assessment of a specific activity to a specific EP Consumer. |
| *Trade-offs* | *T1:* Security, Maintainability |
| *Risks* | *R1:* Failure to achieve *G11 : Proper KW professional information privacy measures* and *G8 : Enable third-parties Assessment of EPs activities* business goals.<br><br>*R2:* Too complex E-Portfolio system maintenance tasks. |
| *Description* | *Security (+)*: The candidate architecture for the E-Portfolio system does not provide the security measures as described in Non-functional requirements of *section 4.5*. This places at risk the achievement of the *G11 : Proper KW professional information privacy measures* business goal. The layering of the authorization (EP and its subsections) is believed to be of great importance for the EP Providers. An EP Provider cannot choose who can access the activities but it is just linked with the access to his/her EP. The EP Providers should be able to decide which sections of an EP have to be shown to a specific EP consumer. This way every EP Consumer might have a different view to the same EP (some activities hidden to a specific EP Consumer rather than another one).<br><br>*Maintainability (-):* The realization of the security measures as described in Non-functional requirements of *section 4.5* increases the complexity of the relationship between the objects of the system. For each EP (read), for each of its section (read) and for each of its activities (read, assess) there is the need to create different authorizations to perform operations for each EP Consumer. This seriously affects the maintainability of the system, for instance in the case the authorization policy changes. |

***Table 17: Trade-offs and risks linked to the support of S1.1 ad S2.1***

The *S1.1* is mainly linked with the *UC23: Handle EP Authorization Requests* and *UC31: Open EP*. Its support by the IT architecture has been discarded because of the difficulties in maintenance that might occur. Moreover the designed authorization policy has been evaluated sufficient to preserve the privacy of the end-users.

The *S2.1* is mainly linked with *UC25: Make Assessment*. As expressed by the candidate architecture, any EP Consumer who has access to an EP can assess an activity without the need to be authorized. The authorization to assess does not add much complexity to the authorization policy. The recommendation is to make an assessment policy through invitation by the EP Provider or by request made by the EP Consumers.

The *M1.1* and *M2.1* scenarios are already supported by the candidate architecture but the trade-offs between their quality attributes have been matter of analysis among the evaluation participants, as shown in *Table 18*. The performance quality attribute is difficult to properly assess without the Deployment viewpoint and some perspectives such as performance and scalability. However the evaluation participants, as shown in *Table 18*, have been able to put in a trade-off the *P1.1* scenario with the support by the candidate architecture of *M1.1* and *M2.1*.

| | |
|---|---|
| *Scenarios* | *M1.1:* IBLC Group changes the verification policy without affecting other system components.<br><br>*M2.1*: IBLC Group changes the authorization policy without affecting other system components<br><br>*P1.1:* Every end-users' request fulfilled within 1 or 2 seconds |
| *Trade-offs* | *T2:* Maintainability, Performance |
| *Risks* | *R3:* Hinder the possibility to make future changes to authorization or verification policies without affecting other E-Portfolio system's components.<br><br>*R2:* Decrease the performance of the E-Portfolio system |
| *Description* | *Maintainability (+)*: The Authorization Service and Verification Services business service components have been created on purpose for the E-Portfolio system to bear any change concerning authorization or verification policy without affecting any other component of the system, especially the EP Services.<br><br>*Performance (-):* Having communication between different components in order to fulfil an end-user request, might compromise the performance quality attribute of the E-Portfolio system as described in Non-functional requirements of *section 4.5*. |

***Table 18: Trade-offs and risks linked to the support of M1.1, M2.1 and P1.1***

The support of M1.1 and M2.1 give more advantages in terms of maintainability of the system. The impact to the system of the communications between Authorization Service and Verification Services with EP Services are believed not to sensibly affect the performance of the system. It is recommended to keep the component structure of the candidate architecture as it is. Eventual changes on the authorization policy have to be accompanied by changes on the Information Model linked with the Authorization Services and Authorization History components.

## 6.5 Other Findings

The ATAM assessment, besides the quality attributes, provided findings on the functionality expressed by the candidate architecture of the E-Portfolio system. The scenario analysis revealed shortfalls on the functionality of the E-Portfolio system.

These shortfalls are attributable, rather than to the architecture definition activity, to the analysis phase, where the business drivers and context have not been properly collected and/or documented. Partly this has been caused by the under development status of Prodis. Although during this project efforts have been made in order to conform to Prodis specifications, they were not stable, influencing also the context of the E-Portfolio system.

The main shortfall is about the roles an Individual actor can have within the system. An Individual actor who has also an HR role for an organization shouldn't be able to access an EP without paying.

The solution proposed is to make the E-Portfolio system aware of the real role an Individual actor has within an Organization partner through the Linking system. The Linking System has to replace the as-is concept of Organization partner of IBLC community with a hierarchical organization structure of Individual actors connected to the Organization partner by the means of links. This way the E-Portfolio system will be aware for each partner whether s/he belongs to an organization and which role(s) s/he fulfils.

In order to have a distinction between Individual actors that have free access to the EPs and those who have to pay instead, a vocabulary within the community has to be made. In the vocabulary are specified the roles that have a free access to the EPs and those who doesn't.

Moreover, in order to perform the payment transactions in real time, the EP Services component has to interface to a financial system. The EP Services therefore, will be given the responsibility to authorize an individual user to open a specific EP upon payment.

Given the fact that is a Prodis responsibility to manage the Organization partners, the solution to this shortfall goes beyond the E-Portfolio system, and therefore this project, scope.

# 7. Conclusions

This chapter presents conclusions and recommendation for this graduation project. This graduation project answered the Research Questions in order to achieve the goal stated in the Final Assignment of *section 3.4* and to produce the requested Research Deliverables as presented in *section 2.5*.

The COMET and ATAM methodologies have been applied in this project in order to answer the main Research Questions by producing the main Research Deliverables. The only question that was answered by not using the above mentioned methodologies was *RQ1*.

*RQ1* has been answered by the Orientation phase that is considered as an introductory phase needed to prepare scope and context for the project and for the E-Portfolio system. The scarce and not formalized documentation about organization and business of IBLC Group, required to change the planned tasks of collecting information into a more time consuming task of investigation of the organizational structure and business of IBLC Group. In order to prevent this to happen for future projects at IBLC Group, it is strongly suggested to improve and formalize the existing documentation. The documentation produced during this graduation project, although considered valid just within the context of the project, can be used as basis to produce documentation about IBLC Group organization and business.

The IT architecture for the E-Portfolio system has been designed by applying the COMET methodology.

The Business Domain Model of COMET defined context and requirements for the E-Portfolio system.

The Business Process and Roles Model did not have a core importance in this project for the following reasons:

- The E-Portfolio system, being basically a social networking system, its end-users, EP Providers and EP Consumers, are the only ones feeding business-data to the system.
- There is a low level of involvement of the E-Portfolio system with IBLC Group's business process and actors. The business process of the E-Portfolio system are few and with a low level of complexity.
- As emerged from the WARM, every process's activity is performed automatically by the E-Portfolio system.

On the other hand, given the interactive nature of the E-Portfolio system, the Use Case Model presents a large amount of use cases. That is because the E-Portfolio system, besides fulfilling the business goals presented in the Goal Model, is designed mainly to fulfill the goals of the end-users (use case fulfillment).

The development of a GUI, that needs to take into account the end-user's concern, was not within the scope of this project, that focused on the business logic of the E-Portfolio system instead. In order to diminish the risk *R1: Lack of E-Portfolio system acceptance by the users*, it is recommended to create a system prototype and use it as a tool to elicit GUI's requirements.

The Architecture Model of COMET has been used to design an IT architecture for the E-Portfolio system based on the Business Domain Model. *RQ4* is partially answered because the design focused on a subset of E-Portfolio system structure needed for the realization of the main functionalities of the system, the Core Model and the only viewpoint used has been the Functional Viewpoint.

Moreover, the IT Manager expected a set of architectural models to automatically generate the code needed to develop the E-Portfolio system. However, the level of abstraction of the architectural models does not support the automatic code generation. In order to have models from which automatically generate code, the PSM of COMET needs to be filled in by using the .NET framework as platform and C#. However the automatic code generation, sponsored by the model driven architecture methodologies such as COMET, is not yet a firm practice in the SDP and for this not widely adopted in every domain. The Architecture Model produced in this project is to be taken as a blueprint of the system and they need to be further specified for detailed operations of the components.

The candidate architecture for the E-Portfolio system has been assessed by using the ATAM methodology. The ATAM methodology indicated some weak areas of the architecture that have to be taken under control.

Although the ATAM assessment aided to discover important findings about the candidate architecture, all the assessment participants did not have experience with it. The ATAM assessment might have given more results if the assessment participants would have been more familiar with the methodology.

Moreover, given the interactive nature of the E-Portfolio system, the ATAM assessment has to be complemented by a prototype based assessment. The end-users are more interested in seeing what they can ask to the system and what they get as response, rather than a conceptual evaluation of a set of models and scenarios. This is possible to see by the tendency of the evaluation team, during the assessment process, of imaging the GUI of the E-Portfolio system rather than its business logic.

It is suggested to IBLC Group to adopt the ATAM as assessment methodology for future projects and future development of the architecture designed for the E-Portfolio system.

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# Glossary

| | |
|---|---|
| AD | Architectural Description |
| ADP | Architecture Development Process |
| ATAM | Architecture Trade-off Analysis Method |
| B2B | Business to Business |
| B2C | Business to Consumer |
| C2C | Consumer to Consumer |
| COMET | Component and model-based development Methodology |
| EP | Electronic Professional Portfolio |
| EU | European Union |
| GUI | Graphical User Interface |
| HR | Human Resources |
| HRIS | Human Resources Information System |
| HRM | Human Resources Management |
| IBLC | International Business Learning Community |
| IT | Information Technology |
| KW | Knowledge Worker |
| LP | Learning Product |
| NGO | Non-governmental organization |
| PIM | Platform Indipendent Model |
| PSM | Platform Specific Model |
| QAUT | Quality Attribute Utility Tree |
| SDP | Software Development Process |
| SLCM | System Life Cycle Model |
| UI | User Interface |
| UML | Unified Modeling Language |

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# Appendices

# 8.1 Appendix A – IBLC Group overview

This appendix presents the results of the Initiation phase that did not find space in the main report. In *section 7.1.1* the complete IBLC Group Vision statement. In *section 7.1.2* a brief introduction about the Millenials.

## 8.1.1 IBLC Group Vision Statement

Within the European Union (EU) the labour market, which has traditionally been production-based, has been affected by two trends:

1. Many EU countries, attracted by cheaper labour costs and less strict work regulations, have been moving their production plants to areas such as East Europe and Asia.

2. In the EU the average age of the population is increasing and the birth rate is decreasing. Consequently there will be fewer fresh forces available in the job market.

The EU, after a careful evaluation of the situation, realized that an inversion of the two trends is not likely to happen and trying to find measures in order to attempt to slow down their growth will be worthless in the long-term. The EU instead believes that, in order to keep its leading role in the worldwide economy, the solution is to move towards other labour market directions. At the Lisbon European Council in March 2000, government leaders set the EU a 10-year mission to become the most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion [1].

Lifelong learning [1] is a core element of this strategy, central not only to competitiveness and employability but also to social inclusion, active citizenship and personal development. The lifelong learning aims at the development of qualitative Knowledge Workers. The Knowledge Worker (KW) is a figure that, in contrast with the traditional manual labour workers, has in the knowledge about specific matters its strength point.

An effective knowledge-based economy requires the knowledge exchange process to deliver the right knowledge to the right people and the various companies' recruitment processes to place the right people on the right spot. The benefits it might bring to the EU economy can be seen from both companies and potential KWs perspective. The potential Knowledge Worker can develop his/her knowledge in the proper directions and the companies can fill the job positions with the most suitable candidates and get advantage of the qualitative knowledge they have to offer.

In this context, organizations, institutions, governments and potential KWs are starting to cooperate within Human Resources (HR) Networks. These HR Networks are communities used to effectively share and exchange knowledge and labour market related information between the involved parties in order to implement the lifelong learning strategy.

The knowledge is exchanged in these HR networks through formal, non-formal or informal learning. Formal and non-formal learning occurs through knowledge stored into specific and structured knowledge sources. The only difference between the two kinds of learning is that the non-formal learning occurs outside the boundaries of the traditional learning systems, such as in private institutes. A structured knowledge source can be a class from a university program (formal learning) or a specialization course offered by a private company (non-formal learning). The

informal learning is based on the day by day experience from unstructured knowledge sources, as it happens for instance during a project or by a conversation with a more experienced fellow worker.

On the other hand, professional information related to any type of learning, such as skills, performed career or specialization courses, from potential KWs are shared among the other HR network parties, such as universities and companies, with the aim to offer to the KWs suitable job position and proper learning packages, such as university career or specialization classes and personal development plans.
A great added value to support the HR network infrastructure is given by the Human Resources Information Systems (HRIS), which rely on information technologies. They allow potentially everybody to have access to the HR networks to use and offer both knowledge and information.

IBLC Group strongly believe in this vision and in order to catch the opportunities offered by the knowledge-based economy founded, within The Netherlands, its own nationwide HR network, IBLC community. IBLC community business is enabled by a custom made HRIS which belongs to IBLC Group IT infrastructure. IBLC Group goal is to expand IBLC Community beyond the Dutch borders in order to act as a platform to support the development of the EU as a powerful knowledge-based economical system.

### 8.1.2 The Millenials Phenomenon

The Business Development department of IBLC Group during the first half of 2007, made an extensive research about the Net Generation phenomena. This research focused on identifying the opportunities this phenomenon was bringing to the HR market, in order to develop suitable solutions for IBLC community.

The Net Generation, also known as Millenials and Generation Y, according to [2] refers to the higher educated, post 1980 group of dynamic, technical and global citizens. The main characteristic of such generation of citizens is to develop their job career and professional skills autonomously. Contrarily to the past where the employees tend to put their development on the hand of the organizations they belong to, the Millenials are always looking for new jobs and knowledge development opportunities. Besides actively auditing the traditional HR market, they are interested in receiving offers about vacant positions available and cooperating within knowledge sharing networks. Of course, such offers have to be meaningful, that means the vacant position or the knowledge should somehow satisfy their career perspective and enhance their capabilities. The new technology development especially in the field of IT and computer networks, give the Millenials the opportunity to effectively organize and structure information about their career and skills, keep them easily updated and make these information available to a wide set of companies in a short time.

## 8.2 Appendix B - Prodis and IT Infrastructure

This appendix shows the set of results obtained during the Orientation phase that did not find space in the report, and a list of the existing documentation used during the initial assignment refinement process. In *section 7.2.1* is presented the documentation already existing at IBLC Group. In other sections an overview of the Prodis HRIS and its business context.

### 8.2.1 Existing Documentation

The existing documentation concerns some parts of the IT-enabled business of IBLC community. The documentation partially covers the Prodis HRIS, currently under development. The documentation consists of basically three sets of not-formalized models, with different versioning:

- A table regarding Prodis system stakeholders and their role within the system;
- A UML-like class diagram regarding IT-enabled business resources;
- A flow chart describing the Booking business process;

These three models are not going to be shown in this graduation project. The motivation underneath this choice is linked to the following documentation's shortfalls:

- They do not cover the whole IT infrastructure;
- They are not formalized and therefore subject of arbitrary interpretation.
- The information abstracted by the models has a non-uniform level of granularity.

### 8.2.2 LP Information

IBLC Community business is based on the exchange of LP information between community partners, in the scope of trading LPs. The LP information is a set of information related to a specific LP. This set of information is divided in two parts. The meta-knowledge about the LP, that describes the knowledge stored in the LP, and other information needed for the trading of LP between partners, such as price and schedule.

The LPs traded within IBLC community mainly rely on the professor-scholar model, such as courses, trainings or seminars. In this kind of LPs, the availability, in terms of seats or places available on a specific timetable, represent valuable LP information in the scope of their trading. However, getting real-time information availability about LPs, involves an interaction between Prodis and the information system of the LP providers. This inter-organizational interaction is not accepted by many LP providers that, for security and privacy reasons, prefer not to have external systems interacting with their information system. Therefore, the availability does not belong to LP information but can be checked by the booking service, as discussed in the next sub-section.

IBLC Group is responsible to control the quality of the LPs' meta-knowledge exchanged within IBLC community. The meta-knowledge should be trustable and semantic. IBLC Group reserves the right to choose its LP providers in order to guarantee the quality of the meta-knowledge exchanged within the community. In the future IBLC Group plans to use certified standards to describe the

LP information stored in IBLC community, in order to use the IT infrastructure to enable the automatic semantic control of the LP information.

### 8.2.3 The Prodis HRIS

This section presents a high level overview of the Prodis system. The Prodis system is part of the to-be IT infrastructure of IBLC community, the environment where the E-Portfolio system is going to operate. The main assumptions underneath this overview, applied also for further phases of this graduation project, is that the first business goal is successfully achieved and Prodis will be implemented as presented in the existing documentation of IBLC Group.

The IT infrastructure of IBLC Group supports IBLC community. The IT infrastructure makes use of the organizational resources of IBLC Group to implement IBLC community related business processes in order to deliver services and products to its business partners.

The IT infrastructure is equivalent to a logistic system. The IT infrastructure can be seen as a network with a main warehouse, where the meta-knowledge is stored. The nodes of the network are IBLC community business partners. Each partner is connected to the network through a transport link. The IT infrastructure delivers its service to the partners through the transport link. It is important to underline that the IT infrastructure is just responsible for the delivery of services to IBLC community business partners and does not provide them any application or graphical interface.

The core processes within IBLC community are enabled by an HRIS belonging to the IT infrastructure. Currently IBLC community business is enabled by an HRIS, CWPro. In the scope of the business extension, IBLC community business will be enabled by a new HRIS, Prodis. Prodis will be incrementally built over the functionalities already offered by CWPro and will be part of the to-be IT infrastructure of IBLC Group. The to-be IT infrastructure will make use of the resources offered by the current organization structure of IBLC Group.

The Prodis HRIS is administered by the General Manager and the IT Manager. Moreover the IT Manager is responsible for technical support about any issue concerning Prodis.

The Prodis HRIS is responsible for the management of IBLC community partners and enables the LP trading business. The Prodis system enables the IT infrastructure Business to Consumer (B2C) and Consumer to Consumer (C2C) transactions as well as B2B transactions, already enabled by CWPro.

Relatively to the LP trading business, the exchanged meta-knowledge is the LP information. The Prodis system has to conform to a set of business rules that constrain IBLC community business partners' behavior relatively to the LP trading business, of as shown in *Appendix-Table 1*. IBLC community business partners are distinguished in two types: individual and organizations.

| | **Consumer** | **Provider** |
|---|---|---|
| **Organization** | LP information | LP information |
| **Individual (KW)** | LP information | / |

***Appendix-Table 1: IBLC Community Business Rules (LP trading business)***

The individual partners are just allowed to consume LP information and cannot provide

LP information within IBLC community. Consequently, the individual provider role in the LP trading business does not exist. The organization partners, as it occurred before the business extension, have the right to both provide and consume LP information.

Taking into account the LP trading business and the business rules in *Appendix-Table 1* above, the business roles within IBLC Community are as shown in *Appendix-Table 2*.

| Individual (KW) | Organization |
|---|---|
| LP Individual Consumer | LP Organization Consumer;<br>LP Provider |

***Appendix-Table 2: IBLC Community Roles (LP trading business)***

An organization partner is considered by the IT infrastructure as a sole entity with no visibility for the members of the organization. That means, an organization partner's member that makes business with IBLC community on behalf of the organization, is not accounted as individual partner.

### 8.2.4 Basic Services and Processes

The basic services enabled by Prodis, as presented in *Appendix-Table 2*, take into account IBLC community roles as shown in *Appendix-Table 1*. Prodis, similarly to CWPro, does not enable the issuing of all the IT infrastructure services as presented in *chapter 1*. The *Brokering* and *Payment* services are not supported. The *Payment* service will be enabled in the future, especially for the B2C related transactions, but it has not been planned yet. These two services, therefore, are not taken into consideration in this overview.

| Service | Community Role | Description |
|---|---|---|
| *Publishing* | LP Provider | The LP provider upload its LPs information n the community. A set of LPs information from the same provider is called **LP assortment**. The LPs assortments are visible and available for purchasing to all the community partners. |
| *Selecting* | LP Organization Consumer | The LP organization consumer selects a set of LPs information, according to certain criteria, among the ones available within the community and deliver it to the organization consumer. A set of LPs information selected by a specific consumer is called **LP selection**. An organization consumer might have more than one LPs selection. |
| *Searching* | LP Organization Consumer,<br>LP Individual Consumer | The LP consumer looks for the LPs information within one of its LP selections. In the case of individual consumer, the LP selection is whole set of LP assortments of IBLC Community. |
| *Booking* | LP Organization Consumer,<br>LP Individual Consumer,<br>LP Provider(involved) | The consumer can attempt to purchase LPs. IBLC Group is responsible to route the request to the LP provider and forward back the response to the LP consumer. |

***Appendix-Table 3: Prodis supported basic services***

In order to make use of the services listed in *Appendix-Table 2*, an individual or organization, has to be partner of IBLC community. To become partner of IBLC Community, and have the right to use

IBLC Group IT infrastructure, a party has to register to Prodis. To register, the party has to provide data to IBLC community called *account information*. These data differ between organization and individual partners. The account data are information about the partner, such as name (individual or organization), surname (individual), business sector (organization) and so on. The registration assigns a *unique account* to every partner, to be uniquely identified within Prodis.

The organizations, in order to register to IBLC community, have to stipulate a paper-based contract directly with IBLC Group General Manager. That involves a meeting arrangement between the two parties. For the individual partners this procedure is neither feasible nor user friendly. The individual consumers can register to IBLC community through a Web Interface, instead. In both cases the account information of the new IBLC community partner are then stored in Prodis.

Prodis issues each basic service by executing the associated business process of the IT infrastructure. Each business process takes the name from the services it is linked to. The
LP individual consumer has the right to use IBLC community infrastructure and its other services, relatively to his/her role, through a Web Interface.

***Publishing Process***

The *Publishing* process is performed to issue the *Publishing* service. This process is triggered by an attempt made by an LP provider to publish its LP information within IBLC community. For an LP provider that uses the *Publishing* service for the first time, the process creates the LP assortment associated to the partner by a *label*. A label is a unique value that associates an LP assortment to a specific LP provider.

For an LP provider that has already published its LP assortment and wants to update it, i.e. adding new LP information or modify the ones already existing, the *Publishing* process uses the label to retrieve the LP assortment and perform the update.

The *Publishing* service can be issued in two ways, direct and indirect. The direct way is enabled by Prodis. The LP provider organization triggers the *Publishing* process by using the Prodis interface. The indirect way is partially enabled by Prodis. The LP information is sent to IBLC Group Operations department, by using an Excel file with IBLC pre-defined format. The Operations department is then responsible to publish or update the LP assortment in Prodis.

***Selecting Process***

The *Selecting* process is performed to issue the *Selecting* service. The *Selecting* service goal is to give more control on the interaction with IBLC community to the LP organization consumer. The LP consumer organizations, i.e. the companies, usually want to make available for their members, i.e. their employees, the possibility to search for LPs information. At the same time, the LP consumer organizations do not want to give the possibility to their members to browse and attempt to book all the LPs available within IBLC community. The organizations would like to give to a specific group of its members, e.g. the marketing department, the possibility to see limited set of LPs information, e.g. LPs about marketing. The Selecting service has been developed by IBLC Group in order to meet this requirement. The LP consumer organization by using this service can create various LP selections, each of them with the related set of selection criteria, from the whole list of LP information available within the community.

