

LUISA

*Learning Content Management System Using Innovative Semantic Web
Services Architecture*

IST- FP6 - 027149



Deliverable D7.3.1

Use case implementation and prototyping v1

Tomás Pariente Lobo
Monique Grandbastien
Benjamin Huynh-Kim-Bang
Elisabetta Parodi
Alessio Gulgiotta
Miguel Angel Sicilia

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EXECUTIVE SUMMARY

The deliverable D7.3.1 presents the realisation of the first prototype of the academic case study.

This prototype is a proof of concept of the LUISA architecture. Consequently, it does not take into account all requirements stated in deliverable D7.1.2. The focus is on the integration aspects, so the ranking rules have been omitted in this prototype.

First of all, the deliverable describes the context of the prototype. It defines its scope, the intended users, the resources used, and gives a vision of the usage of the prototype. Then the document describes the different components and main technical aspects involved in the development of the prototype.

The document is accompanied by the software delivered by the partners specifically for this prototype.

This deliverable will be further extended with the last version of the academic case study prototype in deliverable D7.3.2 by M27.

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Authors (Partner)	Tomás Pariente Lobo (ATOS), Monique Grandbastien (UHP), Benjamin Huynh-Kim-Bang (UHP), Elisabetta Parodi (GIUNTI), Alessio Giuliani (OU), Miguel Angel Sicilia (UAH)		
Responsible Author	Tomás Pariente Lobo		Email Tomas.parientalobo@atosorigin.com
	Partner	ATOS	Phone +34 91 2149321

Project Consortium Information







Partner	Acronym	Contact
Atos Origin S.A.E. (Coordinator)	ATOS 	Nuria de Lama Atos Origin S.A.E. c/ Albasanz 12 E-28037 Madrid, Spain Email: nuria.delama@atosorigin.com Tel.: +34 91 214 9321 Fax: +34 91 754 3252
University of Alcalá de Henares	UAH 	Dr. Miguel-Angel Sicilia Information Research Unit University of Alcalá Ctra. De Barcelona, Km 33.6 E-28871Alcalá de Henares (Madrid), Spain Email: msicilia@uah.es Tel.: +34 91 886 6603 Fax: +34 91 885 6646
University of Uppsala	ULL 	Dr. Ambjorn Naeve University of Uppsala Kyrkogårdsgatan 2 C Uppsala Email: amb@nada.kth.se Fax: +46 184-716-294
Open University	OU 	Dr. John Domingue Knowledge Media Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom Email: j.b.domingue@open.ac.uk Tel.: +44 1908 655014 Fax: +44 1908-653-169
University Henri Poincaré	UHP 	Dr. Monique Grandbastien University Henri Poincaré Vandoeuvre les Nancy 54506, PO Box 239, France. Email: monique.grandbastien@loria.fr Fax: +33 383-278-319
Giunti Interactive Labs S.r.l.	GIUNTI 	Dr. Fabrizio Giorgini Giunti Interactive Labs S.r.l. Abbazia dell'Annunziata Via Portobello Baia del Silenzio 16039 Sestri Levante (GE), Italy Tel.: +39.0185.42123 Fax: +39.0185.43347
EADS FRANCE – Innovation works	EADS 	Anne Monceaux EADS FRANCE – Innovation works Avenue Didier Daurat - Centredra 1, Toulouse, 31700, France. Email: anne.monceaux@airbus.com Tel.: +33 561-184-725 Fax: +33 561-187-611

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1 INTRODUCTION

The LUISA project aims at improving significantly the opportunities for reusing learning objects by providing a framework that allows the easy creation of semantically-enriched e-learning applications. The objective of this document is twofold:

- To describe the first prototype of the academic case study application on top of the current version of the LUISA framework.
- To serve as a proof of concept of the LUISA architecture instantiated for a concrete academic case study.

The deliverable D7.3.1 presents the realisation of the first prototype of the academic case study. It gives an overview of the software, ontologies, and other artefacts specially generated for the prototype.

The deliverable is structured as follows. Section 2 describes the context of the prototype, defining the scope, intended users and resources used, and giving a storyboard or vision of the usage of the prototype. Section 3 introduces the technological solution, explaining the architecture of the prototype and the main technical aspects related with its implementation. Finally section 4 reports on the conclusions and future work.

The most important software listings, database schemas or ontologies specific to the prototype are listed in appendixes. The document is accompanied by the software delivered by the partners specifically for this prototype.

2 PROTOTYPE DESCRIPTION

2.1 Problem addressed

The academic first prototype explores how semantic technologies could be applied to discover the best suited Learning Objects for a given learner in an academic domain.

The context of the prototype is a French diploma (called C2i) for competencies in internet and computer's field described in deliverable D7.1.2 [2]. However, the first prototype does not cover all aspects described in that deliverable, because it is intended as a proof of concept for the LUISA architecture in the academic domain. The scope of the prototype is consequently restricted with respect to what is stated in D7.1.2. It will allow the learner:

- To express a query by **exploring a set of competencies** and additional criteria. From a pedagogical point of view, the exploration and interactions with the competencies tree may improve the user's perception of the learning domain (meta-cognition).
- To obtain the better **resources retrieved** from some simple testing Learning Object Repositories (LOR) specially prepared for the prototype according to the elements of the query.
- To be provided with tentatively **packaged resources**. The system can compose some Learning Objects (LO) to create a new one. The composition rules are very basic in this prototype, so they are introduced as a proof of concept rather than to implement a coherent composition strategy. More advanced and pedagogical compositions will be experimented in the next versions of the prototype.

2.2 Intended users

This section describes the actors addressed by the prototype.

The basic features of the first prototype do not allow experiment it massively. Although the first idea was to experiment with real users, this prototype is more focused on solving architectural and integration issues rather than real testing with user. So the testing will be restricted to the partners of the consortium.

However, the aim of the next version of the prototype (to be delivered soon) is more user-oriented. This version will take into account all aspects (rules, ranking, etc.) requested as functionalities of the basic prototype.

2.3 Inventory of resources

The purpose of this section is to show an inventory of the resources (ontologies and repositories) used in the prototype.

The table below shows the inventory of resources used in this prototype.

Resource	Nature	Description
GCO/C2i	Ontology	Defined in D7.2. Represents the competencies used in the C2I context. These competencies are based on the concepts of the General Competency Ontology presented in D4.1. Example: “k_email” is a KnowledgeElementDefinition required by the “B6 competency: communicate remotely” which is a CompetencyDefinition.
Computer Literacy ontology	Ontology	Defined in D7.2. Represents the items (hardware or software) involved in the C2I competencies. Example: “k_email” is a KnowledgeElementDefinition about “EmailApplication” which is a “PrivateCommunicationTool” in the Computer Literacy Ontology.
Discipline ontology	Ontology	Defined in D7.2. Represents the fields of study in the university. Example: “Medicine” is a specialization of “Health” and is “linked_to” “Biology”.
LOM/WSML	Ontology	LOM/WSML is a semantic implementation of LOM defined in D4.9. It represents all the aspects (from technical requirements to rights management and educational characteristics) of a Learning Object.
Moodle Profile	Database	Including the basic and generic data about a user: login, email...
UHP Profile	Database	MySQL database including all the other data about a user
LO Metadata Repository	LOMR	Metadata about the LOs
LO Repository	LOR	Including at least 50 LOs about C2I. As a matter of interest, the final prototype will be experimented with at least 150 resources.

Listing 1 Inventory of resources

2.4 Storyboard

In this section we provide the scenario focusing on the learner relationship with the prototype. The scenario we describe in this document tries to solve the problem for a learner who wants to find a suitable package of Learning Objects that suits his/her needs. The learners will use the prototype on their own, making use of the LUISA-based application in order to create a work plan to improve their competency.

2.4.1 Step 1 – Login and first set C2i competencies

The learner logs in the LUISA UHP application (Figure 3) and, once authenticated in Moodle, the prototype shows the learner their set of competencies according to their profile (Figure 5). The learner may select the competencies they want to fulfil and sends the query to the Negotiation Layer.

2.4.2 Step 2 – Rules for negotiation

When the learner posts the request, the Negotiation Layer sends it to the SWS Layer by choosing the appropriate WSMO goal. The **first invocation** of the SWS layer tries always to retrieve **LOs for the same competency and discipline that the learner provides**.

The **Query Resolver component** is in charge of analysing the response for all queries performed to the SWS Layer, trying to check the suitability of the selection. In the current prototype we have provided a specialization of the Query Resolver for the UHP case study that implements the following rules:

- R1. If the competency chosen by the learner is a **sub-competency**:
 - R2.1. If there are no LOs that fulfil the exact match: The system selects the LOs about the **same** sub-competency but with a **more general** discipline. Application of organizational specific e-Learning rules.
 - R2.2. If there are no LOs with these features: The system selects the LOs about the **general** competency and the **same** discipline.
 - R2.3. If there are no LOs with these features: The system selects the LOs about the **general** competency and a **more general** discipline.
- R2. If the student chooses a **general competency**:
 - R2.1. If there are no LOs that fulfil the exact match: The system selects a LO about the **same competency** and a **more general discipline** + the LOs about **the same discipline** but whose target competency are **sub-competencies included** in the selected general competency.

2.4.3 Step 3 – Rules for composition

The **Composer** component is in charge of creating learning packages by combination of a set of Learning Objects. The implementation of the composer for the current prototype assumes that the LOs are SCORM compliant and the resulted package is delivered as a new SCORM compliant LO.

The specific rules of composition in the current version of the prototype are common for both case studies. If the Query Resolver proceeds to a decomposition of a competency given by the end-user into a set of sub-competencies, then the Composer gathers and packs the results for each sub-competency in a set that, as a whole, matches the super-competency.

2.4.4 Step 4 – Work plan

Once the user selects the appropriate LOs, the work plan is saved in Moodle as the selection made by the user.

3 TECHNOLOGICAL SOLUTION PROPOSED

3.1 Prototype architecture

This section describes the particular solution of the LUISA architecture (components, data structures and services) adopted for the realization of the current prototype.

Figure 1 depicts the layered general architecture proposed by LUISA as presented in the LUISA deliverable D2.1 [3].

The two orange middle layers represent the SWS-based infrastructure for e-Learning. The green layers represent the actual interfaces of the SWS-based infrastructure.

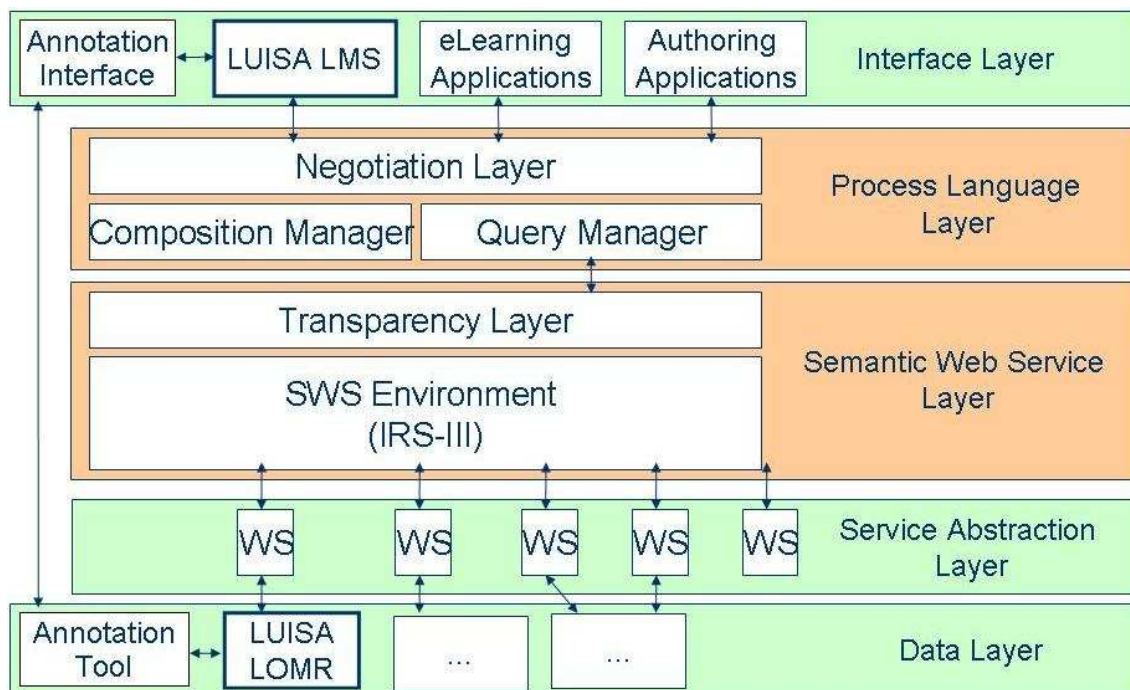


Figure 1: Layered General Architecture proposed by LUISA.

Derived from the general architecture, the Figure 2 shows the architectural components of the UHP prototype. The specific components, data structures and interfaces developed or adapted for the UHP prototype are highlighted in red.