The Selecting process can be actually split in two processes, the *Selection* and *Creation* processes.

The *Selecting* process is triggered by an attempt made by an LP organization consumer that wants to select among the whole list LP information made available by IBLC community, a subset of LP information according to a set of specific criteria. The LP organization consumer can decide to create more than one LP information subset. Each subset is called LP selection.

The *Selection* process takes the criteria chosen by the LP organization consumer and associates to these criteria a set of outbound filters. The LP consumer organization triggers the *Selection* process every time it wants to change these criteria.

The outbound filters are used by the *Creation* process to filter LP information from the whole list of IBLC community and create a specific LP selection. Because more than one LP information consumer might have the same criteria for a specific LP selection, the same LP selection can be assigned to more than one LP organization consumer, instead of creating redundant LP selections. The *Creation* process is periodically triggered in order to update a specific LP selection.

To define the infrastructure transport link usage, the distinction between *Selection* and *Creation* processes has to be taken into account. The *Selecting* service way of issuing depends on the *Creation* process.

The *Selection* process occurs just with the indirect way because the process is not enabled by Prodis. The criteria related to a specific LP selection are given by the LP consumer organization to IBLC Group General Manager which forwards them to IT Control. The latter then creates the outbound filters to be used for the *Creation* process.

The *Creation* process can occur in both direct and indirect ways. In any case the LP selection is created by Prodis according to the outbound filters. With the direct way the LP consumer organization can have its LP selection delivered through the Prodis interface. With the indirect way the LP Selection is periodically sent by IBLC Group Operations department through an Excel file with IBLC pre-defined format, to the LP consumer organization.

***Searching Process***

The *Searching* process is performed to issue the *Searching* service. The process is triggered by an LP consumer that wants to search, within its LP selection(s), a set of LP information that satisfies specific keywords. In the case of an LP individual consumer, the LP selection is the entire list of LP information available within IBLC community.

The *Searching* service can just be issued by using the direct way. That means, the *Searching* process is enabled by Prodis and it can just be triggered by using the Prodis interface. Moreover, just the LP consumer organization that use the direct way for the *Selecting* service can use the *Search* service.

***Booking Process***

The *Booking* process is performed to issue the *Booking* service. The process is considered the main process for IBLC community business because it supports the actual transfer of knowledge between two parties.

The *Booking* process is triggered by an attempt, made by an LP consumer, to purchase an LP related to specific LP information. The process sends the booking request to the Operation department of IBLC Group, which is responsible to check the availability of the LP related to the LP information with the LP provider. The availability check is not performed automatically but with the aid of a human, either by e-mail or phone. The response is then sent, by the Operation department, back to the LP consumer that triggered the process. In case of positive response, i.e. the LP is available, Prodis stores the business transaction. A booking transaction links an LP consumer to specific LP information. The LP consumer might cancel the booking at any time prior to the LP actual delivery.

In the case of the LP organization consumer the *Booking* process workflow can be customized. As already mentioned, from the community viewpoint an organization partner is considered as a sole entity with no visibility for the members of the organization. Therefore in order to have more visibility on the bookings performed by its members, the LP organization consumer might ask to have either one of the two following additional tasks or both in the *Booking* process:

- *Authorization to book*: This task gives to the LP organization consumer the possibility to authorize any booking attempt made by its members. The Operations department of IBLC Group before performing the availability check, contacts the responsible of the LP consumer organization to ask authorization to proceed with the *Booking* process.

- *Authorization to publish*: This task gives to the LP organization consumer the right to decide whether certain booking transactions of its members can be made public within IBLC community or not. The Operations department of IBLC Group, before storing the booking transaction, contacts the responsible of the LP consumer organization to ask authorization to make public the booking transaction. This task has been added on purpose for the E-Portfolio system. The motivations are discussed more in depth in *chapter 4*.

The *authorization to publish* task can be placed, according to the LP organization consumer choice, at any point of the *Booking* process workflow, as long as it occurs before the booking storage. It can also be coupled with the *authorization to book* task.

The *Booking* service can be issued in two ways, direct and indirect. The direct way is enabled by Prodis. The LP consumer triggers the *Booking* process by using the Prodis interface. The indirect way is partially supported by Prodis. The LP consumer gets in contact with IBLC Group Operations department, by e-mail or phone, to perform the booking.

### 8.2.5 The Channel Concept

The interaction of a partner with IBLC community occurs through the transport link of the IT infrastructure. In the case of the individual partners, the transport link connects directly to the Prodis Web interface. Upon registration an individual partner can make use of all the basic services available for his/her role, as listed in *Appendix-Table 3*, through the Web interface.

For the organization partners the transport link is shaped according to three parameters: partner's role (provider or consumer), transport link usage modalities (direct or indirect) and booking process workflow. How these parameters can be set up has been already discussed in the previous sections. The transport link usage, direct and indirect, has been specifically discussed for each service.

If the LP provider's interaction with the IT infrastructure depends just on one parameter (direct/indirect usage of the *Publishing* service) for the LP consumer organization the interaction is more complex. For the LP consumer organization there is the need to set up two parameters, direct/indirect usage and booking process workflow. Moreover according to the constraint on the usage of the *Searching* and Selecting service, there is a correlation between these processes and the *Booking* process. The channel defines the way of interaction of the LP consumer organization with IBLC community. A specific channel is associated to one specific LP consumer organization. Each channel clearly defines all the three interaction parameters and consequently the services available depending on the transport link usage. To each LP selection can be dedicated at the most one channel, therefore a consumer has one different channel for each LP selection.

### 8.2.6 Extra Services

Besides the E-Portfolio product, IBLC community IT infrastructure makes available for its partners other two extra services as listed in *Appendix-Table 4.* Both extra services are available just for the organization partners and related to the LP trading business. The extra services are considered by IBLC Group as products for commercial reasons.

| Extra Service (Product) | Community Role | Description |
|---|---|---|
| *Course Catalogue* | LP Organization Consumer | The Course Catalog product is a customized portal, developed by IBLC Group, for a specific LP consumer organization to interact with its Prodis channel. |
| *Web Services* | LP Organization Consumer<br>LP Provider | The Web Service product makes the updating of the LP Assortment and LP Selection, automatic and with a higher frequency. |

***Appendix-Table 4: IBLC Community extra services***

These extra services do not add any functionality to the IT infrastructure but increase its business quality. Both products are available just for organization partners that use the direct modality to interact with the infrastructure. The two extra services are following discussed more in detail.

***Course Catalogue***

The Course Catalogue product basically concerns on the development by IBLC Group of a customized portal for a specific LP consumer organization that find less convenient to create the portal itself. The portal is a graphical interface that connects to a channel, and therefore to Prodis, related to a specific LP consumer organization. The customization is about the portal "look and feel" and functionality related to the channel services, such as *Booking* and *Searching*. Because of the one to one relationship between each LP selection and channel, a LP consumer organization might have as many Course Catalogues as LP selections.

***Web Services***

The Web Services product is applied to the labels and outbound filters of, respectively, the *Publishing* and *Selecting* services. This way the update frequency for both LP Assortment and LP Selection is higher and the LP Assortment can be automatically updated.

In the future IBLC Group wants to develop Web Services to be applied to other Prodis services such as the *Booking* service.

## 8.3 Appendix C – Business Model

This appendix shows the results and the set of COMET Business Model obtained during the analysis phase that did not find place in chapter 4.

### 8.3.1 Stakeholders Description

*Appendix-Table 5* details the reasons of using the E-Portfolio system for each stakeholder and, in the case of KW trading business stakeholders, their role within the higher general KW trading process of IBLC community.

| Stakeholder | Description | |
|---|---|---|
| **IBLC Group General Manager** | The General Manager is the business owner of the E-Portfolio system. He is interested in monitoring and managing the E-Portfolio system performance in terms of users and transactions. | |
| **IBLC Group IT Manager** | The IT Manager is responsible to configure the E-Portfolio system, maintain it and manage the right to access to the users. He is also responsible for its implementation within IBLC community. | |
| **EP Consumer** | The EP consumers represent the demand side in the KW trading business. They use the E-Portfolio system to look for EPs, access the information stored on them and eventually make an offer to the related KWs, namely the EP providers. The EP consumers might also be requested by the EP providers to assess specific information fields of their EPs. The EP consumers, because of different goals towards the KW trading business, and therefore different requirements and reasons to use the E-Portfolio system, are distinguished in organization and individuals. | |
| | **IBLC community Organizations Partners** | The IBLC community organization partners see the KW trading business as a supporting business for the LP trading business and, in a future perspective, also for the recruitment business of IBLC community. The organization partners use the E-Portfolio system to look for and access EPs, either for LP targeted marketing or for recruitment purposes. In both cases they offer knowledge development opportunities to the KWs who have their EP available in the E-Portfolio system. In the LP trading case the knowledge development opportunity is offered for an economical return (the price of LP). In the case of the recruitment business the opportunity is offered in exchange of using the knowledge potential of the KW for the organization. The organization partners use the E-Portfolio system through the Prodis system. They are also involved in the LP trading business. |
| | **IBLC community individual Partners** | The IBLC community individual partners in the role of EP consumer see the KW trading business as a supporting business to develop and offer their knowledge. They use the E-Portfolio system to look for and access EPs in order to find KWs that require or can provide knowledge about a specific professional topic.<br>The individual partners might also be involved in the LP trading business, but they cannot have the role of LP providers. |
| **EP Providers** | The IBLC community individual partners in the role of EP providers (also called EP owners) represent the offer side in the KW trading business. They see the KW trading business as a supporting business for developing and offering their own knowledge. They use the E-Portfolio system to make their EP available for other IBLC community partners in order to advertise themselves for knowledge development and knowledge tutoring opportunities. In the former case these opportunities can be either in the scope of the recruitment or LP trading businesses, as discussed in the EP organization consumer case, or to receive tutoring opportunities from another individual partner. In the latter case, the knowledge tutoring opportunities, for instance in the case of a teacher, are in the scope of tutoring another individual partner about a specific professional topic, as discussed in the EP individual consumer case. In this context they use the E-Portfolio system also to manage their EPs, by adding information and release access authorization to EP consumers. | |

| Stakeholder | Description |
|---|---|
| | The individual partners might also be involved in the LP trading business, but they cannot have the role of LP providers. |
| **IBLC Group IT Technicians** | The IT technicians are responsible to implement and maintain the E-Portfolio system and its future updates. They are led by the IT manager. |
| **Prodis** | The Prodis system manages IBLC community partners and enables IBLC community LP trading business. All the IBLC community partners and information about the LP trading business are stored in Prodis. The Prodis system interacts with the E-Portfolio system to provide verification about IBLC community partners and automatic EP updates. Moreover Prodis interfaces the interaction of organization partners with the E-Portfolio system. |
| **Guest** | The guests are the E-Portfolio users that are not registered in the E-Portfolio system. The guests can be either IBLC community partners or external to the community. Their interaction in the KW trading business, and therefore with the E-Portfolio, is limited. They can use the E-Portfolio system to look for PPs but they cannot neither access nor publish PPs. Upon registration to the E-Portfolio system, the guests become individual partners of IBLC community (if s/he is not already) and acquires the related privileges to use the E-Portfolio system. |

***Appendix-Table 5: Description of stakeholders involved with the E-Portfolio system***

### 8.3.2 Business Goals Description

*Appendix-Table 6* details the business goals IBLC Group wants to achieve by developing the E-Portfolio system. The indentation of the goals on the table is made according to the hierarchical structure of the goals, as shown in *section 4.2*.

| Goal | Sub-Goals | Higher Goals | Description |
|---|---|---|---|
| G1 : Effective KWs knowledge development and deployment | G2, G3 | | This is the top-goal of the E-Portfolio system. Each KW belonging to IBLC community use the system to effectively develop his/her knowledge by receiving related opportunities and identify the areas that need improvements. |
| G2 : Deliver proper knowledge development opportunities | G4, G5 | G1 | A KW by receiving knowledge opportunities suitable for him/her, can sensibly optimize his/her knowledge development without wasting resources, such as time and money in opportunities not in line with his/her development path. |
| G4 : Support recruitment and LP trading business (pull basis) | G7 | G2 | The LPs and job positions represent knowledge development opportunities for a KW. These opportunities might be more suitable for the KW if they are offered according to the information on his/her EP. On the other side the LP trading and recruitment business have benefits in terms of successful transactions. |
| G5 : Support personal tutoring | G7 | G2 | Personal tutoring about a specific knowledge area, represent a knowledge development opportunity for a KW offered by another KW belonging to IBLC community. The tutoring should be focused on his/her EP. |
| G7 : Provide qualitative PPs | G9, G10, G11 | G4, G5, G6 | The quality of KW professional information is defined in terms of reliability and not obsolescence. The information are more reliable if they are verified and they can be modified by authorized parties. |
| G9 : PPs automatic update | | G7 | The EP activities related to transaction performed within IBLC community have to be automatically updated. |

| Goal | Sub-Goals | Higher Goals | Description |
|---|---|---|---|
| G10 : PPs information verification | | G7 | The EP information where, besides the KW, other IBLC community partners are involved should be verified. |
| G11 : Proper KW professional information privacy measures | | G7, G8 | The access to the EP has to be restricted by authorization and privacy measures. |
| G3 : Enable knowledge development planning | G6 | G1 | The activities listed in the EP can refer to future planned activities as well as past and current activities. |
| G6 : Proper Identification of improvement areas | G8, G7 | G3 | A proper identification of weak and strong areas of a KW, from a knowledge perspective, helps the KW to understand the directions to follow in order to fill his/her knowledge gaps. |
| G8 : Enable third-parties Assessment of EPs activities | G11 | G6 | Other parties, belonging to IBLC community, should assess an activity from a EP where they were involved. |

***Appendix-Table 6: E-Portfolio system Goals description***

### 8.3.3 Risk Analysis

The risk analysis describes marketing factors that might influence the E-Portfolio system, good or bad, and things that are required that are not described in the E-Portfolio system's business vision and description.

In this graduation project the *Risk Management* related activities have been performed according to the process guidelines described in [8]. The performed activities are *Risk Identification* and the actual *Risk Analysis*. The *Risk Analysis* results have been used to fill the regarding risks table as prescribed by COMET. The risk types considered for the E-Portfolio system development project are:

- *Business Risks*, concerning the alignment of the E-Portfolio system business aspects with its IT architecture.
- *Technical Risks*, concerning the technical related aspects of the E-Portfolio system.
- *Implementation Risks*, concerning the E-Portfolio system's conformance to the requirements.

The *Risk Identification* activity has been performed through a set of checklist-based interviews. The Top 10 risk items checklists proposed by [8] addresses risk items related software related projects and was not covering all the risks that might be involved in the E-Portfolio development. Therefore such checklist has been integrated with risk items derived by a risk management table used for other projects by IBLC Group.

The *Risk Analysis* consisted in prioritizing the risks and formulating the related contingency plan. Rather than a prioritization a risk selection, based on the experience of the IT manager in similar projects, has been made. The risk prioritization could not be made because of the lack of information and experience necessary to compute the risk-exposure quantity [8]. The selection has

taken into account just major risks. There are of course also smaller risks involved but the focus on the major ones has been given for the following reasons:

- Taking into account small risk items is not a good practice because their occurrence probability is so uncertain that effective contingency plans are difficult to create.
- According to [8] a very risk for a project is the identification of so many risk items that it could be extremely high time consuming to keep all of them under control.
- The time span and scope of this graduation project does not allow performing a really detailed risk analysis.

An important risk item which has been taken into account within the *Risk Analysis* is the users' acceptance. The E-Portfolio system is user-centered, thus it can successfully add value to the business only if users do not have hostile behavior towards it.

*Appendix-Table 7* shows the results of the Risk Analysis activity. It gives a list of all the risk items the project might face and for each risk the event description, the probability with which it might occur, the consequence level and the contingency plan to reduce the risk.

| Event Description | Probability | Consequence | Contingency Plan |
|---|---|---|---|
| ***R1: Lack of E-Portfolio system acceptance by the users.*** | | | |
| The user does not get acquainted with the system or do not think it might be useful and do not use it or use it rarely. The difficulties in reaching the potential end- users of the system make this risk really high. | High | High | • Increase the performance and user friendliness of the system.<br>• Provide training for the inexperienced users.<br>• Make users aware of the benefits the system might give |
| ***R2: System technologies get obsolete during development*** | | | |
| The technology adopted for the system development is totally or partially replaced by new ones during the system development. | Low | High | • Tracking new technologies and developments.<br>• Making a technology analysis based on future perspective.<br>• Use technologies validated and issued by certified and well-known companies or institutes. |
| ***R3: The system does not comply to government law (privacy laws especially)*** | | | |
| The system does not comply with privacy laws or does not offer adequate data protection to its users. | Low | High | • Deep analysis of the main privacy laws and data ownership regulations.<br>• Keep privacy laws and regulations always up-to-date.<br>• Security of private stored information.<br>• Make privacy contracts with third parties who can have access to information.<br>• Strong access authorization measures. |

| Event Description | Probability | Consequence | Contingency Plan |
|---|---|---|---|
| ***R4: Integration with the existing systems and architecture fails*** | | | |
| The system does not integrate with the Prodis system. The under development status of Prodis and the scarcity of documentation makes this risk really high. | High | High | • Test the compatibility of the system with a system prototype before testing with the final system.<br>• Analysis of existing architectural frameworks and provide architectural soundness.<br>• Analysis of the business processes and resource supported and used by Prodis in order to avoid overlapping and data inconsistencies. |
| ***R5: The system is not capable to handle many concurrent accesses*** | | | |
| The system has not the capacity to handle too many users at the same time. | Low | Medium | • The system should be scalable to handle the increase of the number of users.<br>• Make a good analysis to foreseen with a good margin how many users can use the system at the same time. |
| ***R6: The developers are not familiar with the notation used for the architecture*** | | | |
| The notation used to create the architectural description is not understood by the developers. | Low | Medium | • Use a formal notation which is standardized.<br>• Involve developers since the earliest phases of the project to collect their concerns and understand their background |
| ***R7: The system does not last for the forecasted lifecycle.*** | | | |
| The system needs to be replaced because it has become obsolete before the forecasted lifecycle or does not provide a new required functionality. | Medium | High | • The system architecture must guarantee system extensibility for the planned versions.<br>• Use technologies validated and issued by certified and well-known companies or institutes. |
| ***R8: Lack of availability of the system.*** | | | |
| The system is not available to its users for a certain period of time, because of malfunctioning or overloading. | Low | High | • The system should be available for 24/7.<br>• If a system bug occurs it must be solved within 1 working day.<br>• The system should support backups and safe mode. |

***Appendix-Table 7: Risks involved in the E-Portfolio system project***

### 8.3.4 Business Process and Roles model

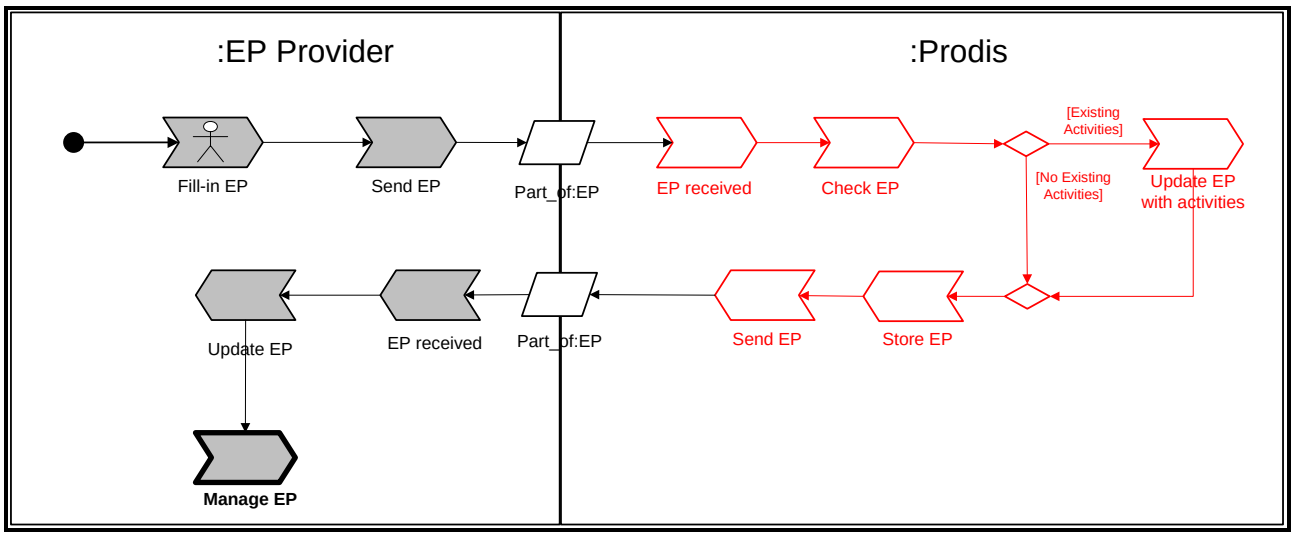
The Business Process and Roles model defines:

- the business processes of the domain which are relevant to the E-Portfolio system, and which will enable the goals to be met;
- the roles of the resources that perform those processes.

Hereby are presented the business processes that detail the higher KW trading business processes according to the business goals described in the *Goal Model* in *section 4.2* that did not find place in *chapter 4*.

### 8.3.4.1 Create EP

The *Create EP* process is the first step for an EP provider to put him/herself in the KW trading business. The process is modelled as shown in the activity diagram of *Appendix-Figure 1*.




***Appendix-Figure 1: Create EP process***

The process is triggered by an EP provider that fills-in his/her EP according to IBLC Group EP predefined format. According to IBLC Group EP predefined format, the activities in the EP are seen within IBLC community as LP booking transactions. Therefore the EP is then sent by the E-Portfolio system to Prodis for the following purposes:

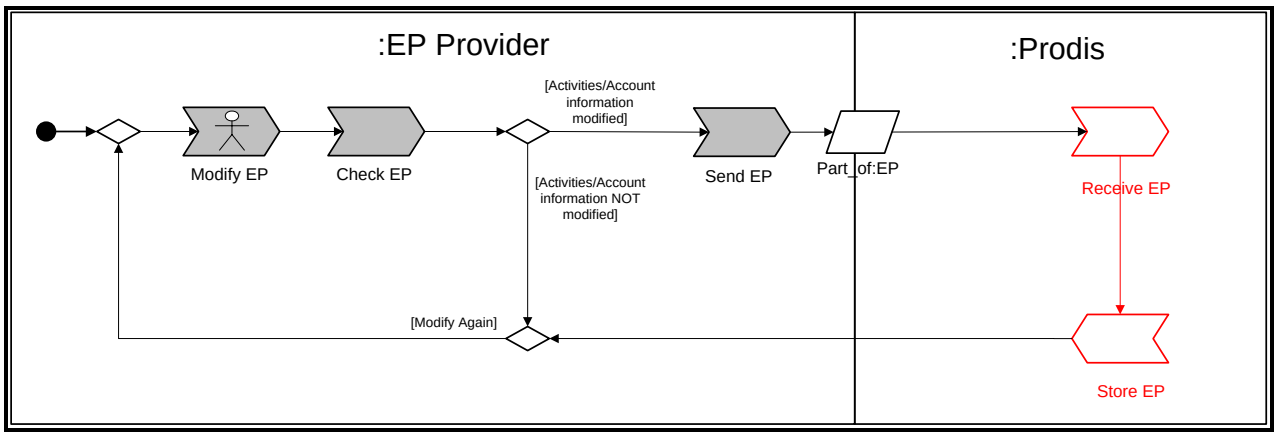
- Check whether the EP provider has activities already stored within IBLC community. If the EP provider has an LP booking history prior to his/her registration to the E-Portfolio system, this is added to his/her EP.