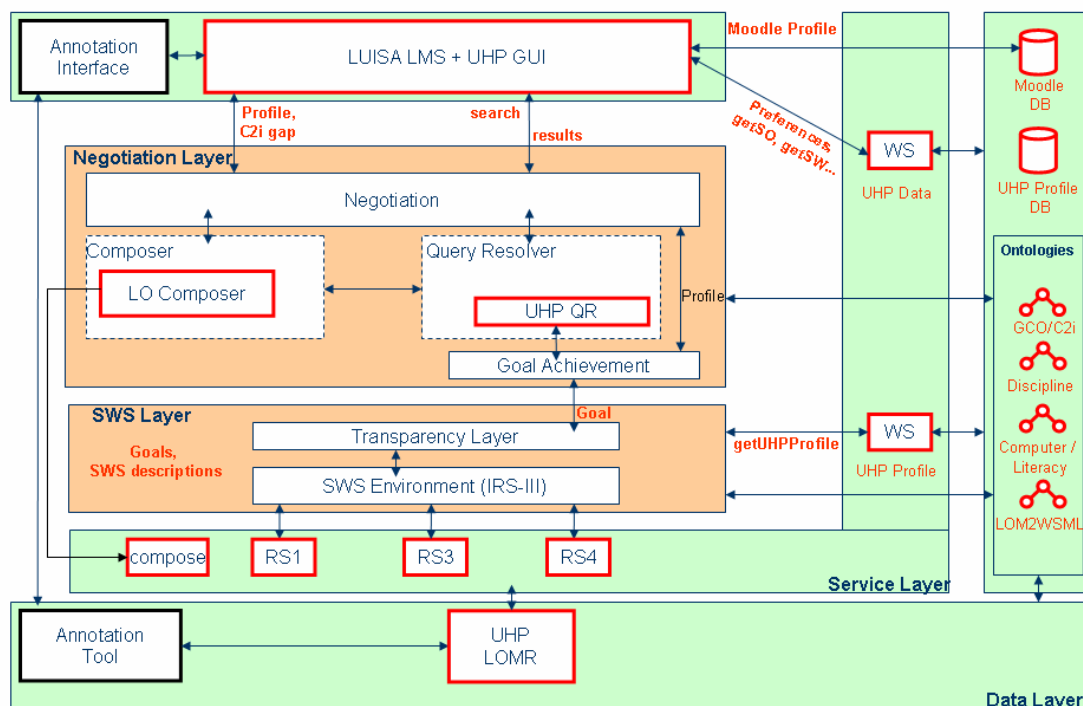


Figure 2: UHP Prototype Architecture

In summary the UHP prototype implementation of the LUISA framework consists of:

- Adaptation of the GUI in Moodle.
- Creation of specific Query Resolver and LO Composer.
- Preparation of the appropriate WSMO goals and descriptions for the LO repositories.
- Implementation of LOMR (in this prototype, the same repository implementation for both case studies).
- Specification and implementation of the UHP user and university profile database.
- Implementation of several Web Services.

Section 3.2 goes into further details of the components implemented.

3.2 Prototype implementation

This section describes the components developed by each LUISA partner especially for the prototype (in red in Figure 2). The description does not comprise the components or their parts that are not developed explicitly for the prototype.

3.2.1 GUI

The SWS infrastructure and the Annotation tool have to be integrated into a Learning Content Management System to allow users to access to the semantic functionalities supported by the core components of the architecture.

For the first prototype an extension of the Open Source Moodle LMS has been developed. The basic style has been changed trying to harmonize the Moodle basic skin and the style of the LUISA project. An idea of the result can be gained by Figure 3.



Figure 3: Moodle login.

Some additional information about the user is needed for the UHP use case respect to the information of the standard Moodle user profile, such information comprises:

- user competencies
- user preferences about operative system, available software, discipline
- university preferences about cost and language

The GUI manages these data allowing storing, updating, retrieving and deletion through proper forms. This data has to be stored into an additional database, accessed through Web Services. The external DB does not replicate data already stored on the LMS so the synchronization policy is:

- insert a new user
 - new user on the LMS as for the base system
 - LUISA specific data: when user accesses for the first time to the LUISA section, s/he is asked to fill-in the LUISA profile and her/his data are inserted into external DB
- retrieve and update users

- LMS data update as for the base system
- LUISA specific data: through specific forms that update only the data onto the external DB
- delete
 - LMS user deletion cascades the deletion also on the additional database
 - Clearing LUISA specific data only just deletes a user's data from the external database.

The Figure 4 represents the form for managing user and university preferences.

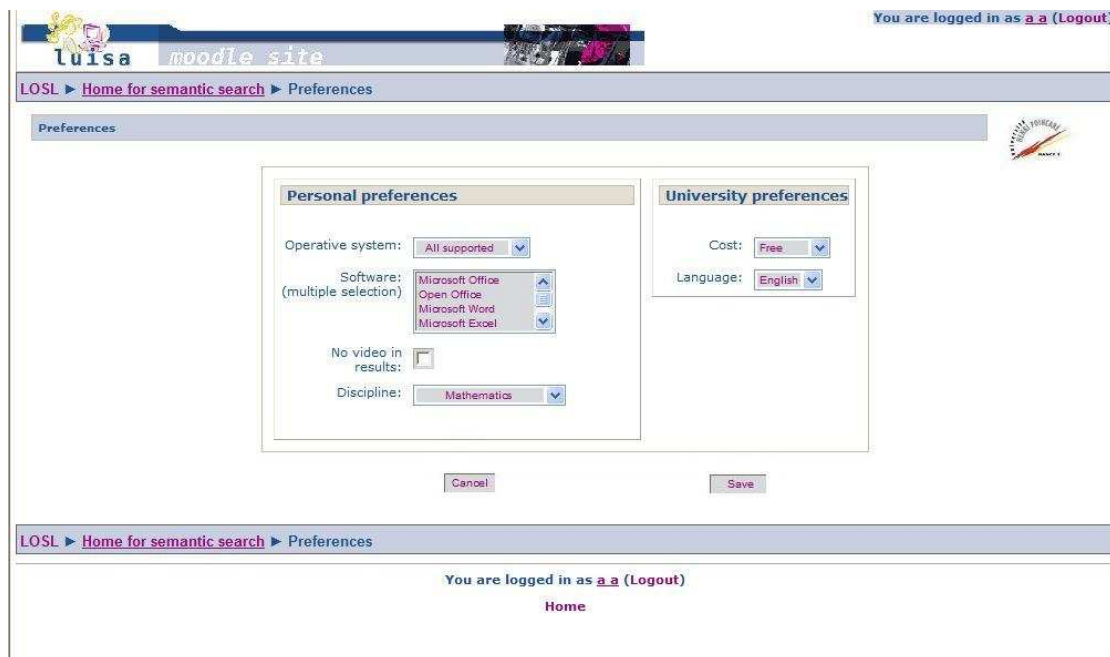
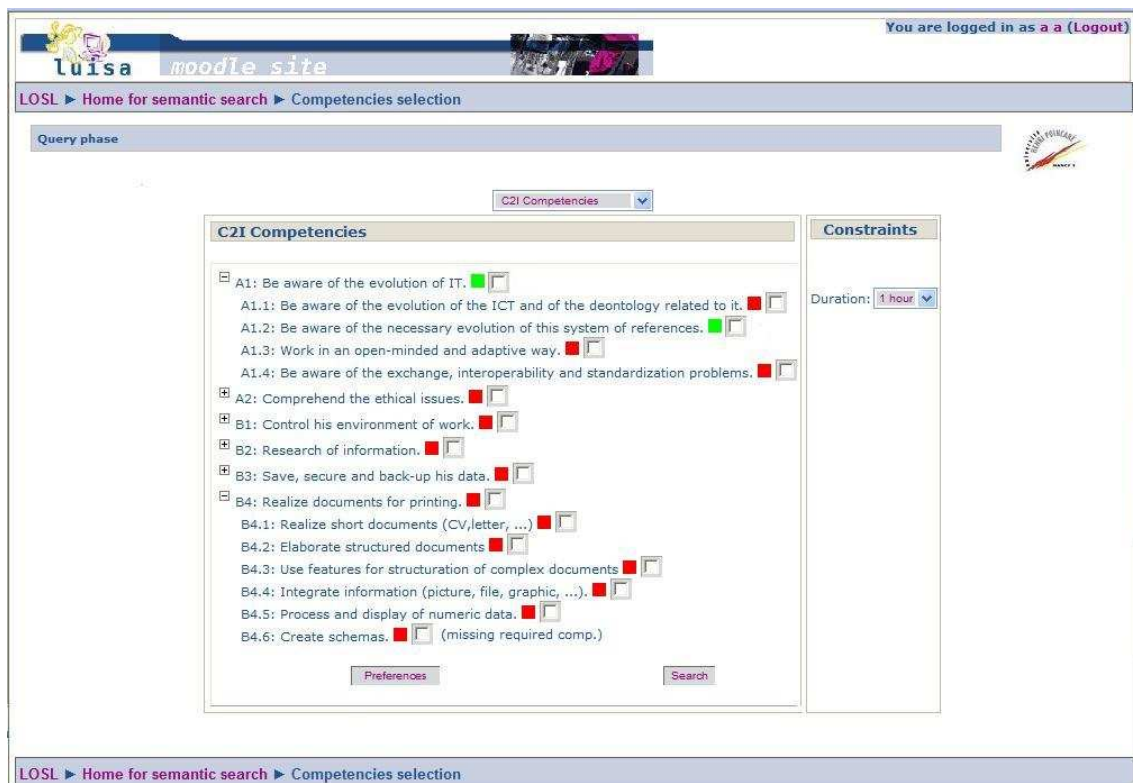


Figure 4: Moodle form that allows LUISA specific data management.

As from Figure 3, there are two groups of preferences: one is the user personal preferences, including operative system, software, capability of playing videos and discipline of study; the other group shows the university preferences – these latter are not modifiable by the student.

During the query phase, the user interacts with the system in order to select the criteria of his/her search. The user must select the competencies s/he desires to acquire and his/her available duration of work. The C2I competencies are presented as a dynamic expandible/ collapsible tree showing the competencies he/she acquired and the missing ones. The tree is dynamic; when the user selects a competency new competencies (depending on the selected one) become available. The user can also select the duration he desires to practice.

A first prototype of the query interface is presented in Figure 5.



The screenshot shows a Moodle query form titled "Query phase". At the top, it says "You are logged in as a a (Logout)". The breadcrumb trail is "LOSL > Home for semantic search > Competencies selection". The main content area is divided into two panels: "C2I Competencies" and "Constraints".

C2I Competencies: This panel displays a tree structure of competencies. Each node has a small icon on the left (a plus sign for expandable, a minus sign for expanded, or nothing for a leaf) and a checkbox on the right. A small green square indicates the user has acquired the competency, and a red square indicates they have not. The competencies listed are:

- A1: Be aware of the evolution of IT.
- A1.1: Be aware of the evolution of the ICT and of the deontology related to it.
- A1.2: Be aware of the necessary evolution of this system of references.
- A1.3: Work in an open-minded and adaptive way.
- A1.4: Be aware of the exchange, interoperability and standardization problems.
- A2: Comprehend the ethical issues.
- B1: Control his environment of work.
- B2: Research of information.
- B3: Save, secure and back-up his data.
- B4: Realize documents for printing.
- B4.1: Realize short documents (CV, letter, ...).
- B4.2: Elaborate structured documents.
- B4.3: Use features for structuration of complex documents.
- B4.4: Integrate information (picture, file, graphic, ...).
- B4.5: Process and display of numeric data.
- B4.6: Create schemas. (missing required comp.)

Buttons for "Preferences" and "Search" are located at the bottom of the C2I Competencies panel.

Constraints: This panel contains a "Duration:" dropdown menu currently set to "1 hour".

Figure 5: Moodle query form.

The competencies ontology is represented as a tree, nodes have a little “+” on the left if they are expansible, a little “-” if they have already been expanded and nothing if they are a leaf. A little checkbox on the right allows the user to select the competencies for which s/he wishes to start the search, while a little square reminds if the user has already acquired a given competency (green) or not (red). If the user is missing the prerequisite competencies for a given one, there’s a label telling that the competency is unreachable (see competency B4.6 of Figure 5). The user can also select the duration from the constraints region on the right.

After the search, the system proposes to the user some LOs. A first group is a first pack defined by the system, here the user can change the LOs order or deselect them. The second group of results shows some alternative LOs. A possible interface is represented in Figure 6.



Figure 6: Moodle LOs proposal.

The user can change the LOs order using the arrows, or deselected them. The [+] icon indicates a composed LO, while the [~] means that the LOs competency was deduced from another ontology of competencies.

3.2.2 Negotiation Layer

The Negotiation Layer provides the relationship between the end-users of the LUISA framework and the Semantic Web Service environment.

The Negotiation Layer consists basically in three main components:

- Negotiation
- Query Resolver
- Composer

Negotiation component:

The **Negotiation component** allows the management of the communication between end-user layer and the rest of the LUISA framework. The negotiation involves collecting data from the end-user and implies verifying the suitability of the user profile to specific Learning Objects, and assuring the persistence of the session with the End-user GUI.

There is a common functionality offered by the Negotiation component for the LUISA framework and the basic core implementation remains agnostic to case study particularities. The particularities of the case study are then not in the component itself, but in the Web service implementation that give access to it and in the specific Query Resolver developed for the case study.

The functionality exposed by the Negotiation Layer WS for the UHP case study is summarized in the following Table:

Functionality	Interface
Search UHP LOs for a given set of competencies and extra LOM-based fields. It returns a list of LO references	<pre>getLOsForCompetenciesUHP (List<c:Competency>; fos:FieldOfStudy; String:IEEELOMInteractivityLevel; String:Language; String:OperativeSystem; String:Software) :List<LORef></pre>
Retrieves the profile of a given UHP registered user. The profile is composed by the user preferences, the university preferences and the competency gap	<pre>getProfileUHP (String: UserId; object: UHPUserPreferences; object: UHPUniversityPreferences; List<c:competencyGap></pre>

Listing 2 Negotiation component interfaces

The Negotiation component, once received the query, transform it to a WSMO goal invocation and sends it to the Semantic Web Service environment.