- The activities in the EP which are not already present in the LP booking history of the EP provider, are added to his/her Prodis LP booking history.

Prodis sends back the LP booking history that will be automatically added to the EP of the EP provider. After creating the EP the EP provider can trigger the *Manage EP* process.

### 8.3.4.2 Manage PP

The *Manage EP* process gives the opportunity to an EP provider to make modifications to his/her EP. The process is modelled as shown in the activity diagram of *Appendix-Figure 2*.

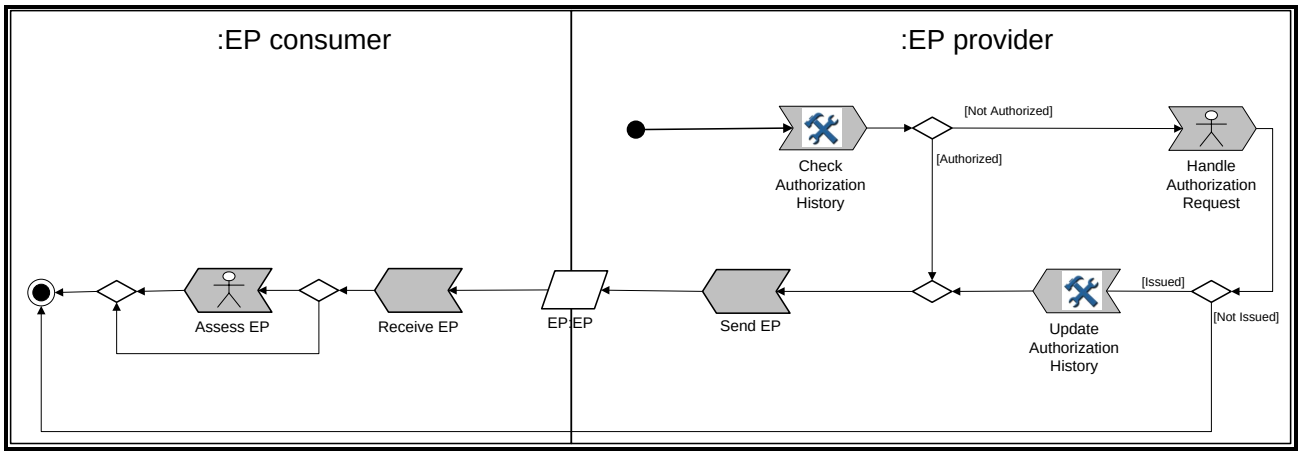



***Appendix-Figure 2: Manage EP process***

The process is triggered by an EP provider that wants to make modification to his/her EP. The modification may concern either the information stored in the EP, according to IBLC Group EP predefined format, or authorization and privacy measures. The modifications on the EP are checked by an automatic task, to see whether account information or activities have been modified or not. In the former case the EP is sent to Prodis that stores updated IBLC community account information and activities as LP booking transactions.

### 8.3.4.3 Acquire EP

The *Acquire EP* process gives the opportunity to an EP consumer to access the information stored in a specific EP. The process is performed for each EP that belongs to the EPs selection created by the EP consumer in the *Select EP* process. The process is modelled as shown in the activity diagram of *Appendix-Figure 3*.




***Appendix-Figure 3: Acquire EP process***

The process is triggered by an EP consumer that wants to access the information of an EP in his/her EP selection. The access to an EP is protected by information measures specified by the EP provider in the *Manage EP* process. This authorization is automatically checked by the *Check Authorization History* task.

If there is not an already issued authorization that entitles the specific EP consumer to open the EP, the process forwards the authorization request to the EP provider. If the EP provider does not release an authorization, the *Acquire EP* process and the EP consumer specific processes end.
If the EP provider releases the authorization, the *authorization history* is automatically updated.

In the case an authorization is issued, the EP is sent to the EP consumer.

The EP consumer after receiving the EP, can access to the information stored in it, according to the authorization measures issued by the EP provider. The EP provider can now evaluate whether the KW is suitable for his/her purposes. The EP consumer, according to the business goal G8: *Enable third parties assessment of KWs* can optionally execute the *Assess EP* task. The *Assess EP* task is to assess the EP according to IBLC Group EP predefined format. Of course the EP assessment has to be authorized by the EP provider.

If the *Assess EP* process is not chosen, the *Acquire EP* process and the *EP consumer specific process* end.

The *Assess EP* is not a structured business task therefore it is not going to be detailed at business level.

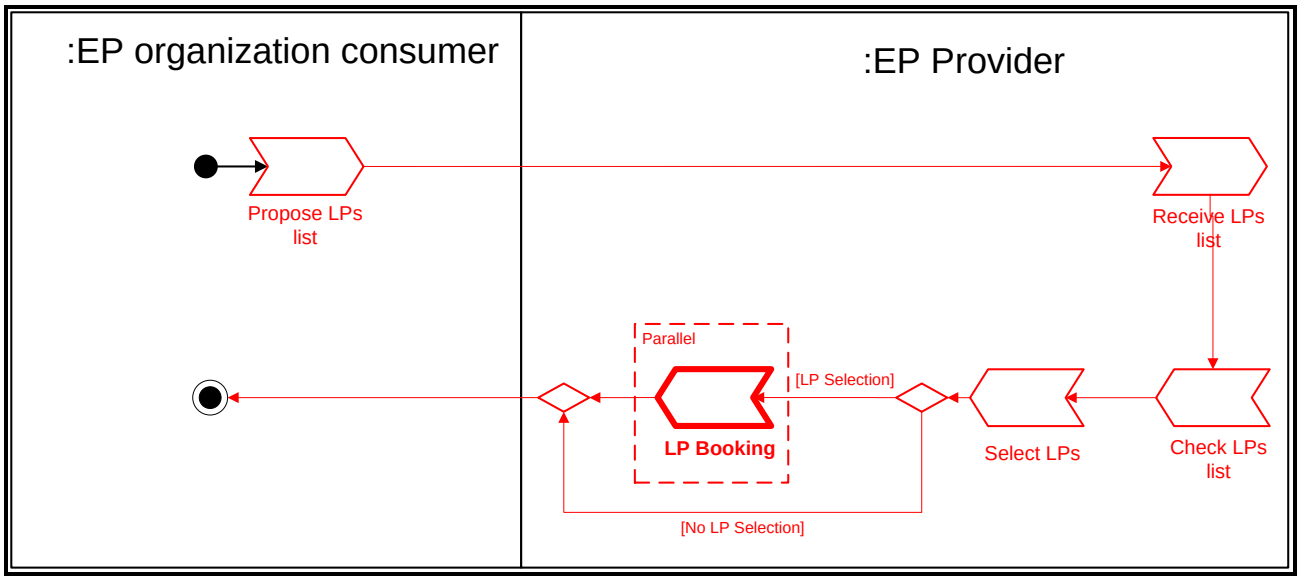
#### 8.3.4.4 The Offer LP process (Prodis)

The *Offer LP* process is a business process of the LP trading business that relates to the higher KW trading business processes. The process corresponds to the *Purchase KW* activity, and the activities partially enabled by the E-Portfolio system of the higher KW trading process. The *Offer LP* process is enabled by the Prodis system but it relates to the business processes of the E-Portfolio system, if the following condition on the higher KW trading business processes occurs:

- The offer to the KW is about LPs.
- The LP individual consumer is also a EP provider.

In the case an EP organization consumer, which is also an LP provider in the LP trading business within IBLC community, wants to offer a set of LPs to a KW the *Offer LP* process is modelled as shown in the activity diagram of *Appendix-Figure 4*.

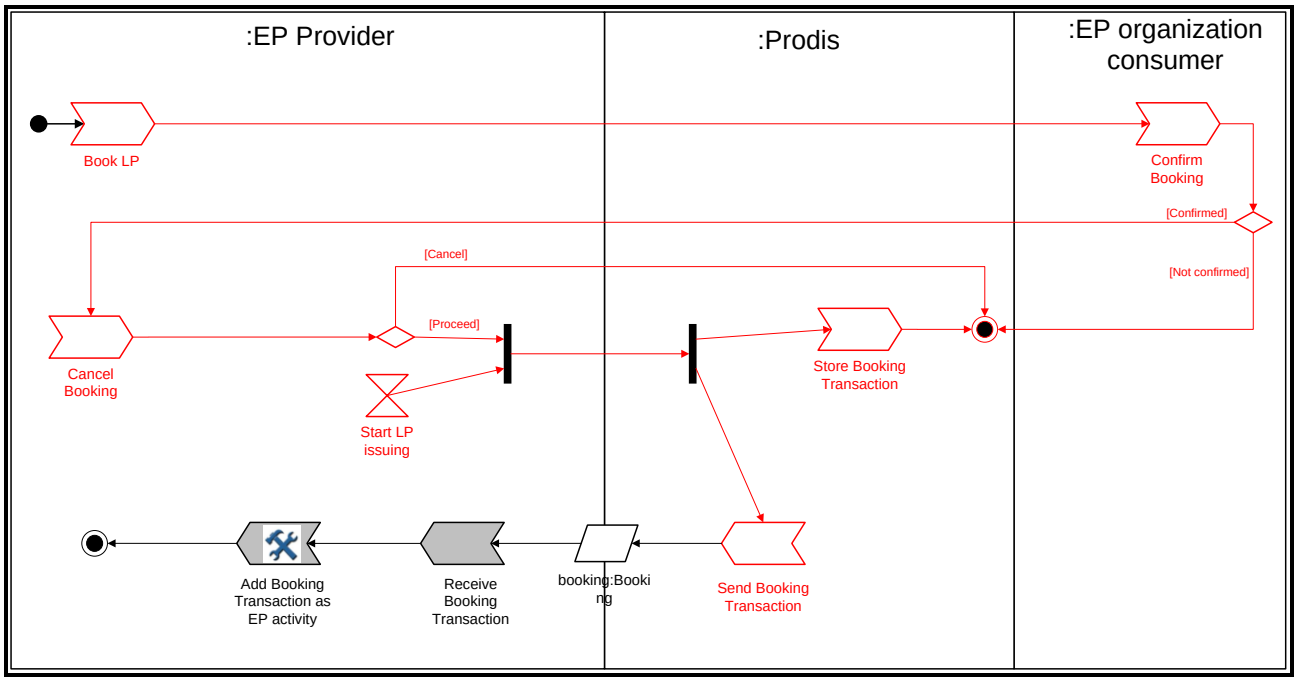
The activity diagram swimlanes correspond to the actors within the scope of the KW trading business. Of course, if extended to the whole IBLC community context the EP organization consumer has to be also a LP provider and the EP provider an LP individual consumer.




***Appendix-Figure 4: Offer LP process (LP trading context)***

The EP organization consumer offers a list of LPs that might be interesting for the EP Provider. This LP offer is based on the information stored in the EP of the EP provider. Once the EP provider receives the LPs list s/he checks them and creates an LPs selection that wants to purchase. For each LP is executed the LP booking process. The *LP booking* process is executed in parallel for every LP in the LP selection. This is modelled by placing the *LP booking* process within a *parallel expansion region* (UML 2). The parallel expansion region, given as input a collection of elements of the same type, executes the activities inside it in parallel for each element of the collection.

The *LP booking* process corresponds to the *Purchase KW* activity of the higher KW trading business processes. The *LP booking* process is modelled as shown in the activity diagram of *Appendix-Figure 5*. The process can be executed independently from the *Offer LP* process. That means that even if the LPs are not offered but directly purchased by an EP provider/LP individual consumer, they will be automatically added to his/her EP in any case.



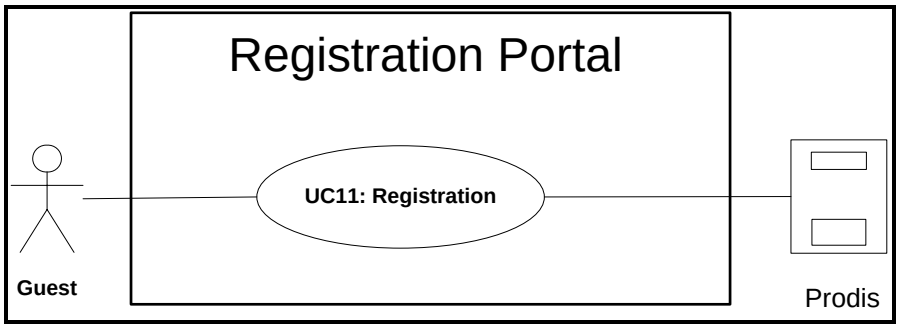

***Appendix-Figure 5: LP booking process (KW trading business)***

In the LP booking process the EP provider books the LP. The EP organization consumer who offered the LP has to confirm the booking. If it is not confirmed the process ends. Once the booking is confirmed the EP provider can cancel it at any time before the LP is issued. When the issuing of the LP starts the booking transaction is stored by Prodis and sent to the EP provider. The booking transaction is then added to the EP as an activity, according to IBLC Group predefined format.

## 8.4 Appendix D – Use Case Scenario Model

This appendix shows the use cases scenarios of the E-Portfolio system. The scenarios are presented by using the format prescribed by COMET. The use cases are presented according to the system sub-grouping made during the Reference Architecture Analysis as shown in section 4.6.

### 8.4.1 Registration Portal




*Appendix-Figure 6: Registration Portal*

The Registration Portal is a tool component of the E-Portfolio system for the Guest actors that want to register to the E-Portfolio system (*UC11: Registration*).

The actors that can make use of the Registration Portal are Guest and Prodis. The Prodis system is a supporting actor.

#### 8.4.1.1 UC11: Registration

The *UC11: Registration* use case maps the *Registration* business process of the Business Process and Roles Model (*section 4.3.1*). The *UC11: Registration* use case leads to the registration of a Guest user to the E-Portfolio system as Individual actor, in order to get involved in the KW trading business. Upon registration the Individual actor is considered as a potential EP individual consumer

within the KW trading business. The Organization actor does not need registration to the E-Portfolio system.

**CONTEXT:** In the *UC11: Registration* uses case, according to the *Registration* process, two scenarios are identified. As previously mentioned an IBLC community individual partner is not necessarily an E-Portfolio Individual actor and, if not registered, it is seen by the system as a Guest actor. On the other hand every E-Portfolio system Individual actor has to be an IBLC community individual partner; therefore every Guest upon registration has to be an IBLC community individual partner.

The main scenario, shown in *Appendix-Table 8*, regards the case when the Guest is already an IBLC community Individual partner. In this case, the Guest has already registered to Prodis and has his/her account information stored in it. Therefore the Guest can use the IBLC community identification data, issued upon registration to Prodis, to register to the E-Portfolio system. The E-Portfolio system will then import the account information from Prodis (which will enable his/her KW trading account in order to use the E-Portfolio system) for that specific partner.

**A) Main scenario (Guest already IBLC Community partner)**

| ***UC 11*** | ***Registration*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Involve Guest in the KW trading business | |
| **Actors** | Guest (initiating), Prodis (involved) | |
| **Pre-conditions** | Guest not already registered in the E-Portfolio system but already IBLC Community partner | |
| **Post-conditions** | Guest registered as E-Portfolio system Individual actor | |
| **Description** | Step | Action |
| | 1 | Fill-in the registration form with IBLC community identification data |
| | 2 | Submit the registration form |
| | 3 | Receive registration to E-Portfolio system confirmation (KW trading account enabled). The identification data for E-Portfolio system are the same as IBLC community |

***Appendix-Table 8: Registration use case Main Scenario***

The alternative scenario regards the case when the Guest is not an IBLC community individual partner. In this case the Guest is not registered in Prodis, therefore s/he is required by the E-Portfolio system to fill in the registration form with his/her account information. The E-Portfolio system will first store the account information, and then submit them to the Prodis system which will release the identification data (enabling both LP and KW trading business accounts). The Guest will then receive, from the E-Portfolio system, a registration confirmation and his/her IBLC community identification data.

In this scenario the truthfulness of the information about company/university indicated by the Guest as current work/study place, can be verified. The E-Portfolio system should ask a confirmation to the company/university indicated by the Guest. Indeed, this verification is feasible just if the given company/university belongs to IBLC community and therefore registered in Prodis. Consequently

the E-Portfolio system should have in its database a list of IBLC community organization partners, given the fact that they do not require registration to the system.

In the scenario shown in *Appendix-Table 9*, the flow of actions lists all the possible form filling combinations (*step 1: Fill-in the registration form with account information*) that influence the system behavior. Other scenarios are obtained by simply taking a subset of the sub-steps of *step 1*. Making one scenario for every possible subset of combination would result in too many models not relevant for the description of the system behavior.

**B) Alternative Scenario (Guest not IBLC Community partner)**

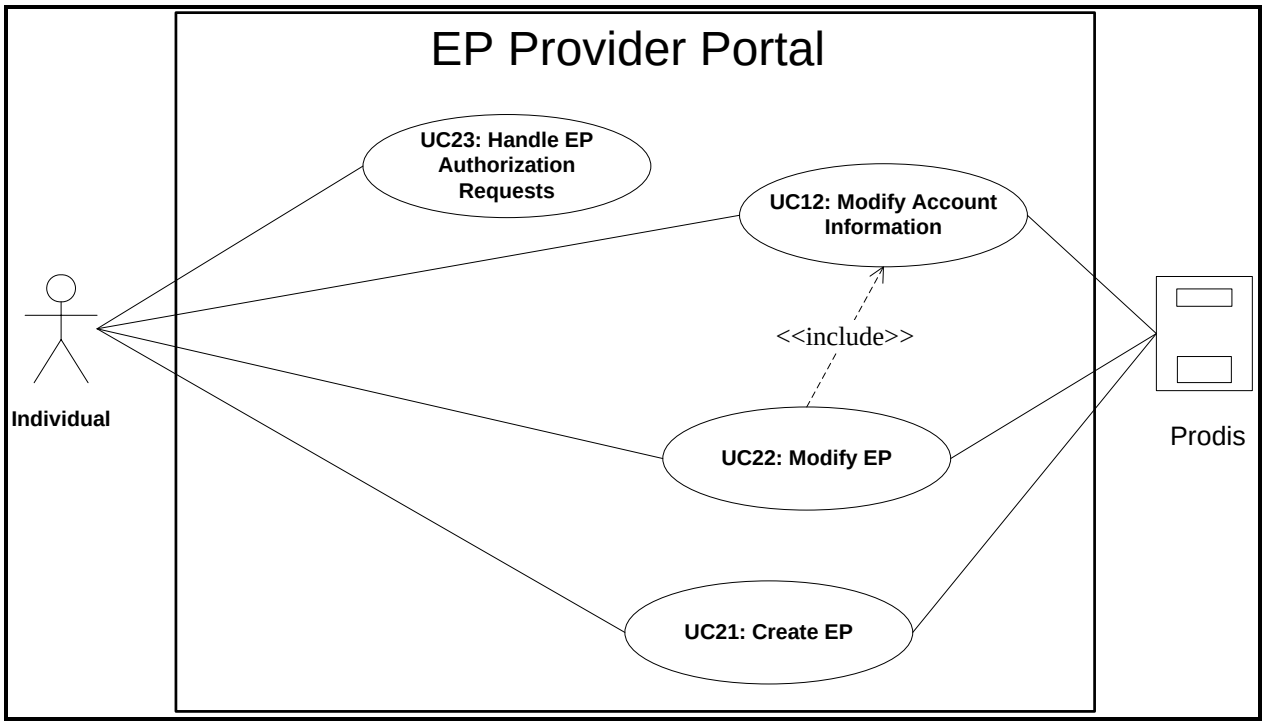
| ***UC 11*** | ***Registration*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Involve Guest in the KW trading business | |
| **Actors** | Guest (initiating), Prodis (involved) | |
| **Pre-conditions** | Guest not already registered | |
| **Post-conditions** | Guest registered as E-Portfolio system Individual actor, account information stored also in Prodis | |
| **Description** | Step | Action |
| | 1 | Fill-in the registration form with account information |
| | 1.1 | If applicable, select current university/company among other E-Portfolio system users (verification possible) |
| | 1.2 | Fill-in other account information |
| | 2 | Submit the registration form |
| | 3.1 | Receive registration confirmation to E-Portfolio system and IBLC Community and IBLC community identification data (are used to identify yourself to get involved in IBLC community business) |
| | 3.2 | Verify information |

***Appendix-Table 9: Registration use case Alternative Scenario***

The steps performed by Prodis occur outside the boundaries of the E-Portfolio system; hence they are not detailed in the scenarios.

The information not verified or with the pending verification status is in any case stored by the system as not verified. The amount of verified information contributes to the IBLC score.

### 8.4.2 EP Provider Portal




***Appendix-Figure 7: EP Provider Portal***

The EP Provider Portal is a tool component of the E-Portfolio system used by the Individual actors for the management of their own EPs and account information. The *UC12: Modify Account Information* and *UC21: Create EP* are the only use cases that do not require the Individual actors to have EP Provider role within the KW trading business.

The actors that can make use of the EP Provider Portal are Individual and Prodis. The Prodis system is not an initiating actor for any use case but it is involved for reasons specific for each use case. These reasons, for each use case, are made explicit in its related subsection.

#### 8.4.2.1 UC12: Modify Account Information

The *UC12: Modify Account Information* use case leads to modification made by an Individual partner to his/her account information.

**CONTEXT:** The *UC12: Modify Account Information* is initiated by an Individual actor that wants to make modifications on his/her account information. The account information is that linked to the partnership of an Individual actor within IBLC community. IBLC Group wants to give the opportunity for the Individual actor to modify his/her account information through the E-Portfolio system, without necessarily interact with Prodis.

The *UC12: Modify Account Information* use case is initiated directly by partners that do not have an EP. When a partner has already his/her own EP the *UC12: Modify Account Information* use case behavior is included in the *UC22: Modify EP* use case, to logically join the account information with the EP.

In the *UC12: Modify Account Information* the Individual actor opens his/her account information, makes the desired modifications and saves them. The modifications may concern both content and authorization measures. Once the account information is saved they are checked by the E-Portfolio system, stored and sent to Prodis. The E-Portfolio system is responsible to automatically verify the truthfulness of information concerning current employment where the involved parties are partners of IBLC community.

In the scenario shown in *Appendix-Table 10*, the flow of actions lists all the possible modification combinations (*step 3: Modify the account information*) that influence the system behavior. Other scenarios are obtained by simply taking a subset of the sub-steps of *step 3*. Making one scenario for every possible subset of combination would result in too many models not relevant for the description of the system behavior.

| ***UC12*** | ***Modify Account Information*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Keep the account information always updated<br>*G7: Provide qualitative EPs* | |
| **Actors** | Individual (initiating), Prodis (involved) | |
| **Pre-conditions** | Individual actor registered | |
| **Post-conditions** | Modified account information stored in E-Portfolio system and Prodis | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve your account information |
| | 3 | Modify your account information |
| | 3.1 | If applicable, select current university/company among other E-Portfolio system users (verification possible) |
| | 3.2 | Modify other account information |
| | 4 | Save account information |
| | 5 | Verify information |

***Appendix-Table 10: Modify Account Information use case Scenario***

The steps performed by Prodis occur outside the boundaries of the E-Portfolio system; hence they are not detailed in the scenario.

The information not verified or with the pending verification status is in any case considered by the system as not verified. The amount of verified information contributes to the IBLC score**.**

#### 8.4.2.2 UC21: Create EP

The *UC21: Create EP* use case leads to the successful creation of an EP by an Individual actor in order to put him/herself within the KW trading market as EP provider. An individual actor that creates his/her EP is called *EP owner*. Once an Individual creates his/her EP, besides being a potential EP individual consumer, becomes an EP provider in the KW trading business.

**CONTEXT:** In the *UC21: Create EP* use case an Individual wants to create his/her own EP by filling-in the EP form according to IBLC Group format and set authorization measures. When the Individual saves his/her EP, the E-Portfolio system stores the EP and sends it to Prodis. The E-Portfolio system is responsible to verify the truthfulness of activities where the involved parties are E-Portfolio system users, by asking confirmation to them. The Prodis system is responsible to add to the EP the LP booking transactions belonging to the EP owner (as LP individual consumer) already stored within IBLC community as activities and send it back to the E-Portfolio system. The status of the activities derived from LP booking transactions in Prodis is already set to verified. The E-Portfolio system will then deliver the complete EP to the Individual.

The account information provided by the Individual actor upon registration is logically considered as part of the EP once it has been created.

Once the EP is created it will be available for EP consumers both Individual and Organizations. This availability is constrained by a set of authorization measures.

In the scenario shown in *Appendix-Table 11*, the flow of actions embraces all the possible EP filling combinations (*step 2: Fill-in EP according to IBLC Group format*) that influence the system behavior. Other scenarios are obtained by simply taking a subset of the sub-steps of *step 2*. Making one scenario for every possible subset of combination would result in too many models not relevant for the description of the system behavior.

| ***UC21*** | ***Create EP*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | *G7: Provide qualitative EPs,*<br>*G3 : Enable knowledge development planning,*<br>*G11 : Proper KW professional information privacy measures* | |
| **Actors** | Individual (initiating), Prodis (involved) | |
| **Pre-conditions** | Individual actor registered, EP not existing | |
| **Post-conditions** | EP created and stored, Individual actor gets EP Provider role | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Fill-in EP according to IBLC Group format |
| | 2.1 | Add activities |
| | 2.1.1 | If applicable, add activity by selecting the issuer among other E-Portfolio system users (verification possible) |
| | 2.2 | Add other information |

| | | |
|---|---|---|
| | 3 | Save EP |
| | 4.1 | Receive complete EP (In the case the Individual actor has activities already registered in Prodis, those will be automatically added to the EP) |
| | 4.2 | Verify information |

***Appendix-Table 11: Create EP use case Scenario***

The steps performed by Prodis occur outside the boundaries of the E-Portfolio system; hence they are not detailed in the scenario.

The activities not verified or with the pending verification status are in any case stored by the system as not verified. The amount of verified information contributes to the IBLC score.

#### 8.4.2.3 UC22: Modify EP

The *UC22: Modify EP* use case leads to modification made to an EP by its owner. The modifications have to conform to IBLC community EP format.

**CONTEXT:** In the *UC22: Modify EP*, an Individual actor wants to make modifications on his/her EP. The Individual retrieves his/her EP, makes the desired modifications and saves the modified EP. The modifications may concern both the content (also account information) and the authorization measures of an EP.

Once the EP is saved it is checked by the E-Portfolio system and then stored. If there are modifications concerning account information or activities (either new ones or modification on existing ones) the EP has to be sent to Prodis. The E-Portfolio system is responsible to automatically verify the truthfulness of activities and current employment where the involved parties are partners of IBLC community.

In the scenario shown in *Appendix-Table 12*, the flow of actions embraces all the possible modification combinations (*step 3: Modify your EP*) that influence the system behavior. Other scenarios are obtained by simply taking a subset of the sub-steps of *step 3*. Making one scenario for every possible subset of combination would result in too many models not relevant for the description of the system behavior.

| ***UC22*** | ***Modify EP*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Keep the EP up-to-date,<br>*G7: Provide qualitative EPs,*<br>*G3 : Enable knowledge development planning,*<br>*G11 : Proper KW professional information privacy* | |
| **Actors** | Individual (initiating), Prodis (involved) | |
| **Pre-conditions** | Individual actor registered, EP already created | |
| **Post-conditions** | EP successfully modified | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve your EP |
| | 3 | Modify your EP |
| | 3.1 | Modify account information according to *UC12: Modify Account Information* |
| | 3.2 | Modify existing activities |
| | 3.3 | Add activities |

| | | |
|---|---|---|
| | 3.3.1 | If applicable, add activity by selecting the issuer among other E-Portfolio system users (verification possible) |
| | 3.4 | Modify existing other information |
| | 3.5 | Add other information |
| | 4 | Save modified EP |
| | 5 | Verify EP information |

***Appendix-Table 12: Modify EP use case Scenario***

The steps performed by Prodis occur outside the boundaries of the E-Portfolio system; hence they are not detailed in the scenario.

The activities not verified or with the pending verification status are in any case stored by the system as not verified. The amount of verified information contributes to the IBLC score.

#### 8.4.2.4 UC23: Handle EP Authorization Requests

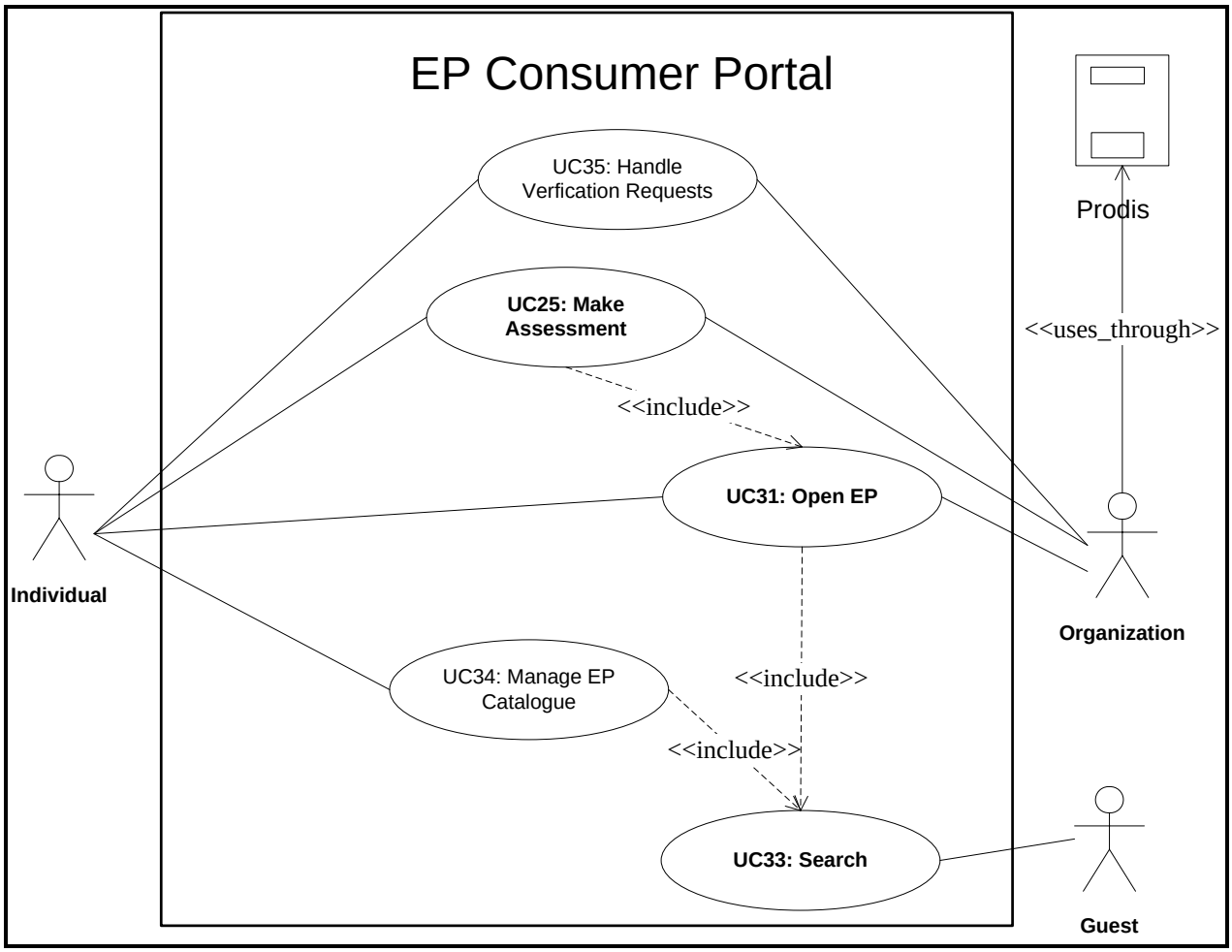
The *UC23: Handle EP Authorization Requests* use case leads to the denial/allowance by the EP owner, of an authorization to perform a specific operation on a EP, to the requesting parties.

**CONTEXT:** In the *UC23: Handle EP Authorization Requests*, an Individual and EP owner retrieves his/her list with the pending EP authorization requests. Each authorization request is submitted by a specific EP consumer, either Individual or Organization, and relates to a specific operation to perform on an EP. The EP owner can either deny or allow the request. Once the EP owner has accepted/denied the requests the interested parties are notified by the E-Portfolio system.

| ***UC23*** | ***Handle EP Authorization Requests*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | *G11 : Proper KW professional information privacy measures* | |
| **Actors** | Individual | |
| **Pre-conditions** | Individual actor registered, EP already created. | |
| **Post-conditions** | Authorization response saved in the authorization history | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve EP authorization list |
| | 3 | Retrieve the EP pending authorization requests |
| | 4 | Accept/Deny the pending requests |
| | 5 | Submit EP authorization list |
| | 6 | Notify interested parties |

***Appendix-Table 13: Handle EP Authorization Requests use case Scenario***

### 8.4.3 EP Consumer Portal




*Appendix-Figure 8: EP Consumer Portal*

The EP Consumer Portal is a tool component of the E-Portfolio system used by Individual and Organization actors, in the role of EP consumers, and contains the use cases for the retrieval, access and modification of EPs belonging to other parties.

The actors that can make use of the EP Consumer Portal are Individual, Organization and Guest. The Guest can just make use of the *UC33: Search* to search for E-Portfolio system users.

#### 8.4.3.1 UC33: Search

The *UC33: Search* use case leads to the retrieval of E-Portfolio system end-users according to a set of criteria chosen by a requesting party.

**CONTEXT:** In the *UC33: Search* use case a party (Individual, Organization or Guest actor) launches a search according to specific criteria. The criteria can be concerning the content of an EP (such as activities or other information) or a specific Organization or Individual actor (such as name, surname or company name). The E-Portfolio system receives the request and delivers the results matching the criteria to the requesting party.

| ***UC24*** | ***Search*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Retrieve E-Portfolio system's users | |
| **Actors** | Individual, Organization, Guest | |
| **Pre-conditions** | - | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 1 | Choose search criteria |
| | 2 | Submit search |
| | 3 | Receive the search results |

***Appendix-Table 14: Search use case Scenario***

The ranking of the results depends, among other factors (such as relevance), on the IBLC score.

#### 8.4.3.2 UC31: Open EP

The *UC31: Open EP* use case leads to the delivery of the information stored in a set of EPs to an E-Portfolio end-user different than their owners.

**CONTEXT:** In the *UC31: Open EP* use case two scenarios are identified. The opening of a specific EP by a third party is constrained by the authorization measures set by the related EP owner. In both scenarios it is assumed that the actor initiating the use case has already, or eventually obtains upon request, the authorization necessary to open the EPs by the EP owners. In the case the authorization is not issued, the actor initiating the use case does not receive that specific EP.

The main scenario regards the case when the EPs to open are selected by an Individual actor from his/her EP Catalogue. The Organization actor cannot have an EP Catalogue therefore it is not involved in this scenario. Once the EP owners are selected, the E-Portfolio system delivers the EP to the requesting Individual actor.

A) **Main Scenario (EPs selected from catalogue)**

| ***UC 31*** | ***Open EP*** | |
|---|---|---|
| **Priority** | 3 | |
| **Goal** | Access information stored on a third party EP<br>*G4 : Support recruitment and LP trading business (pull basis)*<br>*G5 : Support personal tutoring* | |
| **Actors** | Individual | |
| **Pre-conditions** | Individual EP catalogue existing (not empty) | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve your personal EP catalogue |
| | 3 | Select a set of EP owners |
| | 4 | Submit request to access the EPs of the selected EP owners |
| | 5 | Receive EPs |

***Appendix-Table 15: Open EP use case Main Scenario***

The alternative scenario regards the case when the EPs to open are selected by an Individual or an Organization actor by searching among the EP owners available within the E-Portfolio system. Once the EP owners are selected, the E-Portfolio system, if an authorization is issued, delivers the EPs to the requesting party.

**B) Alternative scenario (EPs selected by searching)**

| ***UC 31*** | ***Open EP*** | |
|---|---|---|
| **Priority** | 1 | |
| **Goal** | Access information stored on a third party EP<br>*G4 : Support recruitment and LP trading business (pull basis)*<br>*G5 : Support personal tutoring* | |
| **Actors** | Individual, Organization | |
| **Pre-conditions** | - | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve EPs according to *UC33: Search* |
| | 3 | Select a set of EP owners |
| | 4 | Submit request to access the EPs of the selected EP owners |
| | 5 | Receive EPs |

***Appendix-Table 16: Open EP use case Alternative Scenario***

### 8.4.3.3 UC25: Make Assessment

The *UC25: Make Assessment* use case leads to the assessment of a specific set of activities belonging to an EP made by an E-Portfolio user different than its owner (Individual or Organization actor).

**CONTEXT:** In the *UC25: Make Assessment* use case, a party (Individual or Organization) that wants to assess a specific set of activities of a EP open the desired EP, in order to receive the information stored in it. After the EP is opened, the party chooses the activities to asses, makes the assessment and saves the modification.

The assessment of a specific activity of a specific EP is constrained by the authorization measures set by the EP owner. In the scenario it is assumed that the actor initiating the use case has already, or obtains upon request, the authorization necessary to assess a specific activity of the EP by the related EP owner. In the case the assessment has not been authorized, the assessments are discarded.

| ***UC 25*** | ***Make Assessment*** | |
|---|---|---|
| Priority | 1 | |
| Goal | *G8 : Enable third-parties Assessment of KWs* | |
| Actors | Individual, Organization | |
| Pre-conditions | - | |
| Post-conditions | Selected activities assessed | |
| Description | Step | Action |
| | 1 | Identify yourself |
| | 2 | Open EP according to *UC31: Open EP* |
| | 3 | Select activities to assess |
| | 4 | Assess activities |
| | 5 | Save assessments |

***Appendix-Table 12: Make Assessment use case Scenario***

#### 8.4.3.4 UC34: Manage EP Catalogue

The *UC34: Manage EP Catalogue* use case leads to the add/removal of a set of EP owners to/from the EP Catalogue belonging to an Individual actor. The Organization actor cannot have an EP Catalogue therefore it is not involved in this use case.

**CONTEXT:** The EP Catalogue is used by an Individual actor to save a list of EP owners which are interesting for him/her. The EP owners are not aware to be saved/removed to/from the EP Catalogue, therefore they can be added/removed without the Individual actor to be authorized. Consequently, it is not necessary that the Individual, in order to save EP owners, has authorization to perform any specific operation on their EPs.

In the *UC34: Manage EP Catalogue* use case two scenarios are identified. The main scenario regards the case when the Individual actor wants to add EP owners to his/her EP Catalogue. The alternative scenario regards the case when the Individual actor wants to remove EP owners from his/her EP Catalogue.

In the main scenario the Individual actor retrieves interesting EP owners according to *UC33: Search*. Among the set of results s/he selects those interesting for him/her and add them to his/her EP Catalogue. When the add task is finished the Individual saves his/her EP Catalogue.

**A) Main Scenario (Add EP owners to EP Catalogue)**

| ***UC 34*** | ***Manage EP Catalogue*** | |
|---|---|---|
| **Priority** | 2 | |
| **Goal** | Save interesting EP owners | |
| **Actors** | Individual | |
| **Pre-conditions** | - | |
| **Post-conditions** | Updated EP Catalogue successfully stored in the database | |
| **Description** | Step | Action |
| | 1 | Identify yourself |

| | | |
|---|---|---|
| | 2 | Retrieve your EP Catalogue |
| | 3 | Look for EP owners according to *UC33: Search* |
| | 4 | Select EP owners to add |
| | 5 | Add EP owners |
| | 6 | Save EP Catalogue |

***Appendix-Table 17: Manage EP Catalogue use case Main Scenario***

In the alternative scenario, as shown in *Appendix-Table 18*, the Individual actor retrieves his/her PP Catalogue and selects the EP owners s/he want to remove. When the remove task is finished the Individual save his/her EP Catalogue.

**B) Alternative Scenario (Remove EP owners from EP Catalogue)**

| ***UC 33*** | ***Manage EP Catalogue*** | |
|---|---|---|
| **Priority** | 2 | |
| **Goal** | Remove not interesting EP owners | |
| **Actors** | Individual | |
| **Pre-conditions** | EP catalogue existing (not empty) | |
| **Post-conditions** | Updated EP Catalogue successfully stored in the database | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve your EP Catalogue |
| | 3 | Select EP owners to remove |
| | 4 | Remove EP owners |
| | 5 | Save EP Catalogue |

***Appendix-Table 18: Manage EP Catalogue use case Alternative Scenario***

### 8.4.3.5 UC35: Handle Verification Request

The *UC35: Handle Verification Request* use case leads to the confirm/denial of a verification request by a verifier, either Individual or Organization actor, involved in the information to be verified.

**CONTEXT:** When the E-Portfolio system finds not-verified information about EP activities or current employment of an Individual actor, where the other involved party is an E-Portfolio system end-user, requires this information to be verified. That means that the other involved party, the verifier, should confirm the truthfulness of what is stated in this information. Hence, the E-Portfolio system sends a verification request to these involved parties.

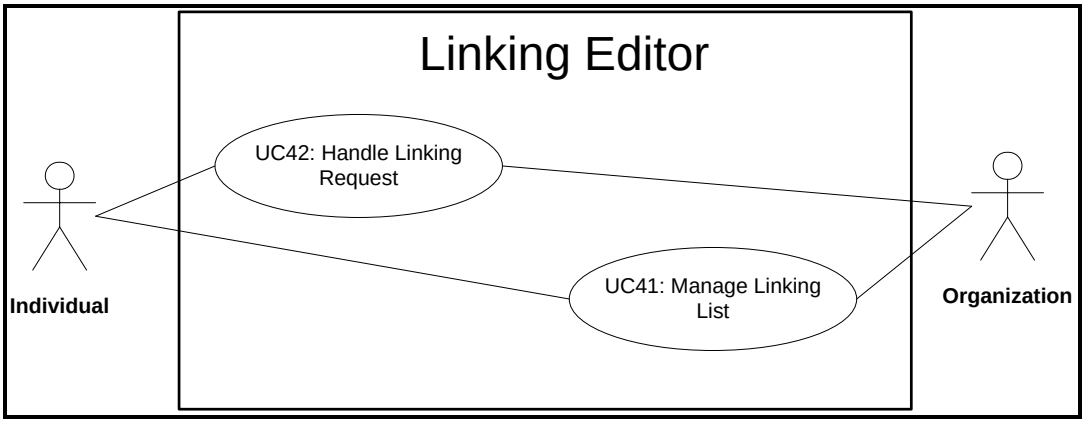
In the *UC35: Handle Verification Request* a verifier, either Individual or Organization actor, retrieves his/her list with pending verification request. Each verification request contains the information to be verified and the Individual actor the information refers to. The verifier can either confirm or deny the verification request. Once the verifier saves his/her pending verification request

list the E-Portfolio system modifies the pending status of the information and notifies the interested parties.

| *UC35* | *Handle Verification Request* | |
|---|---|---|
| **Priority** | 2 | |
| **Goal** | *G10 : EPs information verification* | |
| **Actors** | Individual, Organization | |
| **Pre-conditions** | Pending verification list existing (not empty) | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve pending verification list |
| | 3 | Confirm/Deny the pending requests |
| | 4 | Save pending verification list |

***Appendix-Table 19: Handle Verification Request use case Scenario***

### 8.4.4 Linking Editor




***Appendix-Figure 9: Linking Editor***

The Linking Editor is a tool component of the E-Portfolio system used by Individual and Organization actors to create and manage professional links between them, similarly to the LinkedIn © system.

The linking system is based on the concept of professional link. A professional link occurs between two parties, the Linker, who submits the linking request and the Linked, who receives and accepts the linking request. The parties involved in a professional link can be Individual and Organization actors of the E-Portfolio system. To each link is associated a professional relationship, namely the nature of the link. Example of relationships can be *colleague_of*, *supervised_by* and so on. In a future perspective IBLC Group wants to replace, within IBLC community, the organization partners with an organizational hierarchy of individual partners based on the linking relationships.

An Individual partner can associate to a specific professional relationship a set of authorization measures related to its EP. That means the parties linked to a specific Individual actor with a specific relationship might acquire rights to perform a set of operations on his/her EP. For instance the Individual actor can specify that all the parties linked to him with a *colleague_of* relationship

have the right to open his/her EP without asking authorization, while parties linked to him with *supervised_by* can also assess activities without asking authorization.

#### 8.4.4.1 UC41: Manage Linking List

The *UC41: Manage Linking List* use case leads to the creation/removal of a professional link between two E-Portfolio end-users, either Organization or Individual.

**CONTEXT:** The linking list is used by an Individual actor to save all the professional links s/he has with another IBLC community partner. In the *UC41: Manage Linking List* use case a party (the Linker), either an Individual or Organization, wants to create/remove a professional link with another E-Portfolio system user (the Linked) to/from his/her list. The creation of a link has to be confirmed by both parties involved. For the removal of an existing link it is sufficient the intention of one of the two involved parties, either the Linker or the Linked. The other party does not need to both confirm and be aware of the link removal.

In the *UC41: Manage Linking List* use case two scenarios are identified. The main scenario regards the case when the party wants to add a link to his/her linking list. The alternative scenario regards the case when the party wants to remove a link from his/her linking list.

In the main scenario the Linker looks for the party s/he wants to link according to *UC33: Search*. Among the set of results s/he selects the party to whom s/he wants to be linked. Once the Linked party is selected the Linker has to specify the relationship of the link, either by choosing among those already existing or by creating a new one. Once the linking list is sent, the E-Portfolio system saves the new links with pending status and submits the linking requests to the Linked parties. If the request is accepted by the linked party the E-Portfolio system creates the link, save it in the linking list of both parties and the linker party will receive a confirmation.