Query Resolver:

A **Query Resolver** implements specific organizational learning rules. After receiving the results of the invocation of the SWS environment by the Negotiation component, these results are gathered and digested by the appropriate Query Resolver implemented for UHP that verify the rules to which the invocation are bound.

The UHP rules implemented for the current prototype have been highlighted in section 2.4.2.

Composer:

If the results of the distributed query can be combined automatically in new learning packages, the Query Resolver will invoke the **Composer component** to create this package.

The Composer component makes use of a Composer Web service designed for the creation of SCORM packages in a LUISA LOMR.

3.2.3 SWS Layer

The Semantic Web Service Layer is responsible to select from the available Web Services the most appropriate ones, to achieve a given goal.

Based on the requirements provided by the use case partners, a generic E-Learning scenario was defined which led to the definition of a dedicated sequence of sub-goals which are accomplished to achieve a specific learning objective (see deliverable D2.2). Figure 7 represents the sequence of sub-goals which support the overall learning objective.

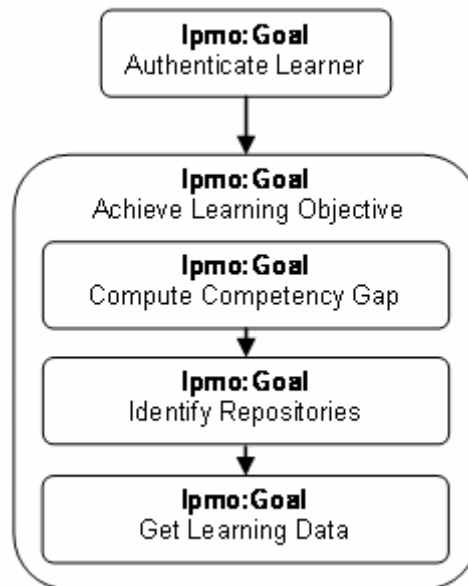


Figure 7: Orchestration of sub-goals to achieve a specific learning objective

As depicted above, in a first step a learner is authenticated to reach awareness about the specific context of the learner – her preferences and requirements. Furthermore, for each specific learning objective, a sequence of goals is to be accomplished. Based on the provided learning objective and the current competency profile of the learner the competency gap is computed. This computation can be implemented based on different computing strategies which may differ between different scenarios, whereas the most appropriate for a given context is selected at runtime. For instance, services from different partners – e. g. OU, EADS or UHP - could be provided to support specific computation strategies.

Given her competency gap, a learner can select and provide the competencies she wants to target. The actual context information – consisting of parameters such as the user preferences and her competency gap – is used within another goal achievement procedure to identify appropriate repositories which target this context. As for the competency gap, different strategies may be implemented by different service providers to select appropriate repositories. Strategies could differ for instance in the prioritization of the distinct context parameters during the matchmaking procedure to identify appropriate repositories.

Finally, based on the context – now enriched with a list of matching repositories – appropriate learning objects can be provided which match all or some of the context parameters. Particularly in the process of selecting appropriate content it is important to highlight, that distinct services can follow different strategies to identify appropriate content, since there may be different answers to the question of which objects match

a given query the best, dependent on distinct viewpoints, perspectives and philosophies.

In the current prototype application, only the last goal of the sequence is represented at the SWS layer and the same services are used for the two use case prototypes. To accomplish such a goal, four distinct services are currently used to provide appropriate learning content, as depicted in Figure 8.

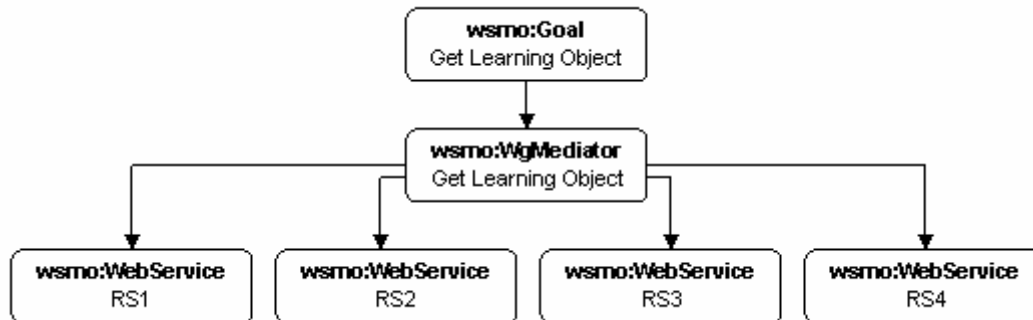


Figure 8: Different utilized Web services to achieve a given goal

These services differ in terms of their input roles and the most appropriate one is selected based on their capability descriptions which are included in appendix 6.2.2 of this document. For instance, RS1 is able to provide content based on a given competency as well as a given field of study, whereas RS3 also considers the language of a user. Dependent on the provided input values, the most appropriate service is selected by the SWS environment IRS III and the learning content is provided to the learner. To provide an idea of the utilized SWS descriptions, the WSMO descriptions – implemented in OCML [1] - of the utilized goal as well as the services depicted above are presented in appendix 6.2.1.

3.2.4 LOMR

The LOMR acts as the data layer in the LUISA architecture. It provides a standard, SOAP-based Web service interface to the rest of the LUISA components. The LUISA LOMR is intended as a framework thus offering in library form several variants, and being devised explicitly for extension with capabilities that are specific to some applications or domains. This section summarizes the design of the interfaces of the LOMR to the rest of the LUISA architecture. Complete information can be found in deliverables 4.3. and 4.5. The version used for the LUISA prototype of M18 is the “Architectural prototype” of the LOMR. The code is provided in open source form at <http://www.cc.uah.es/ie/projects/luisa/lomr>.

The functionality exposed by any LOMR instance is of two kinds, summarized in the following Table.

Functionality	Typical interface	Example
Search of learning	searchXXX(1:LearningNeed):	searchByCompetencyAndField(

Functionality	Typical interface	Example
resources.	Set<LoRef>	c:Competency; fos:FieldOfStudy):List<LORef>
Retrieval of metadata for a given learning resource, which is identified by a learning object reference (LORef).	getXXX(r:LoRef): <i><some piece of metadata></i>	getIEEELOMInteractivityLevel(aLO: LoRef): Integer

Listing 3 LOMR interfaces

Thus, querying LOMR instances is typically done in two phases. First, some calls to search functions for learning resources are issued. Then, for some of the learning object references obtained as search results, additional metadata is retrieved (typically, depending on the information shown in the user interface).

The learningNeed specification varies with the approach used; it might be based on metadata schemas as IEEE LOM, or, as in the example in the Table above, it might be based on some kind of learning need language as competencies. It might also combine both kinds of input elements. In any case, the results is always a collection (ordered or not) of learning object references matching the input criteria.

It is important to clarify that LOMR instances act as black-boxes for the rest of the LUISA architecture, which has two main implications:

1. They are not distinguishable from potential Web-service interfaces provided by non-semantic, existing learning object repositories.
2. LOMR instances might carry out (at its local level) functions of semantic search, composition or inference, but these are transparent to the other components of LUISA. Composition, inference and semantic search are performed at a distributed level inside the components of the Semantic Web Service Layer of LUISA.

The LUISA prototype aims at demonstrating the distributed semantic capabilities of the LUISA architecture. In consequence, the semantic capabilities of an individual implementation of a LOMR are not part of the functionality tested in it.

The LUISA LOMR in the current version includes ontologies of IEEE LOM and IMS LD. The competency-based variant also includes the General Competency Schema developed in LUISA to model the expression of competencies of both use cases.

3.2.5 Profile

The management of the profile is very important in LUISA in order to retrieve the LO taking into account not only the end-user's query, but their preferences or the organizational preferences.

The management of the profile have two different aspects:

- LMS user profile: As LUISA is aimed to be implemented on top of a LMS, the integration of the user profile in LUISA and in the LMS must be guaranteed. As the LMS selected for the prototype is Moodle, the management of this part of the user profile is done in Moodle.
- Particular LUISA profile: The user and organizational profile that allows LUISA to fulfil the correct searching and matching of LOs.

3.2.5.1 Profile in Moodle (Giunti)

The default user profile in Moodle distinguishes between mandatory and optional data. Mandatory data are:

- username
- password
- email
- first name
- surname
- city/town
- country

These data are requested at registration time, as reported in Figure 9.

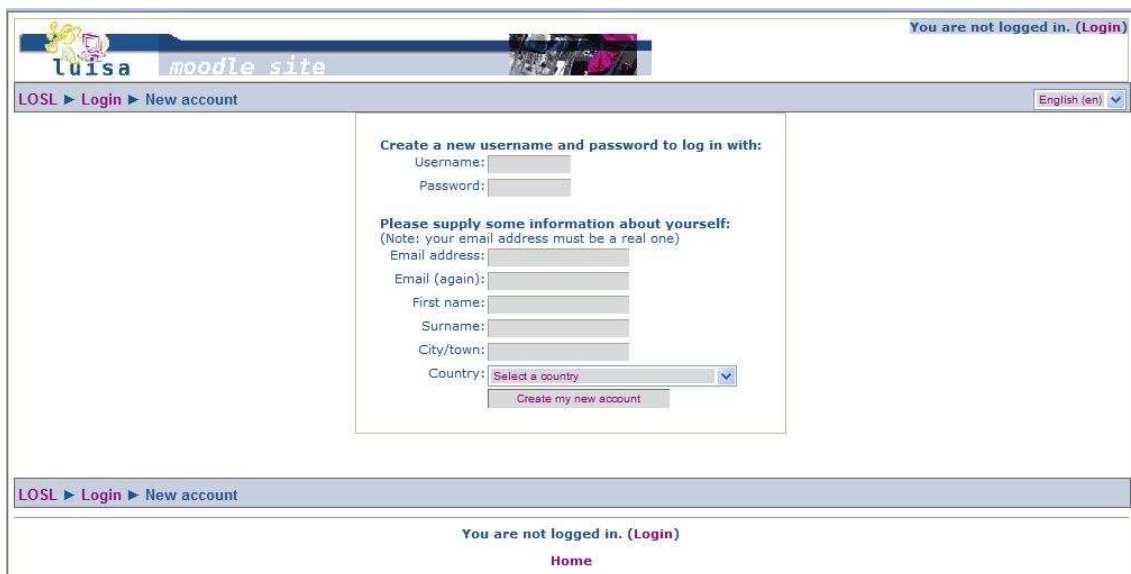
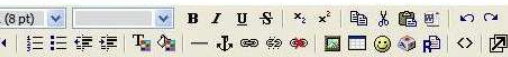


Figure 9: Moodle registration form.

After the registration the user can update her/his data and/or add more data, as from Figure 10.

[Profile](#) | [Edit profile](#) | [Forum posts](#) | [Blog](#)

First name:	<input type="text" value="a"/>
Surname:	<input type="text" value="a"/>
Email address:	<input type="text" value="m.dicerto@giuntillabs.com"/>
Email display:	Allow only other course members to see my email address
Email activated:	This email address is enabled
Email format:	Pretty HTML format
Email digest type:	No digest (single email per forum post)
Forum auto-subscribe:	Yes, when I post, subscribe me to that forum
Forum tracking:	No, don't keep track of posts I have seen
When editing text:	Use HTML editor (some browsers only)
AJAX and Javascript:	No, use basic web features
City/town:	<input type="text" value="a"/>
Country:	Jamaica
Timezone:	Server's local time
Preferred language:	English (en)
Description:	<div style="border: 1px solid #ccc; padding: 5px;"> <p>Trebuchet 1 (8pt) B I U </p> </div>
Path:	<input type="text" value=""/>

The following items are optional:


Current picture:	
New picture:	<input type="text" value=""/> <input type="button" value="Sfoglia..."/>
	<small>Max size: 2MB</small>
Web page:	<input type="text" value=""/>
ICQ number:	<input type="text" value=""/>
Skype ID:	<input type="text" value=""/>
AIM ID:	<input type="text" value=""/>
Yahoo ID:	<input type="text" value=""/>
MSN ID:	<input type="text" value=""/>
ID number:	<input type="text" value=""/> (for the Teacher only)
Phone 1:	<input type="text" value=""/> (for the Teacher only)
Phone 2:	<input type="text" value=""/> (for the Teacher only)
Address:	<input type="text" value=""/> (for the Teacher only)

Figure 10: Moodle update profile form.

The optional data are:

- email display policy: the user can choose if hiding her/his email, showing it to the other course members or showing it to everyone
- email activated: emailing enabled or disabled
- email format: there are two "Pretty HTML format" (which means that the messages will be formatted with different fonts and colours to make them easier to read) and "Plain text format" (plain text with no fancy formatting or colours)

- email digest type: how one receives any posts from forums to which one is subscribed. There are three possible choices: No digest (one receives individual emails), complete (a single digest daily) or subjects (a single digest daily with only the post topics included)
- subscription to forums: the user can decide if s/he wants email copies of posts that are added to forums, or not
- tracking of the participation activity to forums: highlighting the posts that have not read yet
- preferences for text editing
- timezone
- preferred language
- a short personal description
- a personal picture
- the user web page
- ICQ, Skype, AIM, Yahoo, MSN identifiers
- Identifier, telephones and address for teachers

3.2.5.2 *Rest of the user profile*

The rest of the UHP user profile is stored in a separate database and ontologies that must be in synchrony with the user profile stored in Moodle.

UHP	
Feature	Description
University preferences	These preferences are associated to the whole set of users of the university <ul style="list-style-type: none"> - Cost - The maximum cost preferred by the university - Language - The language by default in what the LOs have to be retrieved
User Identification	The id must be a pointer to the LMS identifier of the user
User preferences	<ul style="list-style-type: none"> - List of Operative Systems preferred by the user - Software - List of the software items preferred by the user - Discipline preferred - Video in results

	<ul style="list-style-type: none">- email- duration: maximum duration of the courses (it is composed of the duration and unit of measure)
Competencies-levels	<p>This info is stored in the General Competency Ontology (GCO). In order to ensure synchronization, a pointer between the user profile in the database and the identification of the user in the ontology should be established.</p> <p>A list of couples:</p> <ul style="list-style-type: none">- competency- the current user level

Listing 4 Profile definition

4 CONCLUSION AND FUTURE WORK

The current prototype is part of the iterative prototyping approach followed in LUISA. It shows a specific implementation of the LUISA framework (annotation tool, LOMR, SWS infrastructure, and Negotiation Layer) for the UHP case study (Moodle customization, dedicated interfaces in the Negotiation layer, specific Query Resolver, a prototype LOMR, Web services to accessing the user profile and preferences and annotated LOs using the eLuisa annotation tool). In other words, the prototype covers all the aspects and components of the architecture, so it is in itself the first realization of LUISA from an integrated perspective.

On the other hand, the current prototype can be seen as a proof of concept of the LUISA architecture. However, it does not cover all the requirements gathered in deliverable D7.2.1, so it will not be used for testing with real users.

Following the iterative prototyping approach, we foresee that a new prototype covering the basic process of the LUISA gathered in D7.2.1 will be released in a few months. This prototype will be experimented at UHP. D7.4.1 will include the result of the evaluation of this advanced prototype. This experimentation will allow observing the limits of complex reasoning from two points of view. From a system perspective, we will observe the performance of reasoning across Semantic Web Services. From a designer perspective, we will observe up to which point complex rules applied in the system could stay consistent and useful for the end-user.

We will continue the development of more refined prototypes. The final prototype will be developed in 2008 and delivered on M27. This last prototype will take into account the difficulties and opportunities revealed in the previous ones. It will also investigate advanced features as searching over several ontologies or web 2.0 users' ratings. These features are presented in D7.1.2. and will allow the learner:

- To express a query by **exploring a set of competencies** and additional criteria. From a pedagogical point of view, the exploration and interactions with the competencies tree may improve the user's perception of the learning domain (meta-cognition).
- To obtain the better **resources retrieved** from the available LOR according to the elements of the query. For example, the learner may ask for resources annotated with a competency and be provided among others with resources annotated with a sub-competency of the requested one.
- To be provided with tentatively **packaged resources**. The system can compose some LOs to create a new one. The composition rules are very basic in this prototype. More advanced and pedagogical compositions will be experimented in the second one.
- To be provided with resources **according to the learner profile**. For example, a student in Computer Sciences will obtain some LOs more adapted to her discipline. If no LOs correspond to the user query, the system can propose LOs in a close discipline like Mathematics by using reasoning rules.

The intended users of the next versions of the prototype will be students and professors of the university Henri Poincaré.

- Students: They will look for resources in order to improve their C2I competencies.
- Professors: They will explore the base of LOs in order to be aware of the available contents.

During and after these activities, we will ask them some qualitative questions about their perceptions of the system and its features in order to validate and evaluate the LUISA approach.

5 REFERENCES

- [1] Domingue, J., Motta, E., and Corcho Garcia, O. (1999). Knowledge Modelling in WebOnto and OCML: A User Guide, available from: http://kmi.open.ac.uk/projects/webonto/user_guide.2.4.pdf.
- [2] LUISA Consortium (2007) *D7.1.2 Requirement analysis and specifications: Academic use case*
- [3] LUISA Consortium (2007) *D2.1 Semantic Web Service Infrastructure for e-Learning Applications: using WSMO for linking LO Standards and representing Processes*

6 APPENDIXES

6.1 WSDL files

6.1.1 Negotiation Layer WS

This Web services offers different access operations to access to the user profiles and retrieve LO. It is a common Web service to be used in both LUISA case studies.

```
<wsdl:definitions xmlns="http://schemas.xmlsoap.org/wsdl/" xmlns:apache="http://xml.apache.org/xml-soap" xmlns:impl="http://atosorigin.es/luisa/negotiation/soa/service/" xmlns:tns="http://atosorigin.es/luisa/negotiation/soa/message/" xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/" xmlns:wSDL="http://schemas.xmlsoap.org/wsdl/" xmlns:wSDLsoap="http://schemas.xmlsoap.org/wsdl/soap/" xmlns:xsd="http://www.w3.org/2001/XMLSchema" targetNamespace="http://atosorigin.es/luisa/negotiation/soa/service/">
  <wsdl:types>
    <schema targetNamespace="http://atosorigin.es/luisa/negotiation/soa/message/" xmlns="http://www.w3.org/2001/XMLSchema">
      <import namespace="http://xml.apache.org/xml-soap"/>
      <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
      <complexType name="getLOsReturn">
        <sequence>
          <element name="CorrelationId" nillable="true" type="xsd:string"/>
          <element maxOccurs="unbounded" minOccurs="0" name="competencyLOs" nillable="true" type="tns:competencyResults"/>
        </sequence>
      </complexType>
      <complexType name="ArrayOf_xsd_string">
        <sequence>
          <element maxOccurs="unbounded" minOccurs="0" name="arrayOfStrings" nillable="true" type="xsd:string"/>
        </sequence>
      </complexType>
      <complexType name="competencyResults">
        <sequence>
          <element name="competency" nillable="true" type="xsd:string"/>
          <element maxOccurs="unbounded" minOccurs="0" name="learningObjectInfo" nillable="true" type="tns:learningObjectResults"/>
        </sequence>
      </complexType>
      <complexType name="learningObjectResults">
        <sequence>
          <element name="learningObjectId" nillable="false" type="xsd:string"/>
          <element name="learningObjectTitle" nillable="false" type="xsd:string"/>
          <element name="learningObjectDescription" nillable="true" type="xsd:string"/>
          <element name="learningObjectRanking" nillable="true" type="xsd:int"/>
          <element name="learningObjectComposed" nillable="true" type="xsd:boolean"/>
          <element name="learningObjectLanguage" nillable="false" type="xsd:string"/>
        </sequence>
      </complexType>
      <complexType name="profileEADSReturn">
        <sequence>
          <element name="CorrelationIdEADS" nillable="true" type="xsd:string"/>
          <element name="EADSUserPreferences" nillable="true" type="tns:EADSUserPreferences"/>
          <element name="EADSIndustryPreferences" nillable="true" type="tns:EADSIndustryPreferences"/>
          <element maxOccurs="unbounded" minOccurs="0" name="EADScompetencyDefinition" nillable="true" type="tns:competencyDefinition"/>
        </sequence>
      </complexType>
      <complexType name="EADSUserPreferences">
        <sequence>
          <element name="position" nillable="true" type="xsd:string"/>
        </sequence>
      </complexType>
    </schema>
  </wsdl:types>

```

```

        <element name="nativeLanguage" nillable="true" type="xsd:string"/>
        <element name="workingLocation" nillable="true" type="xsd:string"/>
        <element name="workingDiscipline" nillable="true" type="xsd:string"/>
    </sequence>
</complexType>
<complexType name="EADSIndustryPreferences">
    <sequence>
        <element name="language" nillable="true" type="xsd:string"/>
        <element name="location" nillable="true" type="xsd:string"/>
        <element name="duration" nillable="true" type="xsd:string"/>
        <element name="cost" nillable="true" type="xsd:string"/>
    </sequence>
</complexType>
<complexType name="profileUHPReturn">
    <sequence>
        <element name="CorrelationIdUHP" nillable="true" type="xsd:string"/>
        <element name="UHPUserPreferences" nillable="true" type="tns:UHPUserPreferences"/>
        <element name="UHPUniversityPreferences" nillable="true"
type="tns:UHPUniversityPreferences"/>
        <element maxOccurs="unbounded" minOccurs="0" name="UHPcompetencyDefinition"
nillable="true" type="tns:competencyDefinition"/>
    </sequence>
</complexType>
<complexType name="UHPUserPreferences">
    <sequence>
        <element name="operativeSystem" nillable="true" type="xsd:string"/>
        <element name="discipline" nillable="true" type="xsd:string"/>
        <element maxOccurs="unbounded" minOccurs="0" name="software" nillable="true"
type="xsd:string"/>
    </sequence>
</complexType>
<complexType name="UHPUniversityPreferences">
    <sequence>
        <element name="cost" nillable="true" type="xsd:string"/>
        <element name="language" nillable="true" type="xsd:string"/>
    </sequence>
</complexType>
<complexType name="competencyDefinition">
    <sequence>
        <element name="competencyId" nillable="true" type="xsd:string"/>
        <element name="competencyName" nillable="true" type="xsd:string"/>
        <element name="competencyType" nillable="true" type="xsd:string"/>
        <element name="competencyDescription" nillable="true" type="xsd:string"/>
        <element name="competencyCurrentLevel" nillable="true" type="xsd:int"/>
        <element name="competencyRequiredLevel" nillable="true" type="xsd:int"/>
    </sequence>
</complexType>
</schema>
</wsdl:types>
<wsdl:message name="getLOsByCompetenciesRequest">
    <wsdl:part name="CorrelationIdIn" type="xsd:string"/>
    <wsdl:part name="Comp" type="tns:ArrayOf_xsd_string"/>
    <wsdl:part name="Field" type="xsd:string"/>
    <wsdl:part name="Interac" type="xsd:string"/>
    <wsdl:part name="Lang" type="xsd:string"/>
    <wsdl:part name="OperativeSystem" type="xsd:string"/>
    <wsdl:part name="Software" type="tns:ArrayOf_xsd_string"/>
</wsdl:message>
<wsdl:message name="getLOsByCompetenciesResponse">
    <wsdl:part name="getLOsReturn" type="tns:getLOsReturn"/>
</wsdl:message>
<wsdl:message name="profileRequest">
    <wsdl:part name="UserId" type="xsd:string"/>
</wsdl:message>
<wsdl:message name="profileEADSResponse">
    <wsdl:part name="profileEADSReturn" type="tns:profileEADSReturn"/>
</wsdl:message>
<wsdl:message name="profileUHPResponse">

```

```

    <wsdl:part name="profileUHPReturn" type="tns:profileUHPReturn"/>
  </wsdl:message>
  <wsdl:message name="msgFault">
    <wsdl:part name="negotiationFaultCode" type="xsd:string"/>
    <wsdl:part name="negotiationFaultDescription" type="xsd:string"/>
    <wsdl:part name="negotiationFaultActor" type="xsd:string"/>
  </wsdl:message>
  <wsdl:portType name="negotiationLayerPort">
    <wsdl:operation name="getLOsForCompetenciesEADS" parameterOrder="CorrelationIdIn Comp Field
Interac Lang OperativeSystem Software">
      <wsdl:input name="getLOsByCompetenciesRequest"
message="impl:getLOsByCompetenciesRequest"/>
      <wsdl:output name="getLOsByCompetenciesResponse"
message="impl:getLOsByCompetenciesResponse"/>
      <wsdl:fault name="negotiationFault" message="impl:msgFault"/>
    </wsdl:operation>
    <wsdl:operation name="getLOsForCompetenciesUHP" parameterOrder="CorrelationIdIn Comp Field
Interac Lang OperativeSystem Software">
      <wsdl:input name="getLOsByCompetenciesRequest"
message="impl:getLOsByCompetenciesRequest"/>
      <wsdl:output name="getLOsByCompetenciesResponse"
message="impl:getLOsByCompetenciesResponse"/>
      <wsdl:fault name="negotiationFault" message="impl:msgFault"/>
    </wsdl:operation>
    <wsdl:operation name="getProfileEADS" parameterOrder="UserId">
      <wsdl:input message="impl:profileRequest" name="profileRequest"/>
      <wsdl:output message="impl:profileEADSResponse" name="profileEADSResponse"/>
      <wsdl:fault name="negotiationFault" message="impl:msgFault"/>
    </wsdl:operation>
    <wsdl:operation name="getProfileUHP" parameterOrder="UserId">
      <wsdl:input message="impl:profileRequest" name="profileRequest"/>
      <wsdl:output message="impl:profileUHPResponse" name="profileUHPResponse"/>
      <wsdl:fault name="negotiationFault" message="impl:msgFault"/>
    </wsdl:operation>
  </wsdl:portType>
  <wsdl:binding name="luisaNegotiationLayerPortSoapBinding" type="impl:negotiationLayerPort">
    <wsdlsoap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
    <wsdl:operation name="getProfileEADS">
      <wsdl:input name="profileRequest">
        <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:input>
      <wsdl:output name="profileEADSResponse">
        <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:output>
      <wsdl:fault name="negotiationFault">
        <wsdlsoap:fault name="negotiationFault" use="encoded"
encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:fault>
    </wsdl:operation>
    <wsdl:operation name="getProfileUHP">
      <wsdl:input name="profileRequest">
        <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:input>
      <wsdl:output name="profileUHPResponse">
        <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:output>
      <wsdl:fault name="negotiationFault">
        <wsdlsoap:fault name="negotiationFault" use="encoded"
encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:fault>
    </wsdl:operation>
    <wsdl:operation name="getLOsForCompetenciesEADS">
      <wsdl:input name="getLOsByCompetenciesRequest">
        <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:input>
      <wsdl:output name="getLOsByCompetenciesResponse">
        <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding"/>
      </wsdl:output>