**A) Main Scenario (Create a link)**

| ***UC 41*** | ***Manage Linking List*** | |
|---|---|---|
| **Priority** | 3 | |
| **Goal** | Create link with other E-Portfolio system users | |
| **Actors** | Individual, Organization | |
| **Pre-conditions** | - | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve linking list |
| | 3 | Search partners according to *UC33: Search* |
| | 4 | Propose links |
| | 4.1 | Select parties to link |
| | 4.2 | Specify linking relationship |
| | 5 | Save linking list |
| | 6 | Receive linking confirmations |

***Appendix-Table 20: Manage Linking List use case Main Scenario***

In the alternative scenario a party retrieves his/her linking list and selects the links s/he wants to remove. When the remove task is finished the party submit his/her linking list. The E-Portfolio system then removes the selected links from the linking list of both parties.

**A) Alternative Scenario (Remove a link)**

| *UC 41* | *Manage Linking List* | |
|---|---|---|
| **Priority** | 3 | |
| **Goal** | Remove link to other E-Portfolio system users | |
| **Actors** | Individual, Organization | |
| **Pre-conditions** | Linking list existing (not empty) | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve linking list |
| | 3 | Select links to remove |
| | 4 | Remove links |
| | 5 | Save linking list |

***Appendix-Table 21: Manage Linking List use case Alternative Scenario***

### 8.4.4.2 UC42: Handle Linking Request

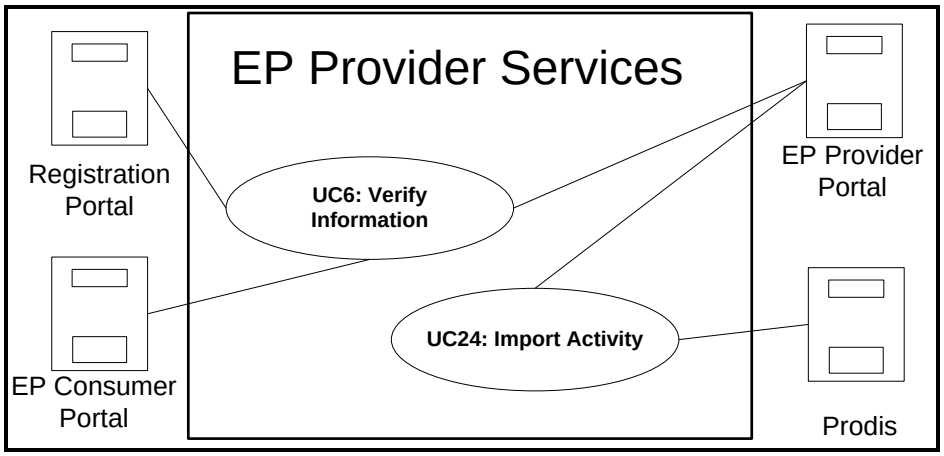
The *UC42: Handle Linking Requests* use case leads to the denial/allowance by a Linked party, either Individual or Organization, of a linking request.

**CONTEXT:** In the *UC42: Handle Linking Requests*, a Linked party retrieves his/her linking list with the pending linking requests. Each linking request is submitted by a Linker party, either Individual or Organization. The Linked party can either deny or allow the request. Once the Linked party saves his/her linking list, the E-Portfolio system modifies the pending status of the links and notifies the Linker parties.

| *UC 42* | *Handle Linking Request* | |
|---|---|---|
| **Priority** | 3 | |
| **Goal** | Accept/Deny link with other IBLC Community partners | |
| **Actors** | Individual, Organization | |
| **Pre-conditions** | - | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Identify yourself |
| | 2 | Retrieve linking list |
| | 3 | Retrieve pending linking requests |
| | 4 | Accept/Deny the pending requests |
| | 5 | Save linking list |

***Appendix-Table 22: Handle Linking Request use case Scenario***

### 8.4.5 EP Provider Services




***Appendix-Figure 10: EProvider Services***

The EP Provider Services is a business service component of the E-Portfolio system that provides services for the EP Provider Portal and Registration Portal tool components and Prodis.

The component contains two use cases *UC24: Import Activity* and *UC6: Verify Information* which are not initiated by any E-Portfolio system human actor.

#### 8.4.5.1 UC24: Import Activity

The *UC24: Import Activity* use case leads to the adding of an LP booking transaction made by an Individual actor, in the scope of the LP trading business, to his/her EP as activity.

**CONTEXT:** In the *UC24: Import Activity*, the Prodis system sends the LP booking transaction to the E-Portfolio system. The E-Portfolio system checks the LP booking transaction retrieves the EP of the Individual and adds the LP booking transaction as activity. The activities added through LP booking transactions are always considered as verified.

| *UC24* | *Import Activity* | |
|---|---|---|
| **Priority** | 2 | |
| **Goal** | *G9 : EPs automatic update* | |
| **Actors** | Prodis, Individual(involved) | |
| **Pre-conditions** | Individual actor registered, EP already created | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Receive LP booking transaction |
| | 2 | Check LP booking transaction |
| | 3 | Retrieve EP |
| | 4 | Add the LP booking transaction to the EP as activity |
| | 5 | Set activity status as verified |

***Appendix-Table 23: Import Activity use case Scenario***

#### 8.4.5.2 UC6: Verify Information

The *UC6: Verify Information* use case leads to the verification of information belonging to a specific E-Portfolio system Individual actor.

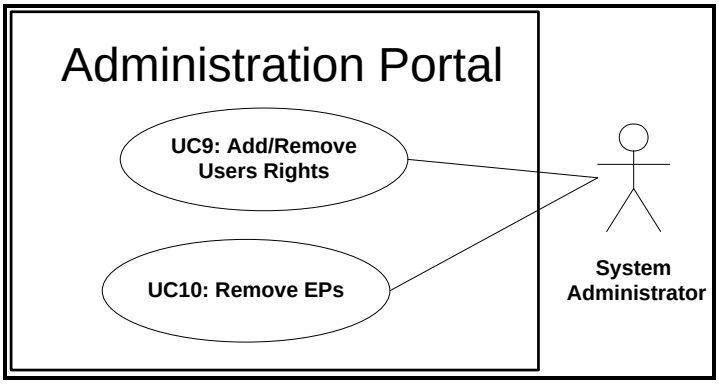
**CONTEXT:** The *UC6: Verify Information* use case is initiated by and involves tool components. Every time an EP or, in the case an Individual actor is not a EP provider, the account information of an Individual actor are saved, the EP Provider Portal or Registration Portal tool components send them to the EP Provider services.

In the *UC6: Verify Information* the EP or account information are checked for modifications. The modified information about company/university indicated by the Individual actor as current work/study place and activities where the involved parties are E-Portfolio system end-users, are to be verified. The E-Portfolio system sends a verification request to the E-Portfolio system users involved in the information indicated by the individual. Once the verification request's response is received the verification status of the activities is modified and the Individual actor that owns the information notified.

| *UC6* | *Verify Information* | |
|---|---|---|
| **Priority** | 2 | |
| **Goal** | G10 : EPs information verification | |
| **Actors** | EP Provider Portal, Registration Portal, EP Consumer Portal (involved) | |
| **Pre-conditions** | - | |
| **Post-conditions** | - | |
| **Description** | Step | Action |
| | 1 | Receive modified information |
| | 2 | Check information |
| | 3 | Retrieve related E-Portfolio system users |
| | 4 | Send verification requests to users |
| | 5 | Receive verification responses according to *UC35: Handle Verification Request* |
| | 5.1 | Change verification status of activities |
| | 5.2 | Notify Individual actor |

***Appendix-Table 24: Verify Information use case Scenario***

### 8.4.6 Administration Portal




***Appendix-Figure 11: Administration Portal***

The Administration Portal is a tool component used by the System Administrator to administrate the E-Portfolio system. The system administrator use the Administration Portal to add/remove users and their rights, according to *UC9: Add/Remove Users rights*, and to remove EPs, according to *UC10: Remove EPs*. The system administrator may find some EPs not qualitative or not conforming to IBLC community quality standards.

#### 8.4.6.1 UC9: Add/Remove Users

| ***UC9*** | ***Add/Remove Users*** | |
|---|---|---|
| **Goal** | Administer users privileges | |
| **Actors** | System Administrator | |
| **Pre-conditions** | System Administrator identified | |
| **Post-conditions** | User and right successfully stored in the E-Portfolio system | |
| **Description** | Step | Action |
| | 1 | The system administrator identifies himself |
| | 2 | The system administrator creates/removes users and assign roles |
| | 3 | The system administrator assigns/removes rights for each user. |

| | | |
|---|---|---|
| | 4 | The system administrator saves the users and rights |
| | 5 | The system stores the modifications. |

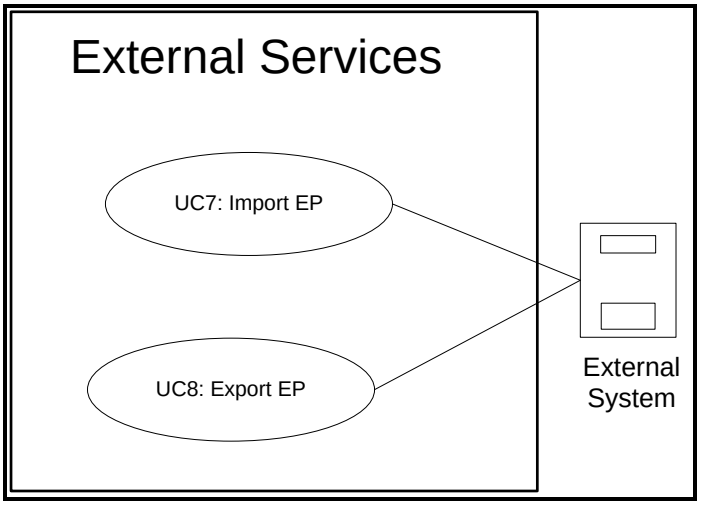
***Appendix-Table 25: Add/Remove Users use case Scenario***

#### 8.4.6.2 UC10: Remove EPs

| ***UC10*** | ***Remove PPs*** | |
|---|---|---|
| **Goal** | Administer EPs<br>*G7: Provide qualitative EPs* | |
| **Actors** | System Administrator | |
| **Pre-conditions** | System Administrator identified | |
| **Post-conditions** | Selected PPs successfully removed from the E-Portfolio system | |
| **Description** | Step | Action |
| | 1 | The system administrator identifies himself |
| | 2 | The system administrator selects the EPs to be removed |
| | 3 | The system administrator saves the modification. |
| | 4 | The system removes the selected EPs. |

***Appendix-Table 26: Remove EPs use case Scenario***

### 8.4.7 External Services




***Appendix-Figure 12: External Services***

The External Services are to import/export EPs from/to a system external to IBLC community. The imported EPs have to conform to IBLC Group predefined format. These services are not of high priority because the standardization formats for the exchange of EPs between different system are not well defined yet.

#### 8.4.7.1 UC7: Import EP

When an external system wants to import an EP to the E-Portfolio system, it has to provide identification about the Individual actor who performed the import request. The individual partner has to have a KW trading account enabled and he does not have to own an EP within IBLC community.

| ***UC7*** | ***Import EP*** |
|---|---|
| Goal | *G7 : Provide qualitative EPs* |
| Actors | External System |

| Pre-conditions | Individual partner identified with a KW trading account enabled and not EP owner | |
|---|---|---|
| Post-conditions | Imported EP successfully stored in E-Portfolio system | |
| Description | Step | Action |
| | 1 | The external system identifies itself |
| | 2 | The external system sends the EP |
| | 3 | The system receives the EP and checks for the individual partner |
| | 4 | The system stores the EP |

***Appendix-Table 27: Import EP use case Scenario***

#### 8.4.7.2 UC8: Export EP

When an external system wants to export an EP from the E-Portfolio system, it has to provide identification about the Individual actor who performed the export request. The individual partner has to have a KW trading account enabled and he has to own an EP within IBLC community.

| ***UC9*** | ***Export EP*** | |
|---|---|---|
| Goal | Exporting EP to other systems | |
| Actors | External System | |
| Pre-conditions | Individual partner identified with a KW trading account enabled and EP existing | |
| Post-conditions | EP successfully exported to the external system | |
| Description | Step | Action |
| | 1 | The external system identifies itself |
| | 2 | The external system sends the export EP request |
| | 3 | The system receives the request and checks for the individual partner |
| | 4 | The system retrieves the EP |
| | 5 | The system sends the EP to the external system |

***Appendix-Table 28: Export EP use case Scenario***

## 8.5 Appendix E – Architecture Model

This appendix shows the results and the set of COMET Architecture Model obtained during the design phase that did not find place in chapter 5.

### 8.5.1 Component Structure Model

The purpose of the Component Structure Model is to understand and describe the components that together build up the E-Portfolio system, the dependencies between the components, the interfaces they offer, and their use/access of other components through their interfaces.

The Component Structure Model should document:

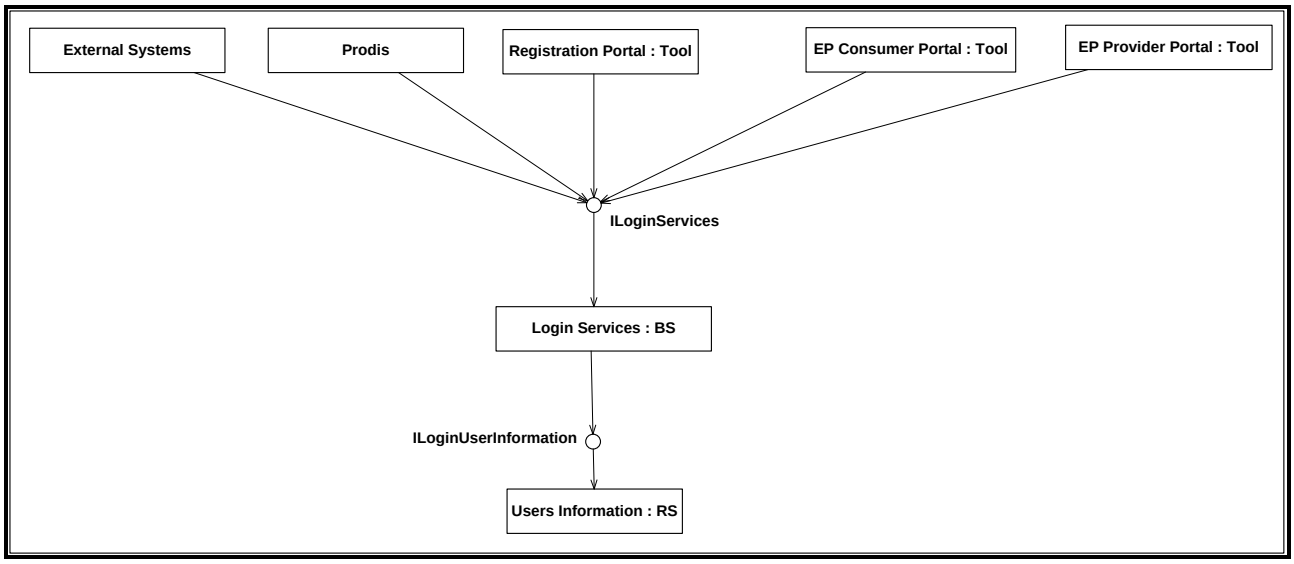
- The software (and hardware) architecture represented by the components that comprise the product. The purpose of a system architecture specification is to subdivide the system into comprehensible units that represent meaningful groupings (according to Reference Architecture Analysis);

- The dependencies between components, and the interfaces realised and required by them.

Hereby are presented Component Structure Model that do not describe functionality specific for the E-Portfolio system and therefore were not shown in *chapter 4*.

#### 8.5.1.1 Login Model

The Login Model is a view on the Component Structure Model that describes the component involved in the login mechanism for the E-Portfolio system. The login mechanism is made according to the pattern described in [11].

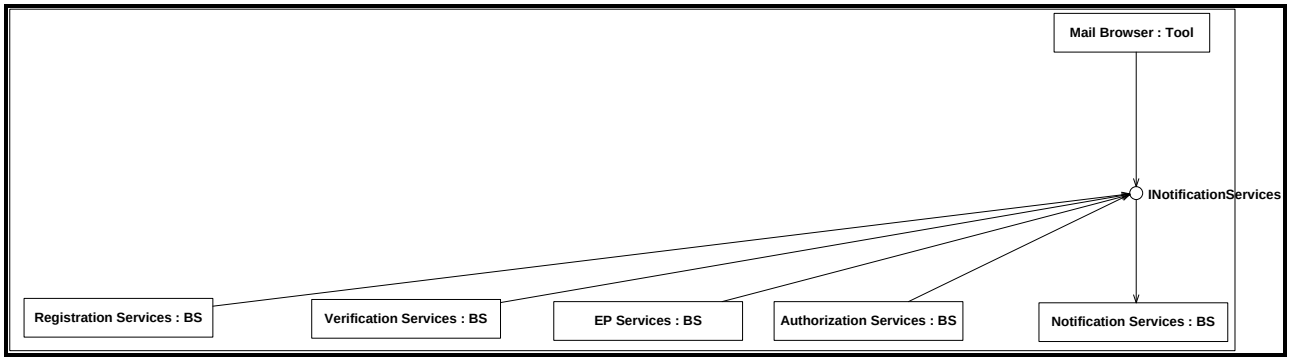



*Appendix-Figure 13: Login Component Structure Model for the E-Portfolio system*

### 8.5.1.2 Notification Model

The Notification Model is a view on the Component Structure Model that describes the component involved in the notification mechanism for the E-Portfolio system. The Notification Services is the business services component responsible to send the notifications to end-users upon request made by other business service components.

The notifications are received by the end-users through a Mail Browser tool component.




*Appendix-Figure 14: Notification Component Structure Model for the E-Portfolio system*

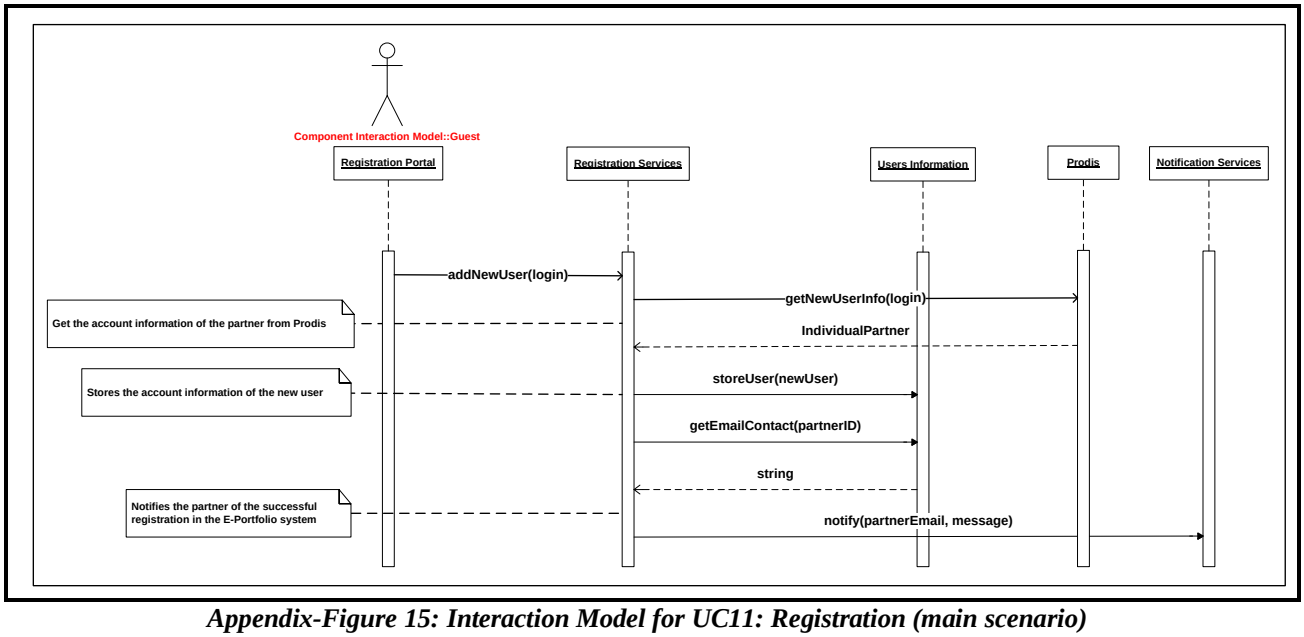
### 8.5.2 Interaction Model

The Component Interaction Model offers a dynamic view of the E-Portfolio system, focusing on the collaboration between components for the purpose of offering services. The services the E-Portfolio system has to offer are those needed to fulfill the use cases identified and described in the Use Case Model of *section 4.4*.

The Interaction Model realizes just the cases where the EP Consumer is an Individual actor. In the case the EP Consumer is an Organization actor, it is sufficient to replace the EP Consumer Portal with the Prodis system.

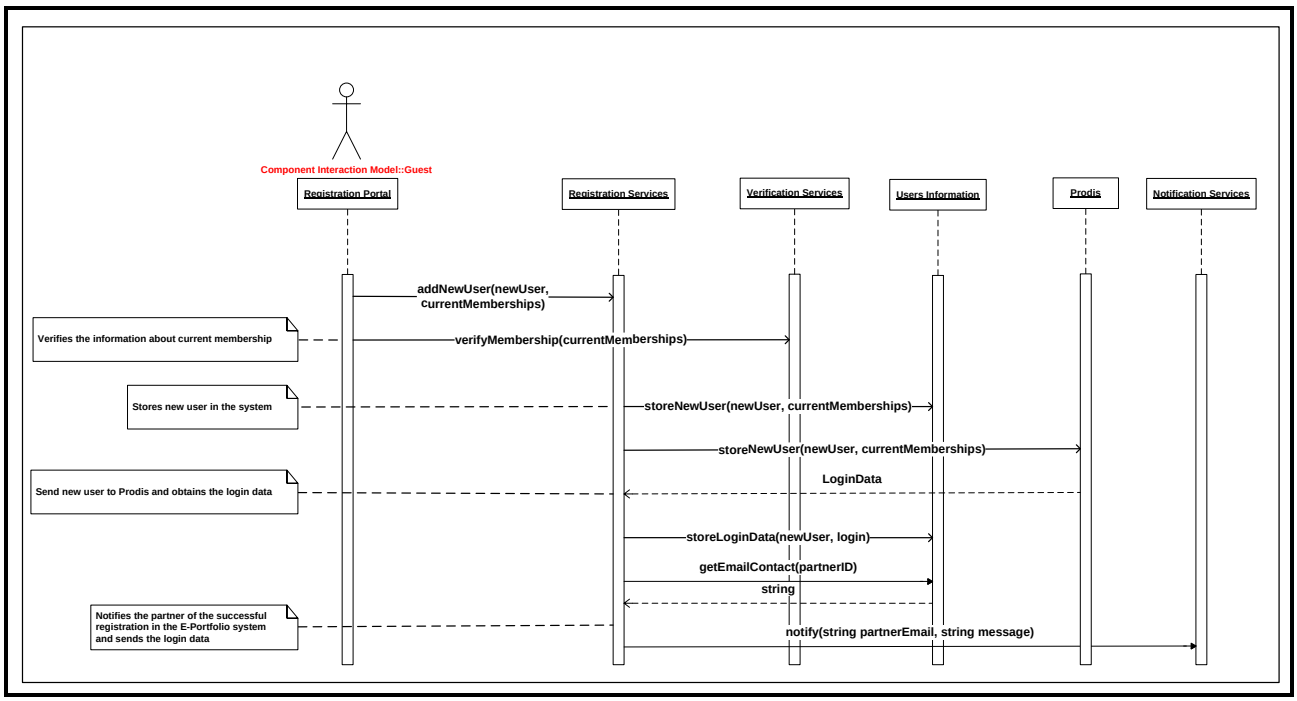
#### 8.5.2.1 UC11: Registration

The Interaction Model for the *UC11: Registration* is composed, according to the Use Case Scenario Model of *section 4.4.2*, by two scenarios.