```

```

    <wsdl:fault name="negotiationFault">
      <wsdlsoap:fault name="negotiationFault" use="encoded"
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" />
    </wsdl:fault>
  </wsdl:operation>
  <wsdl:operation name="getLOsForCompetenciesUHP">
    <wsdl:input name="getLOsByCompetenciesRequest">
      <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" />
    </wsdl:input>
    <wsdl:output name="getLOsByCompetenciesResponse">
      <wsdlsoap:body use="encoded" encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" />
    </wsdl:output>
    <wsdl:fault name="negotiationFault">
      <wsdlsoap:fault name="negotiationFault" use="encoded"
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" />
    </wsdl:fault>
  </wsdl:operation>
</wsdl:binding>
<wsdl:service name="negotiationLayer.luisa">
  <wsdl:port name="negotiationLayerPort" binding="impl:luisaNegotiationLayerPortSoapBinding">
    <wsdlsoap:address location="http://localhost:8080/NegotiationLayerService-
v1/services/negotiationLayerPort" />
  </wsdl:port>
</wsdl:service>
</wsdl:definitions>

```

Listing 5 Negotiation Layer Web service

6.1.2 UHP Profile WS

This Web service interfaces allows the access to retrieve the user profile. It is used internally by the Negotiation Layer.

```

<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions targetNamespace="http://service.uhpws.luisa.atosorigin.eu"
xmlns:apacheSOAP="http://xml.apache.org/xml-soap" xmlns:impl="http://service.uhpws.luisa.atosorigin.eu"
xmlns:intf="http://service.uhpws.luisa.atosorigin.eu"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:tns2="http://profile.types.luisa.atosorigin.eu" xmlns:tns3="http://userPreferences.types.luisa.atosorigin.eu"
xmlns:tns4="http://types.luisa.atosorigin.eu" xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
xmlns:wsdlsoap="http://schemas.xmlsoap.org/wsdl/soap/" xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <!--WSDL created by Apache Axis version: 1.4
Built on Apr 22, 2006 (06:55:48 PDT)-->
  <wsdl:types>
    <schema targetNamespace="http://userPreferences.types.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
      <import namespace="http://profile.types.luisa.atosorigin.eu"/>
      <import namespace="http://types.luisa.atosorigin.eu"/>
      <import namespace="http://service.uhpws.luisa.atosorigin.eu"/>
      <import namespace="http://schemas.xmlsoap.org/soap/encoding/" />
      <complexType name="UHPUniversityPreferences">
        <sequence>
          <element name="cost" type="xsd:int"/>
          <element name="language" nillable="true" type="soapenc:string"/>
        </sequence>
      </complexType>
      <complexType name="UHPUserPreferences">
        <sequence>
          <element name="OS" nillable="true" type="impl:ArrayOf_soapenc_string"/>
          <element name="discipline" nillable="true" type="soapenc:string"/>
          <element name="duration" type="xsd:int"/>
          <element name="durationMeasure" nillable="true" type="soapenc:string"/>
          <element name="email" nillable="true" type="soapenc:string"/>
          <element name="sw" nillable="true" type="impl:ArrayOf_soapenc_string"/>
          <element name="video" type="xsd:int"/>
        </sequence>
      </complexType>
    </schema>
  </wsdl:types>

```

```

        </sequence>
    </complexType>
</schema>
<schema targetNamespace="http://profile.types.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
    <import namespace="http://userPreferences.types.luisa.atosorigin.eu"/>
    <import namespace="http://types.luisa.atosorigin.eu"/>
    <import namespace="http://service.uhpws.luisa.atosorigin.eu"/>
    <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
    <complexType name="ProfileUniversityUHP">
        <sequence>
            <element name="id" nillable="true" type="soapenc:string"/>
            <element name="institutionPreferences" nillable="true"
type="tns3:UHPUniversityPreferences"/>
        </sequence>
    </complexType>
    <complexType name="ProfileUserUHP">
        <sequence>
            <element name="gap" nillable="true"
type="impl:ArrayOf_tns4_UHPCompetencyDefinition"/>
            <element name="id" nillable="true" type="soapenc:string"/>
            <element name="userPreferences" nillable="true" type="tns3:UHPUserPreferences"/>
        </sequence>
    </complexType>
    <complexType name="ProfileUHP">
        <sequence>
            <element name="institutionProfile" nillable="true" type="tns2:ProfileUniversityUHP"/>
            <element name="userProfile" nillable="true" type="tns2:ProfileUserUHP"/>
        </sequence>
    </complexType>
</schema>
<schema targetNamespace="http://types.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
    <import namespace="http://profile.types.luisa.atosorigin.eu"/>
    <import namespace="http://userPreferences.types.luisa.atosorigin.eu"/>
    <import namespace="http://service.uhpws.luisa.atosorigin.eu"/>
    <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
    <complexType name="UHPCompetencyDefinition">
        <sequence>
            <element name="actualLevel" type="xsd:int"/>
            <element name="description" nillable="true" type="soapenc:string"/>
            <element name="id" nillable="true" type="soapenc:string"/>
            <element name="name" nillable="true" type="soapenc:string"/>
        </sequence>
    </complexType>
</schema>
<schema targetNamespace="http://service.uhpws.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
    <import namespace="http://profile.types.luisa.atosorigin.eu"/>
    <import namespace="http://userPreferences.types.luisa.atosorigin.eu"/>
    <import namespace="http://types.luisa.atosorigin.eu"/>
    <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
    <complexType name="ArrayOf_tns4_UHPCompetencyDefinition">
        <complexContent>
            <restriction base="soapenc:Array">
                <attribute ref="soapenc:arrayType"
wsdl:arrayType="tns4:UHPCompetencyDefinition[]"/>
            </restriction>
        </complexContent>
    </complexType>
    <complexType name="ArrayOf_soapenc_string">
        <complexContent>
            <restriction base="soapenc:Array">
                <attribute ref="soapenc:arrayType" wsdl:arrayType="soapenc:string[]"/>
            </restriction>
        </complexContent>
    </complexType>
</schema>

```

```

</wsdl:types>
<wsdl:message name="saveUserProfileResponse">
  <wsdl:part name="saveUserProfileReturn" type="xsd:int"/>
</wsdl:message>
<wsdl:message name="getUserProfileRequest">
  <wsdl:part name="in0" type="soapenc:string"/>
</wsdl:message>
<wsdl:message name="getProfileResponse">
  <wsdl:part name="getProfileReturn" type="tns2:ProfileUHP"/>
</wsdl:message>
<wsdl:message name="saveUserProfileRequest">
  <wsdl:part name="in0" type="tns2:ProfileUserUHP"/>
</wsdl:message>
<wsdl:message name="getInstitutionProfileRequest">
  <wsdl:part name="in0" type="soapenc:string"/>
</wsdl:message>
<wsdl:message name="getUserProfileResponse">
  <wsdl:part name="getUserProfileReturn" type="tns2:ProfileUserUHP"/>
</wsdl:message>
<wsdl:message name="saveInstitutionProfileRequest">
  <wsdl:part name="in0" type="tns2:ProfileUniversityUHP"/>
</wsdl:message>
<wsdl:message name="getInstitutionProfileResponse">
  <wsdl:part name="getInstitutionProfileReturn" type="tns2:ProfileUniversityUHP"/>
</wsdl:message>
<wsdl:message name="saveInstitutionProfileResponse">
  <wsdl:part name="saveInstitutionProfileReturn" type="xsd:int"/>
</wsdl:message>
<wsdl:message name="getProfileRequest">
  <wsdl:part name="in0" type="soapenc:string"/>
  <wsdl:part name="in1" type="soapenc:string"/>
</wsdl:message>
<wsdl:portType name="UHPPProfileWS">
  <wsdl:operation name="getInstitutionProfile" parameterOrder="in0">
    <wsdl:input message="impl:getInstitutionProfileRequest" name="getInstitutionProfileRequest"/>
    <wsdl:output message="impl:getInstitutionProfileResponse"
name="getInstitutionProfileResponse"/>
  </wsdl:operation>
  <wsdl:operation name="saveInstitutionProfile" parameterOrder="in0">
    <wsdl:input message="impl:saveInstitutionProfileRequest" name="saveInstitutionProfileRequest"/>
    <wsdl:output message="impl:saveInstitutionProfileResponse"
name="saveInstitutionProfileResponse"/>
  </wsdl:operation>
  <wsdl:operation name="getUserProfile" parameterOrder="in0">
    <wsdl:input message="impl:getUserProfileRequest" name="getUserProfileRequest"/>
    <wsdl:output message="impl:getUserProfileResponse" name="getUserProfileResponse"/>
  </wsdl:operation>
  <wsdl:operation name="saveUserProfile" parameterOrder="in0">
    <wsdl:input message="impl:saveUserProfileRequest" name="saveUserProfileRequest"/>
    <wsdl:output message="impl:saveUserProfileResponse" name="saveUserProfileResponse"/>
  </wsdl:operation>
  <wsdl:operation name="getProfile" parameterOrder="in0 in1">
    <wsdl:input message="impl:getProfileRequest" name="getProfileRequest"/>
    <wsdl:output message="impl:getProfileResponse" name="getProfileResponse"/>
  </wsdl:operation>
</wsdl:portType>
<wsdl:binding name="UHPPProfileLuisaWSSoapBinding" type="impl:UHPPProfileWS">
  <wsdlsoap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
  <wsdl:operation name="getInstitutionProfile">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getInstitutionProfileRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getInstitutionProfileResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="saveInstitutionProfile">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="saveInstitutionProfileRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="saveInstitutionProfileResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="getUserProfile">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getUserProfileRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getUserProfileResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="saveUserProfile">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="saveUserProfileRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="saveUserProfileResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="getProfile">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getProfileRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getProfileResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
</wsdl:binding>
</wsdl:service>

```

```

</wsdl:operation>
<wsdl:operation name="saveInstitutionProfile">
  <wsdlsoap:operation soapAction=""/>
  <wsdl:input name="saveInstitutionProfileRequest">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:input>
  <wsdl:output name="saveInstitutionProfileResponse">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:output>
</wsdl:operation>
<wsdl:operation name="getUserProfile">
  <wsdlsoap:operation soapAction=""/>
  <wsdl:input name="getUserProfileRequest">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:input>
  <wsdl:output name="getUserProfileResponse">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:output>
</wsdl:operation>
<wsdl:operation name="saveUserProfile">
  <wsdlsoap:operation soapAction=""/>
  <wsdl:input name="saveUserProfileRequest">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:input>
  <wsdl:output name="saveUserProfileResponse">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:output>
</wsdl:operation>
<wsdl:operation name="getProfile">
  <wsdlsoap:operation soapAction=""/>
  <wsdl:input name="getProfileRequest">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:input>
  <wsdl:output name="getProfileResponse">
    <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
  </wsdl:output>
</wsdl:operation>
</wsdl:binding>
<wsdl:service name="UHPPProfileWSService">
  <wsdl:port binding="impl:UHPPProfileLuisaWSSoapBinding" name="UHPPProfileLuisaWS">
    <wsdlsoap:address location="http://localhost:8080/axis/services/UHPPProfileLuisaWS"/>
  </wsdl:port>
</wsdl:service>
</wsdl:definitions>

```

Listing 6 UHP Profile Web service

6.1.3 UHP Data needed by the GUI WS

This Web service is intended to be used directly by the GUI. It allows access to retrieve the several information that the GUI needs to display, such as combo boxes of Operative Systems, list of available software, etc. It is then used by the GUI with no need of accessing to the Negotiation Layer.

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions targetNamespace="http://service.uhpws.luisa.atosorigin.eu"
xmlns:apachesoap="http://xml.apache.org/xml-soap" xmlns:impl="http://service.uhpws.luisa.atosorigin.eu"
xmlns:intf="http://service.uhpws.luisa.atosorigin.eu"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/" xmlns:tns2="http://types.luisa.atosorigin.eu"
xmlns:tns3="http://userPreferences.types.luisa.atosorigin.eu" xmlns:wSDL="http://schemas.xmlsoap.org/wsdl/"
xmlns:wSDLsoap="http://schemas.xmlsoap.org/wsdl/soap/" xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <!--WSDL created by Apache Axis version: 1.4
  Built on Apr 22, 2006 (06:55:48 PDT)-->
  <wsdl:types>
    <schema targetNamespace="http://types.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
      <import namespace="http://userPreferences.types.luisa.atosorigin.eu"/>
      <import namespace="http://service.uhpws.luisa.atosorigin.eu"/>
      <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
      <complexType name="Resource">
        <sequence>
          <element name="name" nillable="true" type="soapenc:string"/>
          <element name="url" nillable="true" type="soapenc:string"/>
        </sequence>
      </complexType>
    </schema>
    <schema targetNamespace="http://service.uhpws.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
      <import namespace="http://userPreferences.types.luisa.atosorigin.eu"/>
      <import namespace="http://types.luisa.atosorigin.eu"/>
      <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
      <complexType name="ArrayOf_tns2_Resource">
        <complexContent>
          <restriction base="soapenc:Array">
            <attribute ref="soapenc:arrayType" wsdl:arrayType="tns2:Resource[]" />
          </restriction>
        </complexContent>
      </complexType>
      <complexType name="ArrayOf_soapenc_string">
        <complexContent>
          <restriction base="soapenc:Array">
            <attribute ref="soapenc:arrayType" wsdl:arrayType="soapenc:string[]" />
          </restriction>
        </complexContent>
      </complexType>
    </schema>
    <schema targetNamespace="http://userPreferences.types.luisa.atosorigin.eu"
xmlns="http://www.w3.org/2001/XMLSchema">
      <import namespace="http://types.luisa.atosorigin.eu"/>
      <import namespace="http://service.uhpws.luisa.atosorigin.eu"/>
      <import namespace="http://schemas.xmlsoap.org/soap/encoding"/>
      <complexType name="UHPUniversityPreferences">
        <sequence>
          <element name="cost" type="xsd:int"/>
          <element name="language" nillable="true" type="soapenc:string"/>
        </sequence>
      </complexType>
      <complexType name="UHPUserPreferences">
        <sequence>
          <element name="OS" nillable="true" type="impl:ArrayOf_soapenc_string"/>
          <element name="discipline" nillable="true" type="soapenc:string"/>
          <element name="duration" type="xsd:int"/>
          <element name="durationMeasure" nillable="true" type="soapenc:string"/>
        </sequence>
      </complexType>
    </schema>
  </wsdl:types>

```

```

        <element name="email" nillable="true" type="soapenc:string"/>
        <element name="sw" nillable="true" type="impl:ArrayOf_soapenc_string"/>
        <element name="video" type="xsd:int"/>
    </sequence>
</complexType>
</schema>
</wsdl:types>
<wsdl:message name="getUserPreferencesRequest">
    <wsdl:part name="in0" type="soapenc:string"/>
</wsdl:message>
<wsdl:message name="saveUserPreferencesResponse">
    <wsdl:part name="saveUserPreferencesReturn" type="xsd:int"/>
</wsdl:message>
<wsdl:message name="getDisciplinesRequest"/>
<wsdl:message name="getUniversityPreferencesResponse">
    <wsdl:part name="getUniversityPreferencesReturn" type="tns3:UHPUniversityPreferences"/>
</wsdl:message>
<wsdl:message name="getOSResponse">
    <wsdl:part name="getOSReturn" type="impl:ArrayOf_tns2_Resource"/>
</wsdl:message>
<wsdl:message name="getSwResponse">
    <wsdl:part name="getSwReturn" type="impl:ArrayOf_tns2_Resource"/>
</wsdl:message>
<wsdl:message name="getSwRequest"/>
<wsdl:message name="getUserPreferencesResponse">
    <wsdl:part name="getUserPreferencesReturn" type="tns3:UHPUserPreferences"/>
</wsdl:message>
<wsdl:message name="saveUserPreferencesRequest">
    <wsdl:part name="in0" type="soapenc:string"/>
    <wsdl:part name="in1" type="tns3:UHPUserPreferences"/>
</wsdl:message>
<wsdl:message name="getUniversityPreferencesRequest">
    <wsdl:part name="in0" type="soapenc:string"/>
</wsdl:message>
<wsdl:message name="getDisciplinesResponse">
    <wsdl:part name="getDisciplinesReturn" type="impl:ArrayOf_tns2_Resource"/>
</wsdl:message>
<wsdl:message name="getOSRequest"/>
<wsdl:portType name="UHPDataWS">
    <wsdl:operation name="getOS">
        <wsdl:input message="impl:getOSRequest" name="getOSRequest"/>
        <wsdl:output message="impl:getOSResponse" name="getOSResponse"/>
    </wsdl:operation>
    <wsdl:operation name="getSw">
        <wsdl:input message="impl:getSwRequest" name="getSwRequest"/>
        <wsdl:output message="impl:getSwResponse" name="getSwResponse"/>
    </wsdl:operation>
    <wsdl:operation name="getDisciplines">
        <wsdl:input message="impl:getDisciplinesRequest" name="getDisciplinesRequest"/>
        <wsdl:output message="impl:getDisciplinesResponse" name="getDisciplinesResponse"/>
    </wsdl:operation>
    <wsdl:operation name="getUniversityPreferences" parameterOrder="in0">
        <wsdl:input message="impl:getUniversityPreferencesRequest"
name="getUniversityPreferencesRequest"/>
        <wsdl:output message="impl:getUniversityPreferencesResponse"
name="getUniversityPreferencesResponse"/>
    </wsdl:operation>
    <wsdl:operation name="getUserPreferences" parameterOrder="in0">
        <wsdl:input message="impl:getUserPreferencesRequest" name="getUserPreferencesRequest"/>
        <wsdl:output message="impl:getUserPreferencesResponse"
name="getUserPreferencesResponse"/>
    </wsdl:operation>
    <wsdl:operation name="saveUserPreferences" parameterOrder="in0 in1">
        <wsdl:input message="impl:saveUserPreferencesRequest"
name="saveUserPreferencesRequest"/>
        <wsdl:output message="impl:saveUserPreferencesResponse"
name="saveUserPreferencesResponse"/>
    </wsdl:operation>

```

```
</wsdl:portType>
<wsdl:binding name="UHPDataLuisaWSSoapBinding" type="impl:UHPDataWS">
  <wsdlsoap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
  <wsdl:operation name="getOS">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getOSRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getOSResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="getSw">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getSwRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getSwResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="getDisciplines">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getDisciplinesRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getDisciplinesResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="getUniversityPreferences">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getUniversityPreferencesRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getUniversityPreferencesResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="getUserPreferences">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="getUserPreferencesRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="getUserPreferencesResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
  <wsdl:operation name="saveUserPreferences">
    <wsdlsoap:operation soapAction=""/>
    <wsdl:input name="saveUserPreferencesRequest">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:input>
    <wsdl:output name="saveUserPreferencesResponse">
      <wsdlsoap:body encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
namespace="http://service.uhpws.luisa.atosorigin.eu" use="encoded"/>
    </wsdl:output>
  </wsdl:operation>
</wsdl:binding>
</wsdl:portType>
```

```
</wsdl:operation>
</wsdl:binding>
<wsdl:service name="UHPDataWSService">
  <wsdl:port binding="impl:UHPDataLuisaWSSoapBinding" name="UHPDataLuisaWS">
    <wsdlsoap:address location=" http://localhost:8080/axis/services/UHPDataLuisaWS"/>
  </wsdl:port>
</wsdl:service>
</wsdl:definitions>
```

Listing 7 UHP Data Web service

6.2 SWS descriptions

6.2.1 Goal and Mediator Description

```
(DEF-CLASS LUISA-GET-LO-GOAL
  (GOAL)
  ?GOAL
    (HAS-INPUT-ROLE :VALUE HAS-METHOD :VALUE HAS-COMP :VALUE HAS-FIELD
      :VALUE HAS-LANG :VALUE HAS-INTERACT)
  (HAS-INPUT-SOAP-BINDING
    :VALUE
  (HAS-METHOD "string")
    :VALUE
  (HAS-COMP "string")
    :VALUE
  (HAS-FIELD "string")
    :VALUE
  (HAS-LANG "string")
    :VALUE
  (HAS-INTERACT "string"))
  (HAS-OUTPUT-ROLE :VALUE HAS-LEARNING-OBJECT)
  (HAS-OUTPUT-SOAP-BINDING
    :VALUE
  (HAS-LEARNING-OBJECT "string"))
  (HAS-METHOD :TYPE STRING)
  (HAS-COMP :TYPE GET-LO-BY-COMPETENCY-REQUEST)
  (HAS-FIELD :TYPE GET-LO-BY-FIELD-REQUEST)
  (HAS-LANG :TYPE GET-LO-BY-LANG-REQUEST)
  (HAS-INTERACT :TYPE GET-LO-BY-INTERACT-REQUEST)
  (HAS-LEARNING-OBJECT :TYPE STRING)
  ;;(HAS-LEARNING-OBJECT :TYPE LEARNING-OBJECT-MULTIREF)
  (HAS-NON-FUNCTIONAL-PROPERTIES
    :VALUE
    LUISA-GET-LO-GOAL-NON-FUNCTIONAL-PROPERTIES)))
(DEF-CLASS LUISA-GET-LO-MED
  (WG-MEDIATOR)
  ?MEDIATOR
  ((HAS-SOURCE-COMPONENT :VALUE LUISA-GET-LO-GOAL)
  (HAS-NON-FUNCTIONAL-PROPERTIES
    :VALUE
    LUISA-GET-LO-MED-NON-FUNCTIONAL-PROPERTIES)))
```

Listing 8 Goal and mediator description

6.2.2 Web Service Descriptions

```
(DEF-CLASS LUISA-RS1-WS
  (WEB-SERVICE)
  ?WEB-SERVICE
  ((HAS-CAPABILITY :VALUE LUISA-RS1-WS-CAPABILITY)
  (HAS-INTERFACE :VALUE LUISA-RS1-INTERFACE)
  (USED-MEDIATOR :VALUE LUISA-GET-LO-MED)
  (HAS-NON-FUNCTIONAL-PROPERTIES
  :VALUE
  LUISA-RS1-WS-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS1-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES
  (NON-FUNCTIONAL-PROPERTIES)
  NIL)

(DEF-CLASS LUISA-RS1-WS-CAPABILITY
  (CAPABILITY)
  ?CAPABILITY
  ((USED-MEDIATOR :VALUE LUISA-GET-LO-MED)
  (HAS-ASSUMPTION
  :VALUE
  (KAPPA
  (?WEB-SERVICE)
  (AND (AND (AND (= (WSMO-ROLE-VALUE
  ?WEB-SERVICE
  'HAS-LANG)
  ""))
  (= (WSMO-ROLE-VALUE
  ?WEB-SERVICE
  'HAS-INTERACT)
  ""))
  (NOT (= (WSMO-ROLE-VALUE
  ?WEB-SERVICE
  'HAS-COMP)
  ""))) (NOT (= (WSMO-ROLE-VALUE
  ?WEB-SERVICE
  'HAS-FIELD)
  ""))))))
  ))
```

```
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS1-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS1-INTERFACE-NON-FUNCTIONAL-PROPERTIES
(NON-FUNCTIONAL-PROPERTIES)
NIL)

(DEF-CLASS LUISA-RS1-INTERFACE-CHOREOGRAPHY
(CHOREOGRAPHY)
((HAS-GROUNDING
:VALUE
((GROUNDED-TO-HTTP
(NORMAL
(NIL (METHOD COMP FIELD))))))))

(DEF-CLASS LUISA-RS1-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN
(PROBLEM-SOLVING-PATTERN)
NIL)

(DEF-CLASS LUISA-RS1-INTERFACE-ORCHESTRATION
(ORCHESTRATION)
((HAS-PROBLEM-SOLVING-PATTERN
:VALUE
LUISA-RS1-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN)))

(DEF-CLASS LUISA-RS1-INTERFACE
(INTERFACE)
?INTERFACE
((HAS-CHOREOGRAPHY
:VALUE
LUISA-RS1-INTERFACE-CHOREOGRAPHY)
(HAS-ORCHESTRATION
:VALUE
LUISA-RS1-INTERFACE-ORCHESTRATION)
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS1-INTERFACE-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS1-WS-PUBLISHER-INFORMATION
```

```
(PUBLISHER-INFORMATION)
((HAS-ASSOCIATED-WEB-SERVICE-INTERFACE
:VALUE
LUISA-RS1-INTERFACE)
(HAS-WEB-SERVICE-HOST :VALUE "193.146.58.138")
(HAS-WEB-SERVICE-PORT :VALUE 8080)
(HAS-WEB-SERVICE-LOCATION :VALUE "/axis/RS1.jws"))
```

Listing 9 RS1 LOMR Web service

```
(DEF-CLASS LUISA-RS2-WS
(WEB-SERVICE)
?WEB-SERVICE
((HAS-CAPABILITY :VALUE LUISA-RS2-WS-CAPABILITY)
(HAS-INTERFACE :VALUE LUISA-RS2-INTERFACE)
(USED-MEDIATOR :VALUE LUISA-RS2-MED)
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS2-WS-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS2-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES
(NON-FUNCTIONAL-PROPERTIES)
NIL)

(DEF-CLASS LUISA-RS2-WS-CAPABILITY
(CAPABILITY)
?CAPABILITY
((USED-MEDIATOR :VALUE LUISA-RS2-MED)
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS2-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS2-INTERFACE-NON-FUNCTIONAL-PROPERTIES
(NON-FUNCTIONAL-PROPERTIES)
NIL)

(DEF-CLASS LUISA-RS2-INTERFACE-CHOREOGRAPHY
(CHOREOGRAPHY)
((HAS-GROUNDING
:VALUE
((GROUNDED-TO-HTTP
```

```
(NORMAL
(NIL (METHOD COMP FIELD))))))

(DEF-CLASS LUISA-RS2-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN
(PROBLEM-SOLVING-PATTERN)
NIL)

(DEF-CLASS LUISA-RS2-INTERFACE-ORCHESTRATION
(ORCHESTRATION)
((HAS-PROBLEM-SOLVING-PATTERN
:VALUE
LUISA-RS2-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN)))