***Appendix-Figure 15: Interaction Model for UC11: Registration (main scenario)***

*Appendix-Figure 15* shows the realization of the scenario when the Guest that wants to register is already partner of IBLC Community. The Registration Services obtains the account information of the Guest actor from Prodis by sending his/her partner's login data.




***Appendix-Figure 16: Interaction Model for UC11: Registration (alternative scenario)***

*Appendix-Figure 16* shows the realization of the scenario when the Guest that wants to register is not partner of IBLC Community. In this case the Registration Services is responsible to send the account information of the end-user to Prodis, which generates and send back the login data. The Verification Services is responsible to verify the information about the membership of the Guest.

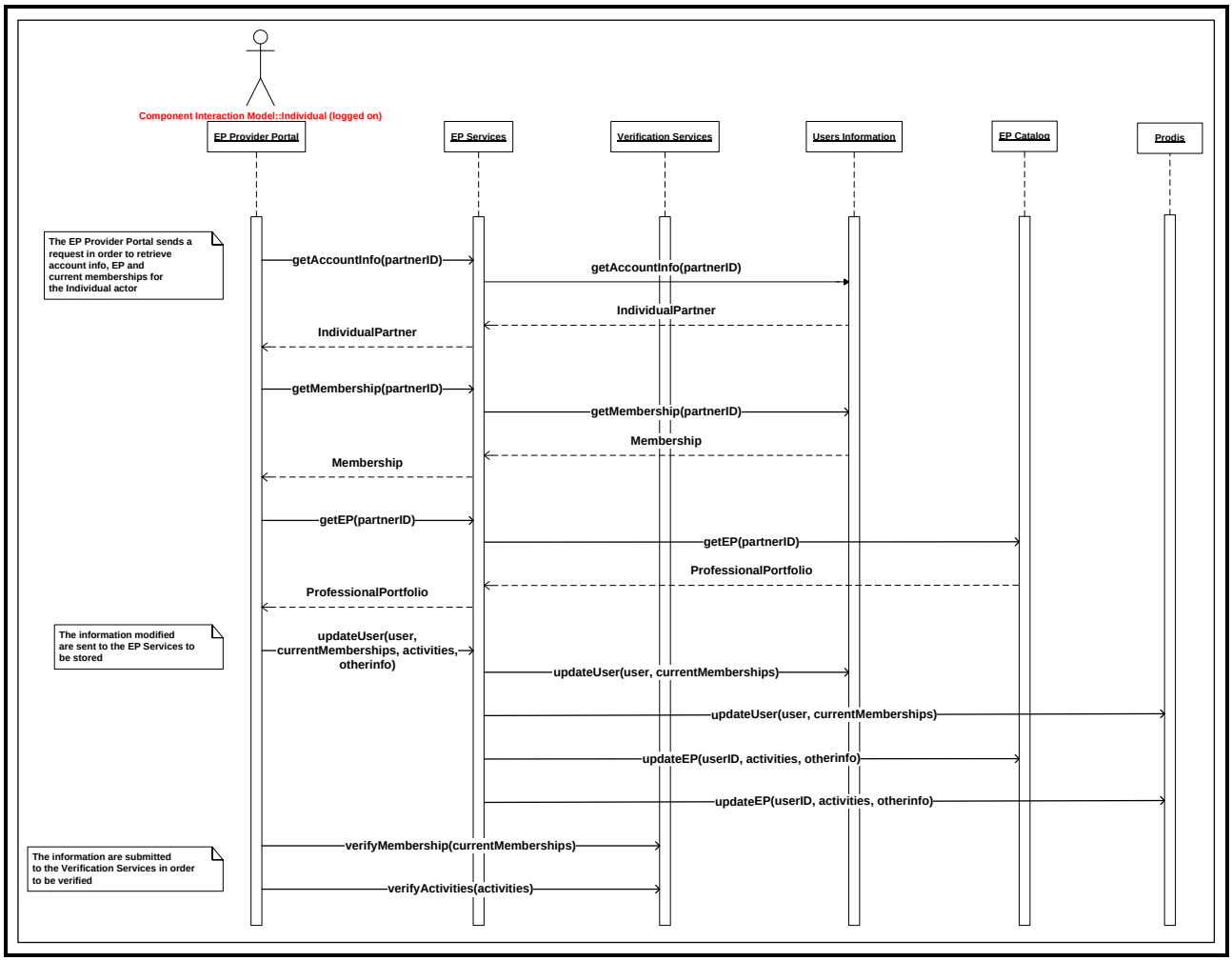
#### 8.5.2.2 UC22: Modify EP

The Interaction Model for the *UC22: Modify EP* realizes, according to the Use Case Scenario Model of *section 4.4.2*, also the *UC12: Modify Account Information.* The end-user through the EP Provider Portal requires to the EP Services his/her account information (which include the memberships) and EP. All the combinations (i.e. just account information) are allowed.

When the Individual actor saves the modified information, the EP Services stores them and send to Prodis. Memberships and activities are submitted by the EP Provider Portal to the Verification Services to be verified.

In the case the Individual partner is not an EP provider and wants to modify his/her account information, s/he will act through the EP Consumer tool component, instead of the EP Provider.

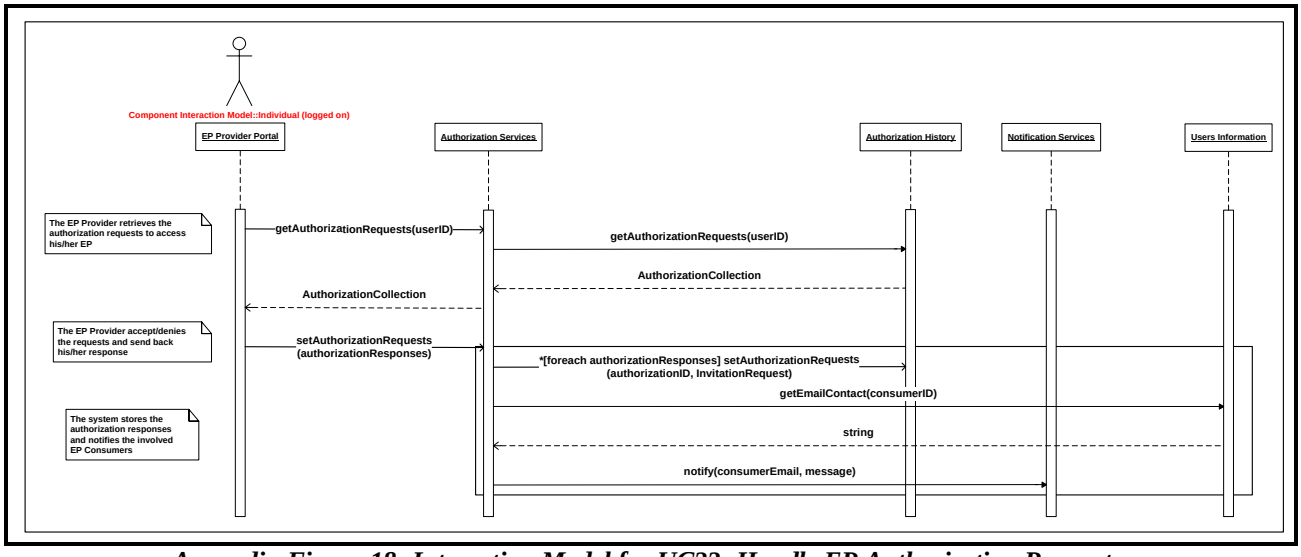
The Interaction Model for the *UC22: Modify EP* is shown in Appendix-Figure 17.




*Appendix-Figure 17: Interaction Model for UC22: ModifyEP*

### 8.5.2.3 UC23: Handle EP Authorization Requests

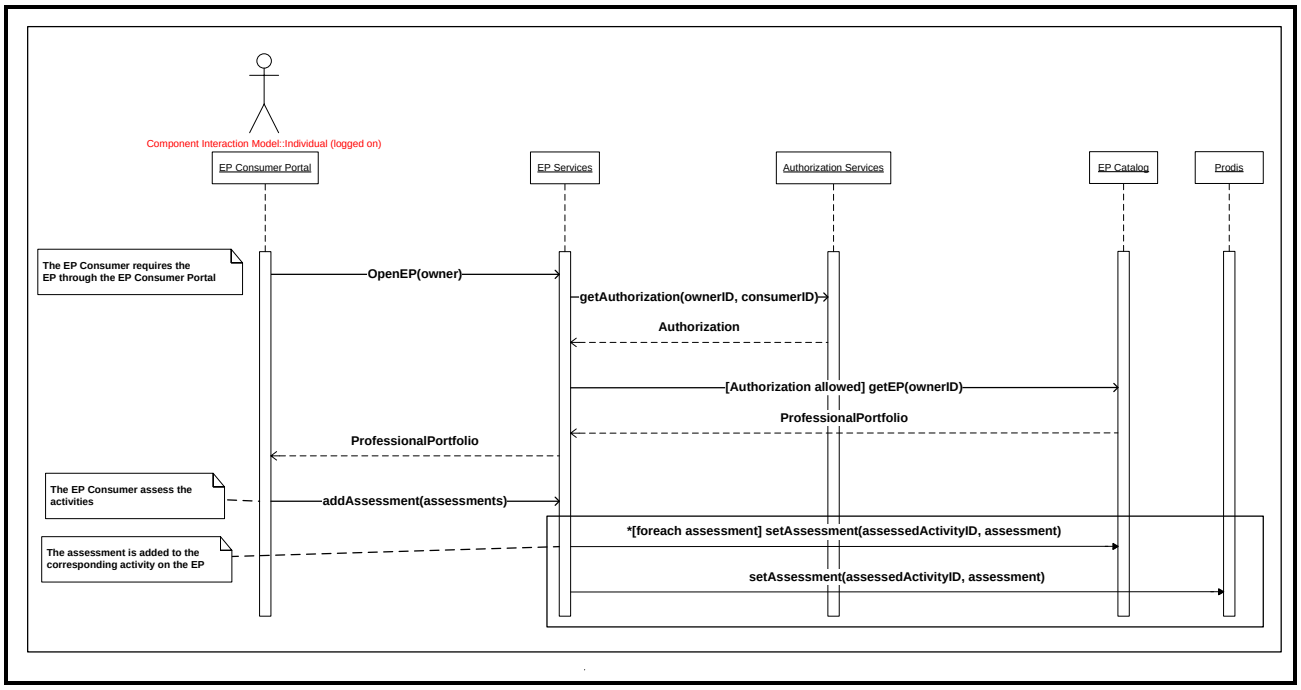
The Interaction Model that realizes *UC23: Handle EP Authorization Requests* is shown in *Appendix-Figure 18.*




*Appendix-Figure 18: Interaction Model for UC23: Handle EP Authorization Requests*

#### 8.5.2.4 UC25: Make Assessment

The Interaction Model that realizes *UC25: Make Assessment* does not conform to the Use Case Scenario Model of *section 4.4.2*. For reasons of maintainability of the E-Portfolio system, the assessments are in any case saved in the EP of the assessed EP Provider, without the need to be authorized. The choice given to the EP Provider is to set the assessments as hidden, by setting the attribute *PublicProvider* as false (see Authorization Services Information Model in *section 8.5.4* of *Appendix E*).

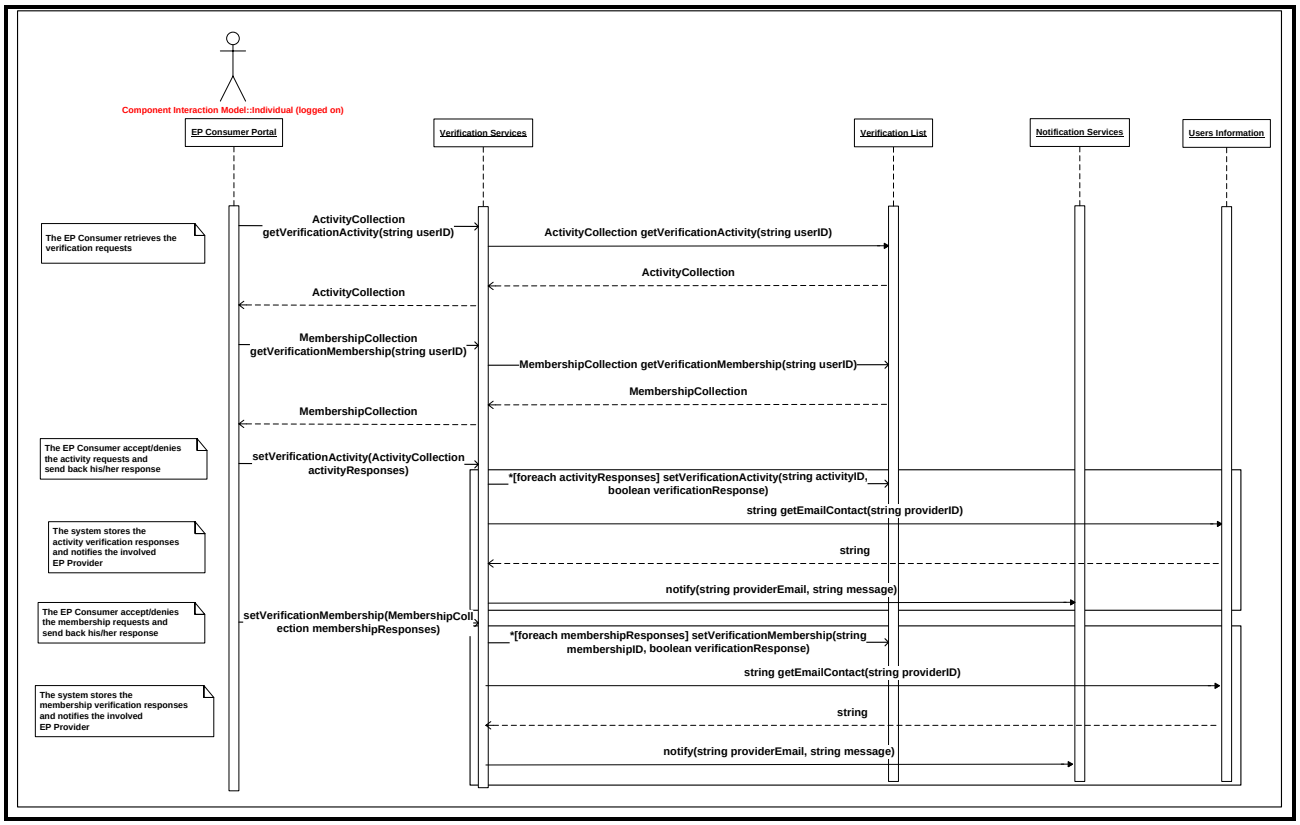



***Appendix-Figure 19: Interaction Model for UC25: Make Assessment***

### 8.5.2.5 UC35: Handle Verification Requests

The Interaction Model for *UC35: Handle Verification Requests* realizes the case when the verification is about information concerning the activities on the EP and the memberships of the account information. All the combinations (i.e. just activities) are allowed.

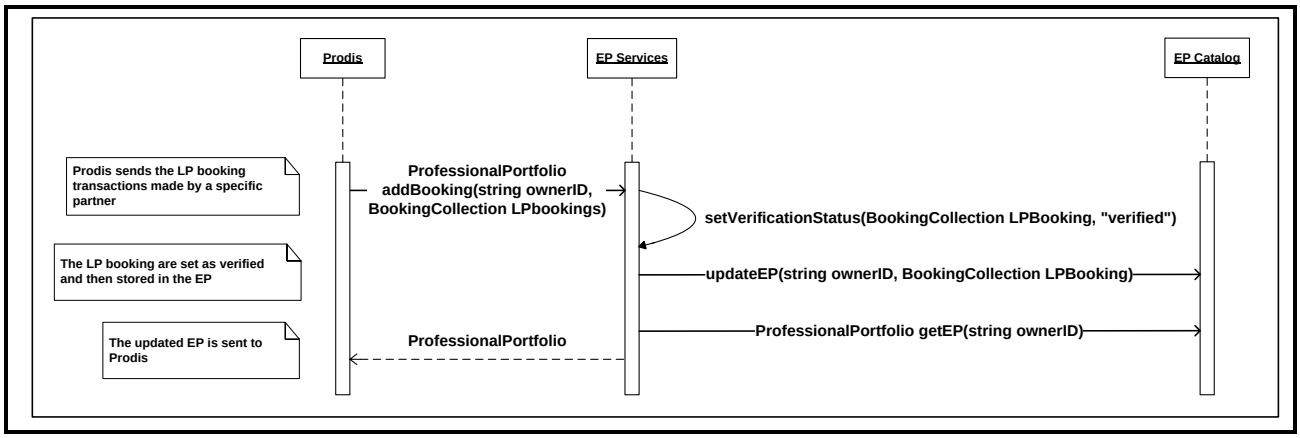
The Interaction Model that realizes *UC35: Handle Verification Requests* is shown in *Appendix-Figure 20.*




***Appendix-Figure 20: Interaction Model for UC35: Handle Verification Requests***

### 8.5.2.6 UC24: Import Activity

The Interaction Model that realizes *UC24: Import Activity* is shown in *Appendix-Figure 21.*

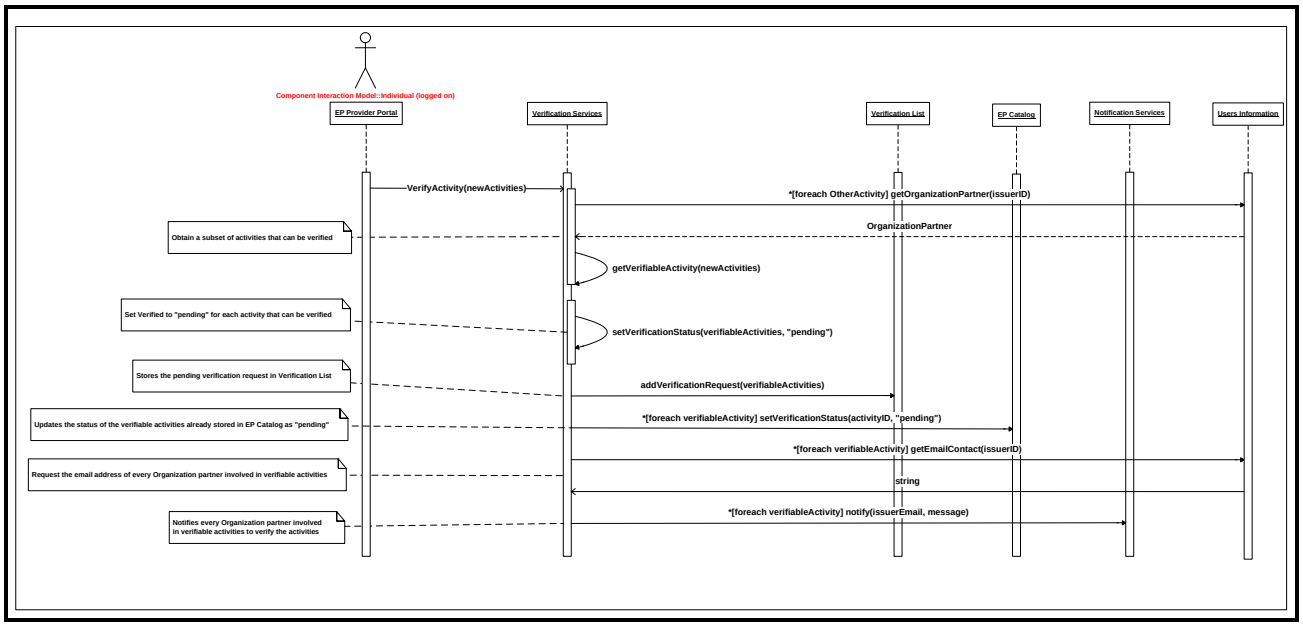



***Appendix-Figure 21: Interaction Model for UC24: Import Activity***

### 8.5.2.7 UC6: Verify Information

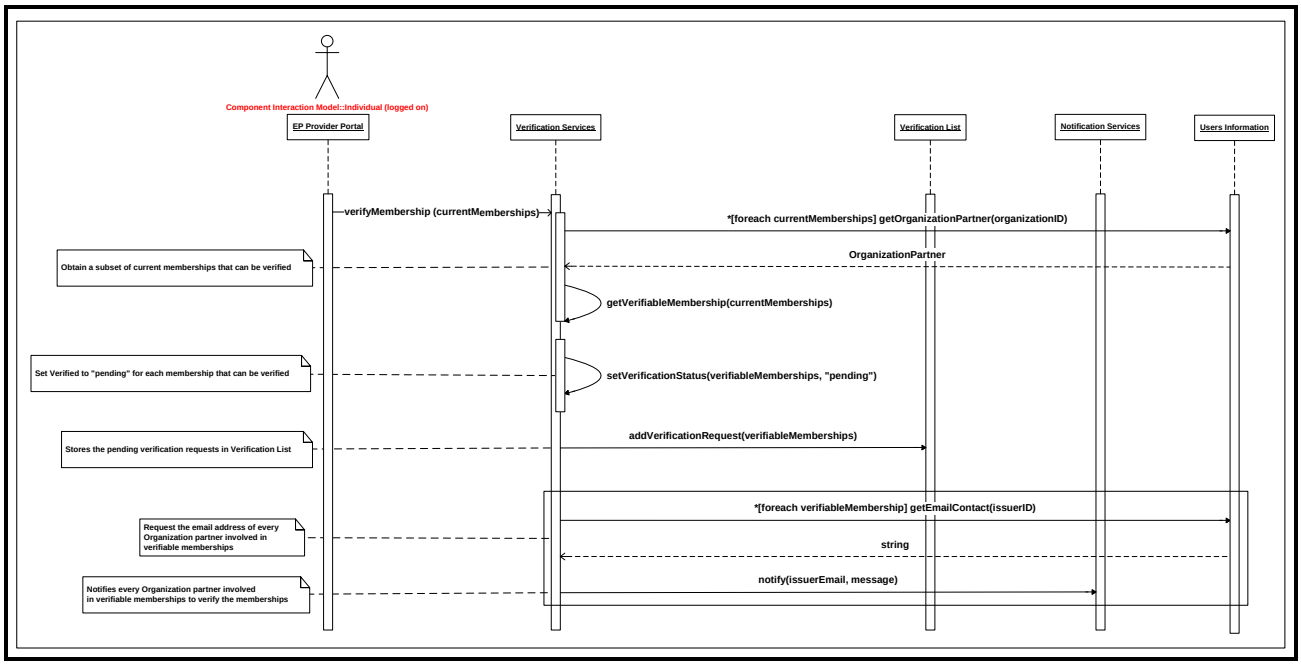
The Interaction Model for *UC6: Verify Information* is composed by two scenarios. The membership concept was not depicted in the Resource Model of *section 4.3.2* and it has been added during the Design phase in the Verification Services Information Model of *section 7.5.4.*

The first scenario, shown in *Appendix-Figure 22* realizes the case when the information to be verified is about activities stored in an EP.




***Appendix-Figure 22: Interaction Model for UC6: Verify Information (activities scenario)***

The second scenario, shown in *Appendix-Figure 23* realizes the case when the information to be verified is about memberships of the Individual partner.




***Appendix-Figure 23: Interaction Model for UC6: Verify Information (membership scenario)***

### 8.5.3 Interface Model

The Interface Model describes the interfaces offered by the components of the E-Portfolio system. Together with details of how components collaborate (from the Component Interaction Model), the Interface Model describes the contracts for components. This includes the interfaces with their operations and protocols. In this graduation project the operations are not specified.

#### 8.5.3.1 IRegistrationServices

| *IRegistrationServices* | *Description* |
|---|---|
| **Identification** | IRegistrationServices |
| **Purpose** | Supports the operations of Guest and Prodis for the registration of new end-users and partners. |
| **Operations** | + addNewUser(In login: LoginData)<br><br>+ addNewUser(In newUser: IndividualPartner, In currentMemberships: [*] Membership) |
| **Scenarios (link)** | *UC11: Registration* |

***Appendix-Table 29: Interface Model for the IRegistrationServices***

#### 8.5.3.2 IUserInformation

| *IUserInformation* | *Description* |
|---|---|
| **Identification** | IUserInformation |
| **Purpose** | Supports operations to store/retrieve account information about end-users |
| **Operations** | + getOrganizationPartner(In organizationID: string): OrganizationPartner<br><br>+ getEmailContact(In issuerID: string): string<br><br>+ storeUser(In newUser: IndividualPartner)<br><br>+ storeNewUser(In newUser: IndividualPartner, In currentMemberships: [*]Memberships)<br><br>+ getEmailContact(In partnerID: string): string<br><br>+ getAccountInfo(In partnerID: string): IndividualPartner<br><br>+ getMembership(In partnerID: string): Membership<br><br>+ updateUser(In user: IndividualPartner, In currentMemberships: [*]Membership) |
| **Scenarios (link)** | *UC6: Verify Information*<br>*UC11: Registration*<br>*UC21: Create EP*<br>*UC22: Modify EP*<br>*UC12: Modify Account Information*<br>*UC31: Open EP*<br>*UC33: Search*<br>*UC35: Handle Verification Request*<br>*UC23: Handle EP Authorization Requests* |

***Appendix-Table 30: Interface Model for IUserInformation***

#### 8.5.3.3 ILoginUserInformation

| *ILoginUserInformation* | *Description* |
|---|---|
| **Identification** | ILoginUserInformation |
| **Purpose** | Supports operations to store/match login information about Individual users |
| **Operations** | + storeLoginData(In newUser: IndividualPartner, In login: LoginData)<br>+ getUserID(In username: string, In password: string): string |
| **Scenarios (link)** | *UC11: Registration* |

***Appendix-Table 31: Interface Model for ILoginUserInformation***

#### 8.5.3.4 IEPServices

| *IEPServices* | *Description* |
|---|---|
| **Identification** | IEPServices |
| **Purpose** | Supports the operations of EP Providers, EP Consumers and Prodis for the retrieval and handling of EPs and account information. |
| **Operations** | + addNewEP(In newActivities: [*]Activity, In otherInfo: string): ProfessionalPortfolio<br><br>+ createEP(In newActivities: [*]Activity, In otherInfo: string): ProfessionalPortfolio<br><br>+ search(In searchQuery: string): [*]IndividualPartner<br><br>+ searchEPAlghorithm(In searchQuery: string)<br><br>+ OpenEP(In owners: [*]IndividualPartner): ProfessionalPortfolio<br><br>+ getAccountInfo(In partnerID: string): IndividualPartner<br><br>+ getMembership(In partnerID: string): Membership<br><br>+ getEP(In partnerID: string): ProfessionalPortfolio<br><br>+ addAssessment(In assessments: [*]Assessment)<br><br>+ addBooking(In ownerID: string, In LPbookings: [*]Booking): ProfessionalPortfolio |
| **Scenarios (link)** | *UC12: Modify Account Information*<br>*UC21: Create EP*<br>*UC22: Modify EP*<br>*UC31: Open EP*<br>*UC33: Search*<br>*UC25: Make Assessment*<br>*UC24: Import Activity* |

***Appendix-Table 32: Interface Model for the IEPServices***

### 8.5.3.5 IEPCatalog

| *IEPCatalog* | *Description* |
|---|---|
| **Identification** | IEPCatalog |
| **Purpose** | Supports operations to store/retrieve information concerning the EPs |
| **Operations** | + storeEP(In newEP: ProfessionalPortfolio)<br>+ getEP(In ownerID: string): ProfessionalPortfolio<br>+ setVerificationStatus(In activityID: string, In verifiable: enum)<br>+ updateEP(In userID:string, In activities: [*]Activity, otherinfo: string)<br>+ setAssessment(In assessedActivityID: string, In assessment: Assessment)<br>+ updateEP(In ownerID: string, In LPBooking: [*]Booking) |
| **Scenarios (link)** | *UC21: Create EP*<br>*UC22: Modify EP*<br>*UC31: Open EP*<br>*UC6: Verify Information*<br>*UC25: Make Assessment*<br>*UC24: Import Activity* |

***Appendix-Table 33: Interface Model for the IEPCatalog***

### 8.5.3.6 IVerificationServices

| *IVerificationServices* | *Description* |
|---|---|
| **Identification** | IVerificationServices |
| **Purpose** | Supports the operation for the verification of information, by other end-users, concerning account information and EPs for the EP owners |
| **Operations** | + verifyActivities(In newActivities: [*]Activity)<br>+ getVerifiableActivity(In newActivities: [*]Activity): [*]Activity<br>+ setVerificationStatus(In verifiableActivities: [*]Activity, In verifiable: enum)<br>+ verifyMembership(In currentMemberships: [*]Membership)<br>+ getVerificationActivity(In userID: string): [*]Activity<br>+ getVerificationMembership(In userID: string): [*]Membership<br>+ setVerificationActivity(In activityResponses: [*]Activity)<br>+ setVerificationMembership(In membershipResponses: [*]Membership) |
| **Scenarios (link)** | *UC12: Modify Account Information*<br>*UC21: Create EP*<br>*UC22: Modify EP*<br>*UC6: Verify Information*<br>*UC11: Registration*<br>*UC35: Handle Verification Request* |

***Appendix-Table 34: Interface Model for the IVerficationServices***

### 8.5.3.7 IVerificationList

| *IVerificationList* | *Description* |
|---|---|
| **Identification** | IVerificationList |
| **Purpose** | Supports operations to store/retrieve information concerning the verification requests |
| **Operations** | + addVerificationRequest(In verifiableMemberships: [*]Membership)<br><br>+ addVerificationRequest(In verifiableActivities: [*]Activity)<br><br>+ getVerificationActivity(In userID: string): [*]Activity<br><br>+ getVerificationMembership(In userID: string): [*]Membership<br><br>+ setVerificationActivity(In activityID: string, In verificationResponse: enum)<br><br>+ setVerificationMembership(In membershipID: string, In verificationResponse: enum) |
| **Scenarios (link)** | *UC6: Verify Information*<br>*UC35: Handle Verification Request* |

***Appendix-Table 35: Interface Model for IVerificationServices***

### 8.5.3.8 IAuthorizationServices

| *IAuthorizationServices* | *Description* |
|---|---|
| **Identification** | IAuthorizationServices |
| **Purpose** | Supports the operations to store, retrieve and update authorization requests for the end-users. |
| **Operations** | + getAuthorization(In ownerID: string, In consumerID: string): Authorization<br><br>+ getAuthorizationRequests(In userID: string): [*]Authorization<br><br>+ setAuthorizationRequests(In authorizationResponses: [*]Authorization) |
| **Scenarios (link)** | *UC31: Open EP*<br>*UC23: Handle EP Authorization Requests* |

***Appendix-Table 36: Interface Model for IAuthorizationServices***

### 8.5.3.9 IAuthorizationHistory

| *IAuthorizationHistory* | *Description* |
|---|---|
| **Identification** | IAuthorizationHistory |
| **Purpose** | Supports operations to store/retrieve information concerning the authorization requests |
| **Operations** | + getAuthorizationRequests(In userID: string): [*]Authorization<br><br>+ setAuthorizationRequests(In authorizationID:string, InvitationRequest: boolean) |
| **Scenarios (link)** | *UC31: Open EP*<br>*UC23: Handle EP Authorization Requests* |

***Appendix-Table 37: Interface Model for IAuthorizationHistory***

### 8.5.3.10 IProdis

| *IProdis* | *Description* |
|---|---|
| **Identification** | IProdis |
| **Purpose** | Supports the operations for sending/requesting information to/from the Prodis system |
| **Operations** | + getLPBooking(In ownerID: string): [*]BookingCollection<br><br>+ storeEP(In newEP: ProfessionalPortfolio)<br><br>+ getNewUserInfo(In login: LoginData): IndividualPartner<br><br>+ storeNewUser(In newUser:IndividualPartner, In currentMemberships: [*]Membership): LoginData<br><br>+ setAssessment(In assessedActivityID: string, In assessment: Assessment) |
| **Scenarios (link)** | *UC12: Modify Account Information*<br>*UC21: Create EP*<br>*UC22: Modify EP*<br>*UC11: Registration*<br>*UC31: OpenEP*<br>*UC25 : Make Assessment* |

***Appendix-Table 38: Interface Model for the IProdis***

### 8.5.3.11 INotificationServices

| *INotificationServices* | *Description* |
|---|---|
| **Identification** | INotificationServices |
| **Purpose** | Supports operations to notify end-users |
| **Operations** | + notify(In email: string, In message: string) |
| **Scenarios (link)** | *UC6: Verify Information*<br>*UC35: Handle Verification Request*<br>*UC23: Handle EP Authorization Requests*<br>*UC11: Registrations* |

***Appendix-Table 39: Interface Model for INotificationServices***

### 8.5.4 Information Model

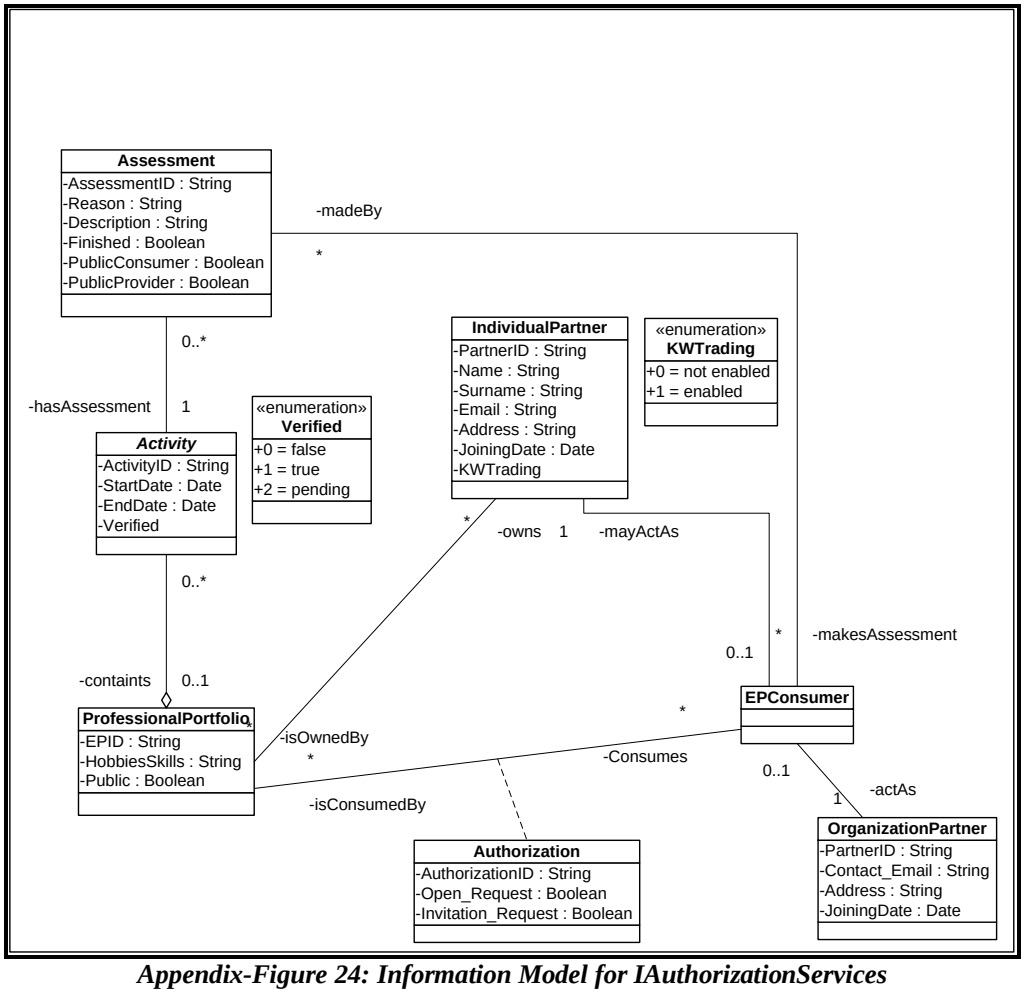
The Information Model is presented as a set of UML Class Diagrams describing the information model for the associated component of the E-Portfolio system that is visible through the operations of each of the identified interfaces.

#### 8.5.4.1 IAuthorizationServices

In *Appendix-Figure 24* the Information Model for the IAuthorizationServices interface is shown.

To model the role-based access by Individual Partner to an EP, it has been applied the *Association Role Solution* [13]. That means an Individual actor can take both EP Provider and EP Consumer roles. The EP Consumer class, in contrast with [13] has been modeled anyway because both Individual and Organization actors can act as EP Consumer. If an EP Consumer wants to open an EP the attribute *Open_Request* of the class Authorization is set to "true". If an EP Provider invites an EP Consumer to open his/her EP, the attribute *Invitation_Request* of the class *Authorization* is set to "true". An EP Consumer has right to open an EP if both attributes are set to "true".

Once the EP is opened the EP Consumer can also assess its activities. Both EP Provider and EP Consumer can decide not to make public an assessment. In order to be public both attributes *PublicConsumer* and *PublicProvider* of the class *Assessment* have to be set to 'true'.



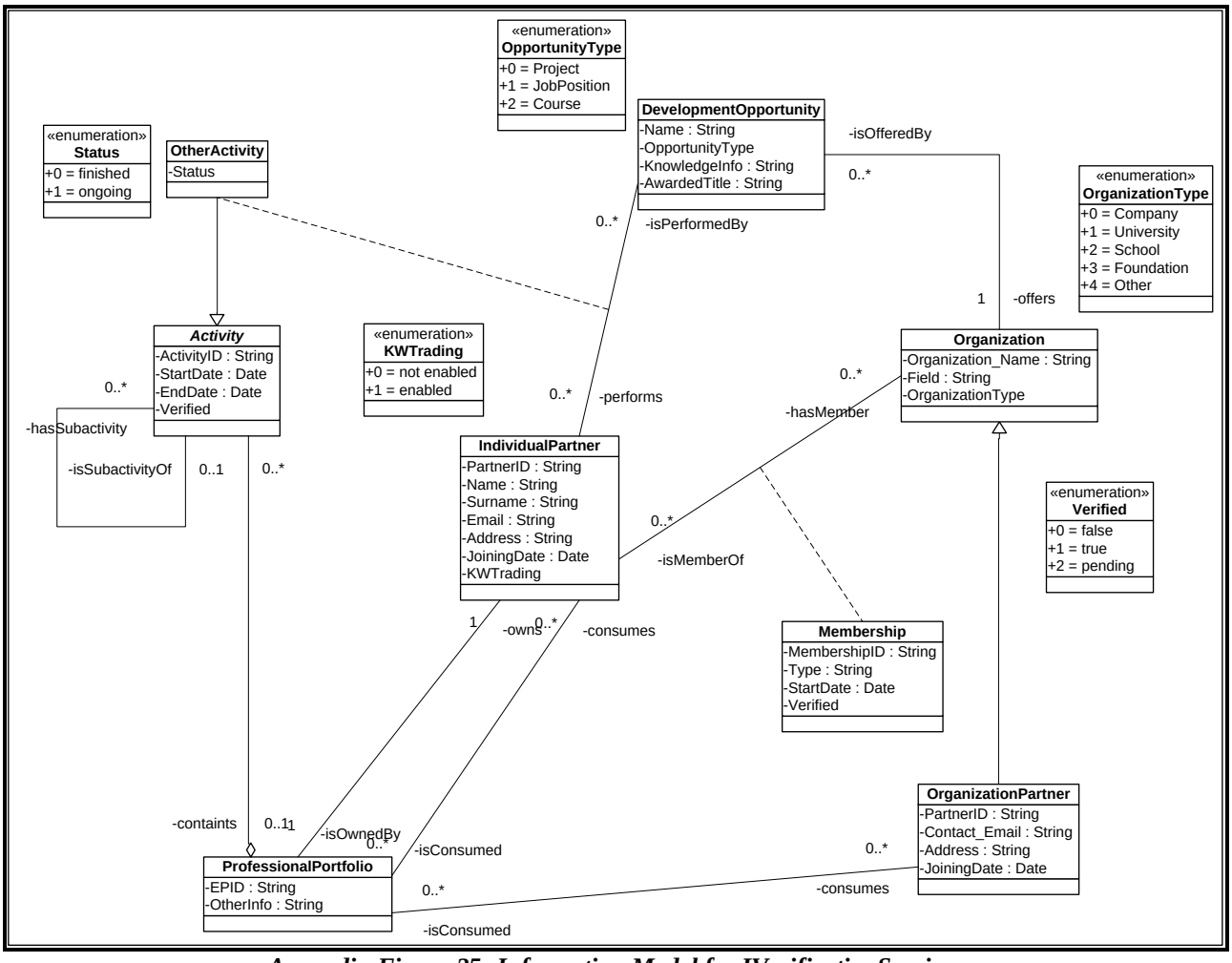

***Appendix-Figure 24: Information Model for IAuthorizationServices***

### 8.5.4.2 IVerificationServices

In *Appendix-Figure 25* the Information Model for the IVerificationServices interface is shown.

The information that can be verified is contained in the classes *Activity* and *Membership*.
The *Verified* attributes of both classes indicates whether the information is 'true', 'false' or with 'pending' status. The *Booking* class is not included in the diagram because for definition an LP booking is always verified.

The *DevelopmentOpportunity* that are offered by *Organization* which is not *OrganizationPartner*, cannot be verified.



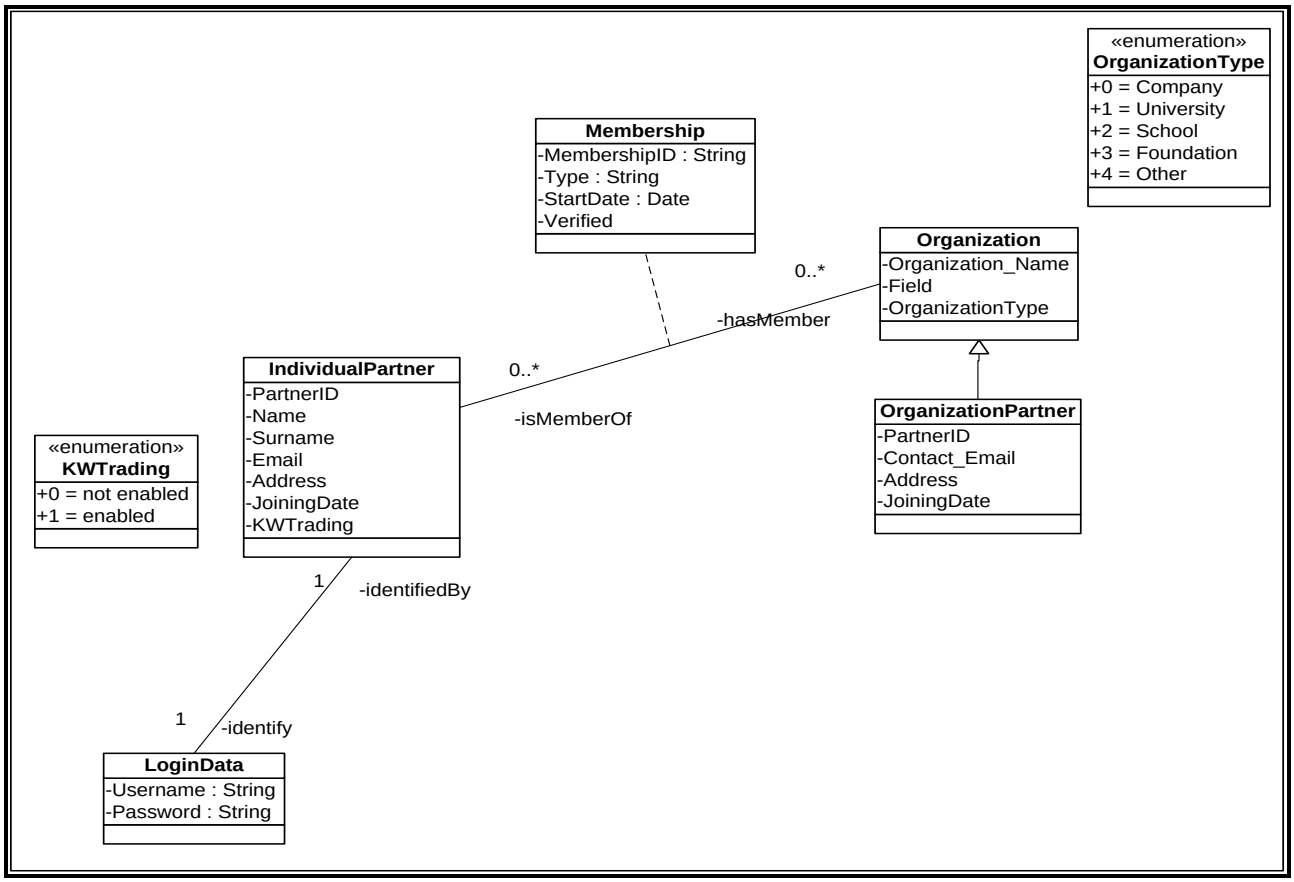

***Appendix-Figure 25: Information Model for IVerificationServices***

### 8.5.4.3 IRegistrationServices

In *Appendix-Figure 26* the Information Model for the IRegistrationServices interface is shown. The same information model is used by the *LoginServices.*

The account information of the Individual partner is contained by the class *IndividualPartner*. The *KWTrading* attribute in the scope of the E-Portfolio system is always set to 'true'.

The *LoginData* class contains the login data of the Individual partner. The login data are issued by Prodis. In the case the Guest that performs the registration is already an Individual partner, his/her login data are used by the Registration Services to obtain the account information from Prodis.




***Appendix-Figure 26: Information Model for RegistrationServices***

# 8.6 Appendix F – ATAM Report

## 8.6.1 Introduction

This document describes the process undertaken and the results produced during the validation phase of the graduation project *"Design of an IT Architecture for the E-Portfolio system of IBLC Group"*.

The methodology used for the assessment of the candidate architecture of the E-Portfolio system is ATAM. ATAM stands for Architecture Trade-off Analysis Method. The ATAM gets its name because it not only reveals how well an architecture satisfies particular quality goals (such as performance or modifiability), but it also provides insight into how those quality goals interact with each other, namely how they trade-off against each other [14, 6].