(DEF-CLASS LUISA-RS2-INTERFACE
(INTERFACE)
?INTERFACE
((HAS-CHOREOGRAPHY
:VALUE
LUISA-RS2-INTERFACE-CHOREOGRAPHY)
(HAS-ORCHESTRATION
:VALUE
LUISA-RS2-INTERFACE-ORCHESTRATION)
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS2-INTERFACE-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS2-WS-PUBLISHER-INFORMATION
(PUBLISHER-INFORMATION)
((HAS-ASSOCIATED-WEB-SERVICE-INTERFACE
:VALUE
LUISA-RS2-INTERFACE)
(HAS-WEB-SERVICE-HOST :VALUE "193.146.58.138")
(HAS-WEB-SERVICE-PORT :VALUE 8080)
(HAS-WEB-SERVICE-LOCATION :VALUE "/axis/RS2.jws")))
```

Listing 10 RS2 LOMR Web service

```
(DEF-CLASS LUISA-RS3-GOAL
  (GOAL)
  ?GOAL
  ((HAS-INPUT-ROLE :VALUE HAS-METHOD :VALUE HAS-COMP :VALUE HAS-FIELD :VALUE
HAS-LANG)
  (HAS-INPUT-SOAP-BINDING
  :VALUE
  (HAS-METHOD "string")
  :VALUE
  (HAS-COMP "string")
  :VALUE
  (HAS-FIELD "string")
  :VALUE
  (HAS-LANG "string"))
  (HAS-OUTPUT-ROLE :VALUE HAS-LEARNING-OBJECT)
  (HAS-OUTPUT-SOAP-BINDING
  :VALUE
  (HAS-LEARNING-OBJECT "string"))
  (HAS-METHOD :TYPE STRING)
  (HAS-COMP :TYPE GET-LO-BY-COMPETENCY-REQUEST)
  (HAS-FIELD :TYPE GET-LO-BY-FIELD-REQUEST)
  (HAS-LANG :TYPE GET-LO-BY-LANG-REQUEST)
  (HAS-LEARNING-OBJECT :TYPE STRING)
  ;;(HAS-LEARNING-OBJECT :TYPE LEARNING-OBJECT-MULTIREF)
  (HAS-NON-FUNCTIONAL-PROPERTIES
  :VALUE
  LUISA-RS3-GOAL-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS3-MED-NON-FUNCTIONAL-PROPERTIES
  (NON-FUNCTIONAL-PROPERTIES)
  NIL)

(DEF-CLASS LUISA-RS3-MED
  (WG-MEDIATOR)
  ?MEDIATOR
  ((HAS-SOURCE-COMPONENT :VALUE LUISA-RS3-GOAL)
  (HAS-NON-FUNCTIONAL-PROPERTIES
  :VALUE
  LUISA-RS3-MED-NON-FUNCTIONAL-PROPERTIES)))
```

```
(DEF-CLASS LUISA-RS3-WS-NON-FUNCTIONAL-PROPERTIES
  (NON-FUNCTIONAL-PROPERTIES)
  NIL)

(DEF-CLASS LUISA-RS3-WS
  (WEB-SERVICE)
  ?WEB-SERVICE
  ((HAS-CAPABILITY :VALUE LUISA-RS3-WS-CAPABILITY)
   (HAS-INTERFACE :VALUE LUISA-RS3-INTERFACE)
   (USED-MEDIATOR :VALUE LUISA-GET-LO-MED)
   (HAS-NON-FUNCTIONAL-PROPERTIES
    :VALUE
    LUISA-RS3-WS-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS3-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES
  (NON-FUNCTIONAL-PROPERTIES)
  NIL)

(DEF-CLASS LUISA-RS3-WS-CAPABILITY
  (CAPABILITY)
  ?CAPABILITY
  ((USED-MEDIATOR :VALUE LUISA-GET-LO-MED)
   (HAS-ASSUMPTION
    :VALUE
    (KAPPA
     (?WEB-SERVICE)
     (AND (AND (AND (NOT (= (WSMO-ROLE-VALUE
       ?WEB-SERVICE
       'HAS-LANG)
       ""))
        (= (WSMO-ROLE-VALUE
       ?WEB-SERVICE
       'HAS-INTERACT)
       ""))
        (NOT (= (WSMO-ROLE-VALUE
       ?WEB-SERVICE
       'HAS-COMP)
       ""))) (NOT (= (WSMO-ROLE-VALUE
       ?WEB-SERVICE
       'HAS-FIELD)
```

```
""))
))
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS3-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS3-INTERFACE-NON-FUNCTIONAL-PROPERTIES
(NON-FUNCTIONAL-PROPERTIES)
NIL)

(DEF-CLASS LUISA-RS3-INTERFACE-CHOREOGRAPHY
(CHOREOGRAPHY)
((HAS-GROUNDING
:VALUE
((GROUNDED-TO-HTTP
(NORMAL
(NIL (METHOD COMP FIELD LANG)))))))

(DEF-CLASS LUISA-RS3-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN
(PROBLEM-SOLVING-PATTERN)
NIL)

(DEF-CLASS LUISA-RS3-INTERFACE-ORCHESTRATION
(ORCHESTRATION)
((HAS-PROBLEM-SOLVING-PATTERN
:VALUE
LUISA-RS3-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN)))

(DEF-CLASS LUISA-RS3-INTERFACE
(INTERFACE)
?INTERFACE
((HAS-CHOREOGRAPHY
:VALUE
LUISA-RS3-INTERFACE-CHOREOGRAPHY)
(HAS-ORCHESTRATION
:VALUE
LUISA-RS3-INTERFACE-ORCHESTRATION)
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS3-INTERFACE-NON-FUNCTIONAL-PROPERTIES)))
```

```
(DEF-CLASS LUISA-RS3-WS-PUBLISHER-INFORMATION
  (PUBLISHER-INFORMATION)
  ((HAS-ASSOCIATED-WEB-SERVICE-INTERFACE
    :VALUE
    LUISA-RS3-INTERFACE)
  (HAS-WEB-SERVICE-HOST :VALUE "193.146.58.138")
  (HAS-WEB-SERVICE-PORT :VALUE 8080)
  (HAS-WEB-SERVICE-LOCATION :VALUE "/axis/RS3.jws"))))
```

Listing 11 RS3 LOMR Web service

```
(DEF-CLASS LUISA-RS4-WS
  (WEB-SERVICE)
  ?WEB-SERVICE
  ((HAS-CAPABILITY :VALUE LUISA-RS4-WS-CAPABILITY)
  (HAS-INTERFACE :VALUE LUISA-RS4-INTERFACE)
  (USED-MEDIATOR :VALUE LUISA-GET-LO-MED)
  (HAS-NON-FUNCTIONAL-PROPERTIES
    :VALUE
    LUISA-RS4-WS-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS4-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES
  (NON-FUNCTIONAL-PROPERTIES)
  NIL)

(DEF-CLASS LUISA-RS4-WS-CAPABILITY
  (CAPABILITY)
  ?CAPABILITY
  ((USED-MEDIATOR :VALUE LUISA-GET-LO-MED)
  (HAS-ASSUMPTION
    :VALUE
    (KAPPA
      (?WEB-SERVICE)
      (AND (AND (AND (= (WSMO-ROLE-VALUE
        ?WEB-SERVICE
        'HAS-LANG)
        ""))
        (NOT (= (WSMO-ROLE-VALUE
          ?WEB-SERVICE
          'HAS-INTERACT)
```

```
""))
(NOT (= (WSMO-ROLE-VALUE
?WEB-SERVICE
'HAS-COMP)
"")) (NOT (= (WSMO-ROLE-VALUE
?WEB-SERVICE
'HAS-FIELD)
"")) ))
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS4-WS-CAPABILITY-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS4-INTERFACE-NON-FUNCTIONAL-PROPERTIES
(NON-FUNCTIONAL-PROPERTIES)
NIL)

(DEF-CLASS LUISA-RS4-INTERFACE-CHOREOGRAPHY
(CHOREOGRAPHY)
((HAS-GROUNDING
:VALUE
((GROUNDED-TO-HTTP
(NORMAL
(NIL (METHOD COMP FIELD INTERAC))))))))

(DEF-CLASS LUISA-RS4-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN
(PROBLEM-SOLVING-PATTERN)
NIL)

(DEF-CLASS LUISA-RS4-INTERFACE-ORCHESTRATION
(ORCHESTRATION)
((HAS-PROBLEM-SOLVING-PATTERN
:VALUE
LUISA-RS4-INTERFACE-ORCHESTRATION-PROBLEM-SOLVING-PATTERN)))

(DEF-CLASS LUISA-RS4-INTERFACE
(INTERFACE)
?INTERFACE
((HAS-CHOREOGRAPHY
:VALUE
LUISA-RS4-INTERFACE-CHOREOGRAPHY)
```

```
(HAS-ORCHESTRATION
:VALUE
LUISA-RS4-INTERFACE-ORCHESTRATION)
(HAS-NON-FUNCTIONAL-PROPERTIES
:VALUE
LUISA-RS4-INTERFACE-NON-FUNCTIONAL-PROPERTIES)))

(DEF-CLASS LUISA-RS4-WS-PUBLISHER-INFORMATION
(PUBLISHER-INFORMATION)
((HAS-ASSOCIATED-WEB-SERVICE-INTERFACE
:VALUE
LUISA-RS4-INTERFACE)
(HAS-WEB-SERVICE-HOST :VALUE "193.146.58.138")
(HAS-WEB-SERVICE-PORT :VALUE 8080)
(HAS-WEB-SERVICE-LOCATION :VALUE "/axis/RS4.jws"))))
```

Listing 12 RS4 LOMR Web service

6.3 Ontologies

The ontologies hereafter have already been provided in D7.2 in a very similar form.

6.3.1 GCO/C2I

```
namespace { _"http://www.cc.uah.es/ie/LUISA#"
}
ontology GCO

concept episode

concept jobSituation subConceptOf episode
timestamp impliesType (1 1) _date
requires inverseOf(wasUsedIn) impliesType (1 *) competency
isInstanceOf impliesType (1 1) jobSituationDefinition

concept competency
level impliesType (1 1) competencyProcessorMeasurementValue
wasUsedIn impliesType (1 *) jobSituation
isInstanceOf impliesType (1 1) competencyDefinition
requires impliesType competencyElement

concept processor
```

isAbleToPerform impliesType (1 *) competency

concept person subConceptOf processor

holds impliesType (0 1) jobPosition

concept competencyDefinition

requires impliesType { competencyDefinition, competencyElementDefinition}

completelyDefined impliesType (1 1) _boolean

details impliesType competencyDefinition

similarTo impliesType competencyDefinition

concept competencyElementDefinition

conforms impliesType (1 *) competencyDefinition

concept knowledgeElementDefinition subConceptOf competencyElementDefinition

prerequisite impliesType knowledgeElementDefinition

concept attitudeDefinition subConceptOf competencyElementDefinition

concept skillDefinition subConceptOf competencyElementDefinition

prerequisite impliesType knowledgeElementDefinition

concept measurement

scaleUsed impliesType (1 *) measurementScale

currentValue impliesType (1 1) value

concept measurementScale

instrumentUsed impliesType measurementInstrument

concept measurementInstrument

concept integerMeasurementScale subConceptOf measurementScale

zeroLevel impliesType (1 1) intValue

topLevel impliesType (1 1) intValue

concept jobPosition

isInstanceOf impliesType (1 1) jobPositionDefinition

concept jobSituationDefinition

requires impliesType (1 *) competencyDefinition

concept jobPositionDefinition

concept jobSituationMeasurementValue subConceptOf measurement
measuresCompetencyDefinition impliesType (1 *) competencyDefinition
requiredFor impliesType (1 *) jobSituationDefinition

concept competencyElementDefinitionMeasurementValue subConceptOf measurement
measuresCompetencyDefinition impliesType (1 *) competencyDefinition
scaledElement impliesType (1 *) competencyElementDefinition

concept competencyElement
isInstanceOf impliesType (1 *) competencyElementDefinition
level impliesType (1 1) measurement

concept knowledgeElement subConceptOf competencyElement
isInstanceOf impliesType knowledgeElementDefinition

concept attitude subConceptOf competencyElement
isInstanceOf impliesType attitudeDefinition

concept skill subConceptOf competencyElement
isInstanceOf impliesType skillDefinition

concept value

concept intValue subConceptOf value
val impliesType (1 1) _integer

concept realValue subConceptOf value
val impliesType (1 1) _decimal

concept stringValue subConceptOf value
val impliesType (1 1) _string

concept competencyProcessorMeasurementValue subConceptOf measurement
measuresCompetency impliesType (1 1) competency
scaledProcessor impliesType (1 1) processor

instance a1 memberOf competencyDefinition