ATAM, in contrast with prototype-based methodologies, does not require the development of a system prototype to perform the assessment. The evaluation of the system is centered on the models produced during the Architecture Definition phase without the need to create a prototype. Moreover, ATAM is proven to be more effective in terms of costs, time and obtained results, than a prototype based methodology [14, 6].

The methodology focuses on the identification of business goals which lead to quality attribute goals that need to be expressed by the architecture. Based upon the quality attribute goals, ATAM is used to analyze how architectural styles aid in the achievement of these goals [14].

ATAM produces analysis commensurate with the level of detail of the architectural specification. Furthermore it need not produce detailed analyses of any measurable quality attribute of a system (such as latency or mean time to failure) to be successful. Instead, success is achieved by identifying *trends* [14].

The ATAM assessment is based on four phases: *Presentation*, *Investigation & Analysis*, *Testing* and *Reporting*. Each phase is composed by a number of steps. In total there are nine steps: three for Presentation, three for Investigation & Analysis, two for Testing and one for Reporting.

The ATAM assessment involves a set of actors. These actors are divided in three different groups: *Evaluation team*, *Project decision makers* and *Architecture stakeholders*. Each of these groups has a different position towards the system and therefore each of them gives a different contribution to the assessment.

ATAM is structured in order to be applied for the assessment of systems of any size and complexity. In the next section it is described how the ATAM has been applied in this project, for the assessment of the candidate architecture for the E-Portfolio system.

### 8.6.2 Assessment Process

This section describes how the ATAM has been applied to this graduation project. First are introduced the factors that shaped the assessment process. Then in the two subsections are described actors and phases, as prescribed by ATAM, performed in order to assess the candidate architecture of the E-Portfolio system.

The application of the ATAM methodology to this project has been driven by the following factors:

5. The methodology used for the ADP;
6. The viewpoint used for the design of the candidate architecture;
7. The size of the company;
8. The availability of project's stakeholders.

The ATAM-based assessment process is based on a set of predefined phases which involve a set of actors, the assessment participants, in order to produce outputs, the assessment results. Both phases and actors have been tailored for this project but keeping the structure prescribed by the ATAM methodology.

The focus of ATAM on the quality attribute requirements, requires to have a characterization for each quality attribute. In this project the quality attributes have been characterized according to [12]. Hence, to preserve consistency, this characterization also applies for the ATAM assessment.

In the following two subsections are described, respectively the assessment participants and the phases of the assessment process. In each section it is first given a brief summary about the ATAM guidelines and then how they have been applied to this project.

#### 8.6.2.1 Evaluation participants

The actors of the assessment process are divided in three different groups: *Evaluation team*, *Project decision makers* and *Architecture stakeholders*.

In this project, given the small size of both company and target system and the overlapping between *Architecture Stakeholders* and *Project decision makers* groups, the actors of the assessment process are divided in two groups: one group accounting the people internal to the project and another accounting people external to the project. The evaluation participants are 4 in total, 2 internal to the project and 2 external. The absence of defined departmental boundaries makes all the actors already acquainted with each other.

The group that accounts people internal to the project is composed by the IT Manager and the General Manager of IBLC Group. Both of them are *Architecture stakeholders* as well as *Project decision makers*. This group was also supposed to account some of the IT developers responsible for the system development, considered as *Architecture stakeholders*. However, the IT developers of IBLC Group are part-time and busy with other projects, hence there was not any developer allocated to the E-Portfolio system project yet.

The group accounting people external to the project is composed by an employee of the Operation function of IBLC Group, which has occasional duties on the IT Development function and therefore familiar with some IT concepts and an employee of the Marketing function which is also cooperating with the General Manager for the Business Development function. This group is considered as the *Evaluation team.*

#### 8.6.2.2 Assessment Phases

The ATAM assessment is based on four phases: Presentation, Investigation & Analysis, Testing and Reporting. The four phases are preceded by an assessment preparation phase, hereby called phase 0.

Phase 0 basically concerns about selecting the evaluation participants, notify them about the details of the meeting (time, place, reasons of the meeting) and get their attendance confirmation.

The first three phases, Presentation, Investigation & Analysis and Testing are the core phases of the assessment process. ATAM prescribes to perform these phases in two different days.

These three phases are usually performed in 8 steps. Phase 1 covers steps from 1 to 6, while phase 2 covers the last 2 steps:

1. **Present the ATAM**: a quick overview by the evaluation team of the ATAM steps, techniques used, and outputs from the process.

2. **Present the business drivers**: a brief presentation by the system manager describing the business drivers and context for the architecture.

3. **Present the architecture**: the architect's presentation of the architecture.

4. **Identify architectural styles**: an itemization of styles discovered as a result of the previous step.

5. **Generate the quality attribute utility tree**: identification, prioritization, and refinement of the most important quality attribute goals in the form of a utility tree.

6. **Elicit and analyze architectural styles**: a probing of the architectural styles in light of the quality attributes in order to identify risks, sensitivity points, and tradeoffs.

7. **Brainstorm and prioritize scenarios**: addition of scenarios from stakeholders and an understanding of their relative importance.

8. **Map scenarios onto styles**: continuing to identify risks, sensitivity points, and trade-offs while noting styles and components within styles that are affected by each scenario.

In the last phase, Reporting, the results of the Evaluation phase are analyzed and re-written in a report by the IT architect and presented to the E-Portfolio system's stakeholders. The results are used to suggest recommendations for the candidate architecture of the E-Portfolio system.

In this project, given the small size of both the system and the evaluation actor's set and the overlapping between *Architecture stakeholders* and *Project decision makers groups,* the evaluation phases have been merged into a unique phase, hereby called *Evaluation phase*.

In this project, given the small size of system and evaluation participants group, these phases have been performed in a single day. Therefore they have been merged into a unique phase hereby called *Evaluation phase*.

The phase 0 basically concerned about selecting the evaluation participants, notify them about the details of the meeting (time, place, reasons of the meeting) and get their attendance confirmation. In this phase the IT architect responsible for the project (myself) prepared the presentation and the planned activities for the *Evaluation phase*. More details about this phase are given in the next section *Phase 0: Meeting Preparation.*

The *Evaluation phase*, consisted in a meeting of the total duration of 2 hours and a half, carried on in a single day. During the meeting a presentation, which gives all the details needed for the evaluation, is held followed by two brainstorming sessions. More details about this phase are given in the section *The Evaluation phase.*

In phase 3 the results of the *Evaluation phase* are analyzed and re-written in a textual form by the IT architect. The results, presented in this report, have been used to suggest proper improvements for the candidate architecture of the E-Portfolio system.

### 8.6.3 Phase 0: Meeting Preparation

In the core phase of the ATAM methodology, the *Evaluation phase*, the candidate architecture is presented to an audience where the people have different interests towards the architecture, different understanding of the concept of IT architecture and, most important, different IT knowledge backgrounds. Given the limited amount of time on one side, and the wish to get as much meaningful results as possible on the other, I had to estimate which models and which level of details to present in order to give me the opportunity to optimize the process.

The small size of the company and the absence of marked departmental boundaries helped me in this task. Before the Evaluation phase, I had the possibility to survey every participant about his IT background knowledge and his acquaintance with the project.

Based on this analysis, performing the *Evaluation Phase*'s steps by rigidly following the ATAM methodology would have overloaded most of the meeting's participants with information too complex for them to understand. That would have result in a poor quality of the assessment, where irrelevant or even useless information would have been collected.

Therefore I opted by a lightweight but more effective version of the steps performed during the *Evaluation phase*. This is better described in the next section *The Evaluation Phase*.

### 8.6.4 The Evaluation Phase

The *Evaluation Phase* consisted on a meeting which took place in the office of the General Manager of IBLC Group. The attendees of the meeting were five, the four evaluation participants and the IT architect responsible for the project (myself). During the meeting a presentation has been held. The presentation has been divided in two parts, each of them followed by a brainstorming session. The schedule of the meeting's activities is as follows (between brackets the adapted steps later discussed in this section):

- First part of the presentation (steps 1 to 4) - 30 minutes
- First brainstorming session (step 5) - 45 minutes
- Second part of the presentation (step 6) - 15 minutes
- Second brainstorming session (step 7) - 1 hour

The application of ATAM to this project, at process level has been driven by the following aspects:

- The merging of Presentation, Investigation & Analysis onto a unique phase, carried in a single day, made all the evaluation participants to join the *Evaluation phase* at the same time (beginning).

- The analysis of the architectural styles has been constrained by the methodology used for the ADP. The COMET methodology, already "forces" the choice of the main architectural style used for the design, a layered architectural approach based on the Boundary Control Entity (BCE) pattern.

- The Functional view used to design the architecture hinders other views, such as the deployment view, which cannot be included in the evaluation.

Other important aspects, already mentioned, are the small size of both system under analysis and amount of participants of the evaluation, and the information gathered during the phase 0.

Hereby it is given, described and motivated the list of the steps performed during the meeting:

8. **Present the concept of the IT architecture**: The *Evaluation Team* is not familiar with the concept of IT architecture. Hence, a brief presentation concerning the main concepts of IT architecture is given, in order to reduce the risk of misunderstanding the subject of the assessment.

9. **Present the ATAM**: The ATAM methodology and the steps for this project are presented to the evaluation participants.

10. **Present the business drivers:** In this step the context underneath the architecture and the business drivers for the E-Portfolio system are presented to the participants. The COMET Domain Models are used to present the business drivers. The Goal Model is used to show a hierarchical representation of the business goals for the E-Portfolio system. The Context Diagram to present the system stakeholders and their interests towards the system. The Resource Model to identify the business resources relevant for the system's domain. The Use Case Model, relatively to the main use cases, to present the functionality requested by the system's actors. The Non-functional requirements to identify the major attribute qualities that

shape the architecture. The Use Case Scenarios related to the Use Case Model are not presented in this phase in order not to bias the results of *step 5*.

11. **Present the Architecture (part1):** In this step the candidate architecture is presented to the participants, with a focus on the quality attributes. The static structure of the architecture is presented by using the Component Structure Model, where the patterns used to design particular qualities, such as security, are pointed out and motivated. The Component Structure Model used in the presentation is about the part of the architecture fully designed, the Core Model. Each component's responsibility and functionality is explained. The interfaces between the components have been ignored because they increased the difficulty of understanding the relationships between components by three out of four participants.

12. **Generate Quality Attribute Utility Tree (QAUT):** The evaluation participants, based on the information gathered on the first 4 steps, generate a QAUT. The quality attributes are identified, discussed, prioritized and refined. For the high priority attributes it is created a scenario to check whether the candidate architecture supports it or not. Those that are not supported, are discussed in order to assess how they can be supported by the architecture, their difficulty of implementation and the risks associated to their failure to be implemented.

13. **Present the Architecture (part 2):** In this step are presented the main scenarios, and the related quality attributes, the architecture supports. The scenarios are presented by using the COMET Use Case Scenario Model and their achievement shown by using the relationships between elements in the Component Structure Model. The Interaction Model has not been used because is really complex to be understood by the *Evaluation Team*. The target use cases for the analyses were the *UC21: Create EP* and the *UC31: Open EP*.

14. **Brainstorm and prioritize Scenarios**: In this last step the two use cases presented in the previous step are taken under analysis to discover new scenarios not covered by the architecture, in order to discover pitfalls in both quality and functionality. Eventually the QAUT is updated with new scenarios and quality attributes.

15. **Present the concept of the IT architecture**: The *Evaluation Team* is not familiar with the concept of IT architecture. Hence, a brief presentation concerning the main concepts of IT architecture is given, in order to reduce the risk of misunderstanding the subject of the assessment.

During the meeting three out of four participants, the *Evaluation Team* and the General Manager approached the evaluation from a user viewpoint. Moreover, the General Manager somehow biased the evaluation because his direct involvement in the project and his position within IBLC Group, gave him better knowledge about the business drivers and context being discussed.

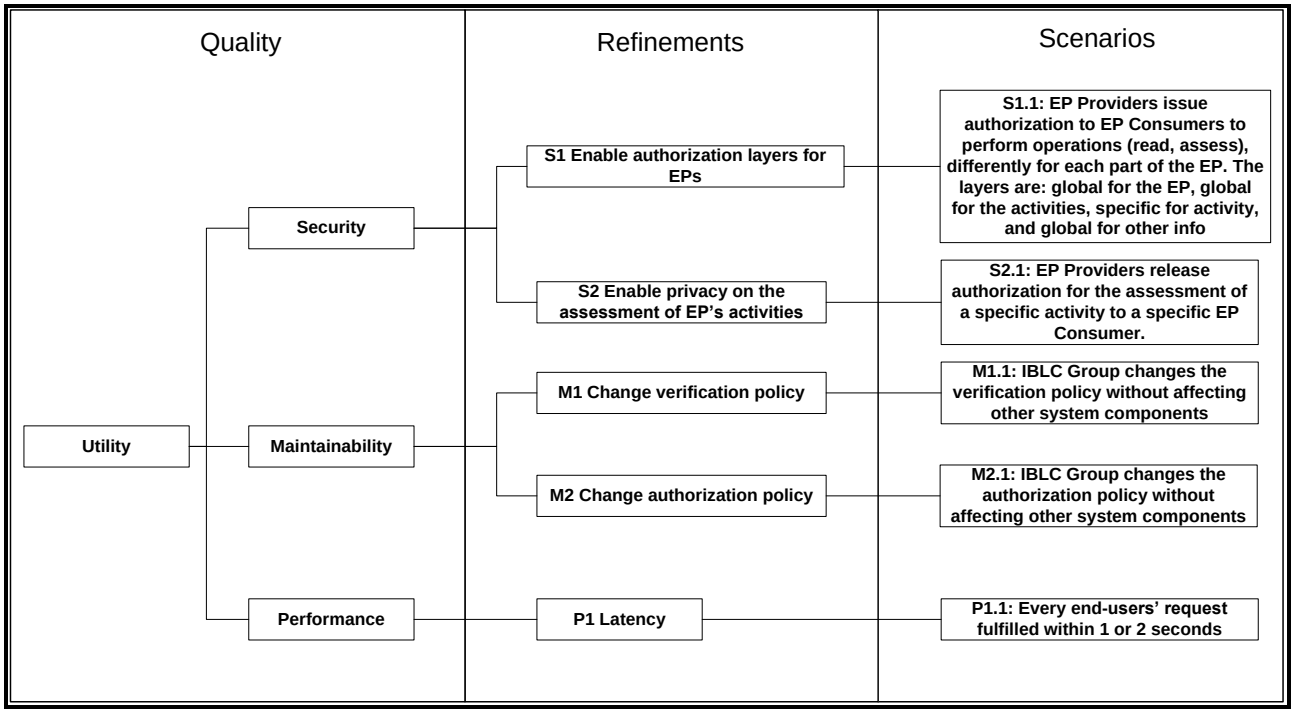
After the meeting, the results of the *Evaluation phase* have been collected and rewritten by the IT architect responsible for the project (myself). The results, and the related suggested changes in the architecture, are shown in the next section.

### 8.6.5 Results and Suggested Changes

The *Evaluation phase* produced a set of results that have been collected and rewritten during the last phase of the Assessment process, the Reporting phase.

The results are summarized by the QAUT as shown in *Figure 1*. The first version of the QAUT is the output of *step 5*, the final version of the QAUT, as shown in Figure 18, is the refined after *step 7*. The QAUT is divided in three sections.

The first section, Quality, refers to the quality attributes, characterized according to [12], identified by the assessment participants. The second section, Refinements, refers to the specification, made during a brainstorming session, of the quality attributes according to how they should be expressed by the candidate architecture of the E-Portfolio system. The third section refers to the scenarios the candidate architecture must support in order to express the quality attribute as listed in the Refinement section.




***Appendix-Figure 27: ATAM Quality Attribute Utility Tree***

The evaluation participants showed a strong focus especially for the security quality attribute of the E-Portfolio system. From an end-user viewpoint the security is considered an important aspect because of the confidential information an EP might contain. Consequently, for IBLC Group, the security of the E-Portfolio system is of utmost importance to push the end-users, especially the EP providers, to use the system in order to achieve the business goals as shown in the Goal Model.

The support of each scenario of *Appendix-Figure 27* by the candidate architecture puts in a trade-off the quality attribute linked to the scenario with the others. Therefore the candidate architecture, by supporting a specific scenario, incurs in a set of risks linked to the trade-off between its quality attributes.

Some trade-offs are linked to the set of design decision taken during the architecture definition activity, creating discrepancies between what is stated in the business drivers and what the candidate architecture expresses instead.

This is the case of *S1.1* and *S2.1* scenarios, which are not supported by the candidate architecture. The trade-off between their quality attributes and the associated risks are presented and described in *Appendix-Table 40* below. The goals listed in the table refer to the Goal Model.

| | |
|---|---|
| *Scenarios* | *S1.1:* EP Providers issue authorization to EP Consumers to perform operations (read, assess), differently for each part of the EP. The layers are: global for the EP, global for the activities, specific for activity, and global for other info.<br><br>*S2.1:* EP Providers release authorization for the assessment of a specific activity to a specific EP Consumer. |
| *Trade-offs* | *T1:* Security, Maintainability |
| *Risks* | *R1:* Failure to achieve *G11 : Proper KW professional information privacy measures* and *G8 : Enable third-parties Assessment of EPs activities* business goals.<br><br>*R2:* Too complex E-Portfolio system maintenance tasks. |
| *Description* | *Security (+)*: The candidate architecture for the E-Portfolio system does not provide the security measures as described in Non-functional requirements. This places at risk the achievement of the *G11 : Proper KW professional information privacy measures* business goal. The layering of the authorization (EP and its subsections) is believed to be of great importance for the EP Providers. An EP Provider cannot choose who can access the activities but it is just linked with the access to his/her EP. The EP Providers should be able to decide which sections of an EP have to be shown to a specific EP consumer. This way every EP Consumer might have a different view to the same EP (some activities hidden to a specific EP Consumer rather than another one).<br><br>*Maintainability (-):* The realization of the security measures as described in Non-functional requirements increases the complexity of the relationship between the objects of the system. For each EP (read), for each of its section (read) and for each of its activities (read, assess) there is the need to create different authorizations to perform operations for each EP Consumer. This seriously affects the maintainability of the system, for instance in the case the authorization policy changes. |

***Appendix-Table 40: Trade-offs and risks linked to the support of S1.1 ad S2.1***

The *S1.1* is mainly linked with the *UC23: Handle EP Authorization Requests* and *UC31: Open EP*. Its support by the IT architecture has been discarded because of the difficulties in maintenance that might occur. Moreover the designed authorization policy has been evaluated sufficient to preserve the privacy of the end-users.

The *S2.1* is mainly linked with *UC25: Make Assessment*. As expressed by the candidate architecture, any EP Consumer who has access to an EP can assess an activity without the need to be authorized. The authorization to assess does not add much complexity to the authorization policy. The recommendation is to make an assessment policy through invitation by the EP Provider or by request made by the EP Consumers.

The *M1.1* and *M2.1* scenarios are already supported by the candidate architecture but the trade-offs between their quality attributes have been matter of analysis among the evaluation participants, as shown in *Appendix-Table 41*. The performance quality attribute is difficult to properly assess without the Deployment viewpoint and some perspectives such as performance and scalability. However the evaluation participants, as shown in *Appendix-Table 41*, have been able to put in a trade-off the *P1.1* scenario with the support by the candidate architecture of *M1.1* and *M2.1*.

| | |
|---|---|
| *Scenarios* | *M1.1:* IBLC Group changes the verification policy without affecting other system components.<br><br>*M2.1*: IBLC Group changes the authorization policy without affecting other system components<br><br>*P1.1:* Every end-users' request fulfilled within 1 or 2 seconds |
| *Trade-offs* | *T2:* Maintainability, Performance |
| *Risks* | *R3:* Hinder the possibility to make future changes to authorization or verification policies without affecting other E-Portfolio system's components.<br><br>*R2:* Decrease the performance of the E-Portfolio system |
| *Description* | *Maintainability (+)*: The Authorization Service and Verification Services business service components have been created on purpose for the E-Portfolio system to bear any change concerning authorization or verification policy without affecting any other component of the system, especially the EP Services.<br><br>*Performance (-):* Having communication between different components in order to fulfil an end-user request, might compromise the performance quality attribute of the E-Portfolio system as described in Non-functional requirements. |

***Appendix-Table 41: Trade-offs and risks linked to the support of M1.1, M2.1 and P1.1***

The support of M1.1 and M2.1 give more advantages in terms of maintainability of the system. The impact to the system of the communications between Authorization Service and Verification Services with EP Services are believed not to sensibly affect the performance of the system. It is recommended to keep the component structure of the candidate architecture as it is. Eventual changes on the authorization policy have to be accompanied by changes on the Information Model linked with the Authorization Services and Authorization History components.

### 8.6.6 Other Findings

The ATAM assessment, besides the quality attributes, provided findings on the functionality expressed by the candidate architecture of the E-Portfolio system. The scenario analysis revealed shortfalls on the functionality of the E-Portfolio system.

These shortfalls are attributable, rather than to the architecture definition activity, to the analysis phase, where the business drivers and context have not been properly collected and/or documented. Partly this has been caused by the under development status of Prodis. Although during this project efforts have been made in order to conform to Prodis specifications, they were not stable, influencing also the context of the E-Portfolio system.

The main shortfall is about the roles an Individual actor can have within the system. An Individual actor who has also an HR role for an organization shouldn't be able to access an EP without paying.

The solution proposed is to make the E-Portfolio system aware of the real role an Individual actor has within an Organization partner through the Linking system. The Linking System has to replace the as-is concept of Organization partner of IBLC community with a hierarchical organization structure of Individual actors connected to the Organization partner by the means of links. This way the E-Portfolio system will be aware for each partner whether s/he belongs to an organization and which role(s) s/he fulfils.

In order to have a distinction between Individual actors that have free access to the EPs and those who have to pay instead, a vocabulary within the community has to be made. In the vocabulary are specified the roles that have a free access to the EPs and those who doesn't.

Moreover, in order to perform the payment transactions in real time, the EP Services component has to interface to a financial system. The EP Services therefore, will be given the responsibility to authorize an individual user to open a specific EP upon payment.

Given the fact that is a Prodis responsibility to manage the Organization partners, the solution to this shortfall goes beyond the E-Portfolio system, and therefore this project, scope.

### 8.6.7 Conclusion about the Evaluation phase

Based on my experience on this project, I can say that the two most important factors that drive the quality of the evaluation results in the ATAM methodology are:

- *How the architecture is presented and explained to the evaluation participants*: a complete and detailed presentation about the architecture under consideration it is useless if not understood by the evaluation participants. The architecture has to be presented by taking into account the backgrounds of each participant or, in the case of a bigger sample, estimate the background of subgroups based on area of expertise (such as department, function).

- *How the IT architect involves and guides the evaluation participants during the brainstorming session:* the different backgrounds of the evaluation participants often bring the discussion about one specific topic towards different directions. Some participants, using an end-user viewpoint, tend to think about user interface and talk about buttons and drop down lists. Others go to technical and talk about the system as a database, thinking about tables and the records stored in it. When a concept is introduced it is important to check whether all the participants are tackling the discussion on the same direction, in order to avoid that the brainstorming goes without control. The IT architect has to have always the lead during the evaluation, in order not to go beyond the context of the system and to avoid the exchange of information that might confuse some participants.