```
completelyDefined hasValue _boolean("true")

instance a2 memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")

instance b1 memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")

instance b2 memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")
  requires hasValue b1

instance b3 memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")
  requires hasValue b1

instance k_basic_textprocessor memberOf knowledgeElementDefinition

instance k_advanced_textprocessor memberOf knowledgeElementDefinition

instance k_basic_spreadsheet memberOf knowledgeElementDefinition

instance k_advanced_spreadsheet memberOf knowledgeElementDefinition

instance b4textprocessor memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")
  requires hasValue {b1, k_basic_textprocessor, k_advanced_textprocessor }

instance b4spreadsheet memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")
  requires hasValue {b1, k_basic_spreadsheet, k_advanced_spreadsheet }

instance b4 memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")
  details hasValue {b4textprocessor, b4spreadsheet }

instance b5 memberOf competencyDefinition
  completelyDefined hasValue _boolean("true")
  requires hasValue b1
```

instance b6 memberOf competencyDefinition

completelyDefined hasValue _boolean("true")

requires hasValue b1

instance b7 memberOf competencyDefinition

completelyDefined hasValue _boolean("true")

requires hasValue {b2, b3, b4, b5, b6 }

instance c2i memberOf competencyDefinition

completelyDefined hasValue _boolean("true")

details hasValue {a1, a2, b7}

instance k_ICT_evolution memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#computerLiteracyItem"

instance k_interoperability memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#software"

instance k_basic_international_laws memberOf knowledgeElementDefinition

about hasValue {_"http://www.uhp-nancy.fr/ontologies/LUISA#p2pTool", _"http://www.uhp-nancy.fr/ontologies/LUISA#publicCommunicationTool" }

instance k_confidentiality memberOf knowledgeElementDefinition

instance k_backup memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#burningApplication"

instance k_critical_mind_on_sources memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#browser"

instance k_politeness memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#communicationTool"

instance k_desktop memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#operatingSystem"

instance k_filetree memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#fileApplication"

instance k_OS_maintenance memberOf knowledgeElementDefinition

about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#operatingSystem"

```
instance k_connect_to_network memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#networkDevice"

instance k_bookmarks memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#browser"
  prerequisites hasValue k_connect_to_network

instance k_distinguish_search_engine memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#searchEngine"

instance k_virus memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#antivirus"

instance k_compress memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#compressTool"

instance k_slides memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#presentationTool"

instance k_online_document memberOf knowledgeElementDefinition
  about hasValue {_"http://www.uhp-nancy.fr/ontologies/LUISA#browser", _"http://www.uhp-nancy.fr/ontologies/LUISA#HtmlEditor?"}

instance k_email memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#emailApplication"

instance k_newsgroup memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#newsgroup"
  prerequisites hasValue k_email

instance k_bulletin_board memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#bulletinBoard"

instance k_chat memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#chatApplication"

instance k_document_versioning memberOf knowledgeElementDefinition
  about hasValue _"http://www.uhp-nancy.fr/ontologies/LUISA#textProcessor"
```

Listing 13 GCO Ontology

6.3.2 Computer Literacy ontology

WSML doesn't allow to point from an instance to a concept; an instance just can point to another instance. So if the instance "WordXP" is "interoperableWith" (relation) the concept "Windows", we use a trick by creating an instance of the concept "Windows" and pointing to it. Thus every concept in this ontology is associated to an ingenious instance with the same name.

```
namespace { _"http://www.uhp-nancy.fr#"
}
ontology computerliteracy
concept ComputerLiteracyItem
concept Hardware subConceptOf ComputerLiteracyItem
concept NetworkDevice subConceptOf Hardware
concept Software subConceptOf ComputerLiteracyItem
  cost impliesType (0 1) _string
  interoperableWith (0 *) impliesType ComputerLiteracyItem
concept OperatingSystem subConceptOf Software
concept Windows subConceptOf OperatingSystem
concept MacOS subConceptOf OperatingSystem
concept Linux subConceptOf OperatingSystem
concept Application subConceptOf Software
concept CompressTool subConceptOf Application
concept Antivirus subConceptOf Application
concept FileApplication subConceptOf Application
concept BurningApplication subConceptOf Application
concept OfficeApplication subConceptOf Application
concept InternetApplication subConceptOf Application
concept PresentationTool subConceptOf OfficeApplication
concept SpreadsheetProcessor subConceptOf OfficeApplication
concept TextProcessor subConceptOf OfficeApplication
concept HtmlEditor subConceptOf InternetApplication
concept SearchEngine subConceptOf InternetApplication
concept P2PTool subConceptOf InternetApplication
concept Browser subConceptOf InternetApplication
concept CommunicationTool subConceptOf InternetApplication
concept PrivateCommunicationTool subConceptOf CommunicationTool
concept PublicCommunicationTool subConceptOf CommunicationTool
concept ChatApplication subConceptOf PrivateCommunicationTool
```

concept EmailApplication subConceptOf PrivateCommunicationTool
concept NewsGroup subConceptOf PublicCommunicationTool
concept Blog subConceptOf PublicCommunicationTool
concept BulletinBoard subConceptOf PublicCommunicationTool
instance Word2003 memberOf TextProcessor
 cost hasValue "notfree"
 interoperableWith hasValue window
instance Excel2003 memberOf SpreadsheetProcessor
 cost hasValue "notfree"
 interoperableWith hasValue window
instance PowerPoint2003 memberOf PresentationTool
 cost hasValue "notfree"
 interoperableWith hasValue window
instance Ubuntu606 memberOf Linux
 cost hasValue "free"
instance MacOSX memberOf MacOS
 cost hasValue "notfree"
instance Windows98 memberOf Windows
 cost hasValue "notfree"
instance WindowsMillenium memberOf Windows
 cost hasValue "notfree"
instance WindowsXP memberOf Windows
 cost hasValue "notfree"
instance WindowsVista memberOf Windows
 cost hasValue "notfree"
instance Firefox2 memberOf Browser
 cost hasValue "free"
instance InternetExplorer7 memberOf Browser
 interoperableWith hasValue window
instance Google memberOf SearchEngine
 cost hasValue "free"
instance YahooSearch memberOf SearchEngine
 cost hasValue "free"
instance MsnSearch memberOf SearchEngine
 cost hasValue "free"
instance OpenWriter2 memberOf TextProcessor
 cost hasValue "free"
 interoperableWith hasValue {window, macOS, linux}
instance OpenImpress2 memberOf PresentationTool
 cost hasValue "free"

```
interoperableWith hasValue {window, macOS, linux}
instance OpenCalc2 memberOf SpreadsheetProcessor
  cost hasValue "free"
  interoperableWith hasValue {window, macOS, linux}

/* ingenious intances*/
instance software memberOf software
instance hardware memberOf hardware
instance networkDevice memberOf networkDevice
instance application memberOf application
instance antivirus memberOf antivirus
instance burningApplication memberOf burningApplication
instance compressTool memberOf compressTool
instance fileApplication memberOf fileApplication
instance internetApplication memberOf internetApplication
instance officeApplication memberOf officeApplication
instance browser memberOf browser
instance communicationTool memberOf communicationTool
instance htmlEditor memberOf htmlEditor
instance p2pTool memberOf p2pTool
instance searchEngine memberOf searchEngine
instance privateCommunicationTool memberOf privateCommunicationTool
instance chatApplication memberOf chatApplication
instance emailApplication memberOf emailApplication
instance publicCommunicationTool memberOf publicCommunicationTool
instance blog memberOf blog
instance bulletinBoard memberOf bulletinBoard
instance newsgroup memberOf newsgroup
instance presentationTool memberOf presentationTool
instance operatingSystem memberOf operatingSystem
instance linux memberOf linux
instance macOS memberOf macOS
instance windows memberOf windows
```

Listing 14 Computer Literacy Ontology

6.3.3 Discipline ontology

```
namespace { _"http://uhp-nancy.fr/"
}
ontology uhpFieldsOfStudy
concept uhpFieldOfStudy subConceptOf _"http://www.cycfoundation.org/concepts/fieldOfStudy"
```

```

linkedTo transitive impliesType fieldOfStudy
concept scientificFieldOfStudy subConceptOf uhpFieldOfStudy
concept health subConceptOf scientificFieldOfStudy
concept mathematicsComputerScience subConceptOf scientificFieldOfStudy
concept lifeSciences subConceptOf scientificFieldOfStudy
concept physicsAndChemistrySciences subConceptOf scientificFieldOfStudy
concept nonScientificFieldOfStudy subConceptOf uhpFieldOfStudy
concept foreignLanguages subConceptOf nonScientificFieldOfStudy
concept enterpriseManagement subConceptOf nonScientificFieldOfStudy
instance sportSciences memberOf scientificFieldOfStudy
instance physics memberOf physicsAndChemistrySciences
    linkedTo hasValue mathematics
instance biophysics memberOf physicsAndChemistrySciences
instance chemicalEngineering memberOf physicsAndChemistrySciences
instance chemistry memberOf physicsAndChemistrySciences
instance geology memberOf physicsAndChemistrySciences
instance medicine memberOf health
    linkedTo hasValue biology
instance pharmacology memberOf health
    linkedTo hasValue biology
instance dentistry memberOf health
instance ergonomics memberOf health
instance biology memberOf lifeSciences
instance biogeography memberOf lifeSciences
instance mathematics memberOf mathematicsComputerScience
instance computerScience memberOf mathematicsComputerScience
instance frenchAsSecondLanguage memberOf foreignLanguages
instance english memberOf foreignLanguages
instance spanish memberOf foreignLanguages
instance accountancy memberOf enterpriseManagement
instance law memberOf enterpriseManagement
instance marketing memberOf enterpriseManagement
instance humanResources memberOf enterpriseManagement

```

Listing 15 Discipline Ontology

6.3.4 LOM/WSML ontology

```

wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://www.cc.uah.es/ie/ontologies/LUISA#"
,
    wsmstudio _"http://www.wsmstudio.org#" }

```

```
ontology _"http://www.cc.uah.es/ie/ontologies/LUISA/LOM2WSML"
  nonFunctionalProperties
    wsmstudio#version hasValue "0.5.5"
  endNonFunctionalProperties

concept LearningObject
  identifier impliesType (0 1) LOMIdentifier
  title impliesType (0 1) LangString
  language impliesType HumanLanguage
  description impliesType LangString
  keyword impliesType LangString
  coverage impliesType LangString
  _"http://www.cc.uah.es/ie/ontologies/LUISA#coverage-SpatialLocation" impliesType
  oc_GeographicalRegion
  _"http://www.cc.uah.es/ie/ontologies/LUISA#coverage-TemporalPeriod" impliesType oc_TimeInterval
  _"http://www.cc.uah.es/ie/ontologies/LUISA#coverage-Jurisdiction" impliesType oc_AdministrativeUnit
  structure impliesType (1 1) VocabularyItem
  aggregationLevel impliesType (1 1) VocabularyItem
  version impliesType (1 1) LangString
  status impliesType (1 1) VocabularyItem
  _"http://www.cc.uah.es/ie/ontologies/LUISA#contribute-entity" impliesType (1 *) vCard
  _"http://www.cc.uah.es/ie/ontologies/LUISA#contribute-date" impliesType (1 1) DateTime
  _"http://www.cc.uah.es/ie/ontologies/LUISA#contribute-role" impliesType (1 1) VocabularyItem
  _"http://www.cc.uah.es/ie/ontologies/LUISA#metadataRecord-identifier" impliesType (0 1)
  LOMIdentifier
  _"http://www.cc.uah.es/ie/ontologies/LUISA#metadataContribution-role" impliesType (1 1)
  VocabularyItem
  _"http://www.cc.uah.es/ie/ontologies/LUISA#metadataContribution-entity" impliesType (1 *) vCard
  _"http://www.cc.uah.es/ie/ontologies/LUISA#metadataContribution-date" impliesType (1 1) DateTime
  metadataSchema impliesType MetadataSchema
  metadataLanguage impliesType HumanLanguage
  format impliesType LangString
  _"http://www.cc.uah.es/ie/ontologies/LUISA#format-MIME" impliesType MIMEType
  size impliesType (1 1) _integer
  location impliesType _iri
  requirement impliesType TechnicalRequirement
  installationRemarks impliesType (0 1) LangString
  otherPlatformRequirement impliesType LangString
  interactivityType impliesType (0 1) VocabularyItem
  learningResourceType impliesType VocabularyItem
  interactivityLevel impliesType (0 1) VocabularyItem
```

semanticDensity impliesType (0 1) VocabularyItem
intendedEndUserRole impliesType VocabularyItem
semanticContext impliesType oc_Microtheory
context impliesType VocabularyItem
typicalAgeRange impliesType LangString
_"http://www.cc.uah.es/ie/ontologies/LUISA#tipycalAgeRange-min" impliesType (0 1) _integer
_"http://www.cc.uah.es/ie/ontologies/LUISA#tipycalAgeRange-max" impliesType (0 1) _integer
difficulty impliesType (0 1) VocabularyItem
typicalLearningTime impliesType (0 1) Duration
duration impliesType (0 1) Duration
educationalDescription impliesType LangString
userLanguage impliesType HumanLanguage
cost impliesType (0 1) VocabularyItem
copyrightAndOtherRestrictions impliesType (0 1) VocabularyItem
rightsDescription impliesType (0 1) LangString
_"http://www.cc.uah.es/ie/ontologies/LUISA#relation" impliesType Relation
annotation impliesType Annotation
classification impliesType Classification

concept LOMIdentifier

catalog impliesType (0 1) _string
entry impliesType (0 1) _string

concept LangString

hasSingleLangString impliesType _"http://www.cc.uah.es/ie/ontologies/LUISA#LangString-Single"

concept _"http://www.cc.uah.es/ie/ontologies/LUISA#LangString-Single"

hasHumanLanguage impliesType (1 *) HumanLanguage
hasCharacterString impliesType (1 *) _string

concept HumanLanguage

nonFunctionalProperties

_"http://purl.org/dc/elements/1.1#description" hasValue "Represents the different LanguageIDs prescribed by ISO 639:1988 and ISO 3166-1:1997 (see the IEEE LOM standard description for element 1.3. for more details"

endNonFunctionalProperties

concept oc_GeographicalRegion

nonFunctionalProperties

_"http://purl.org/dc/elements/1.1#description" hasValue "Geographical region as defined in OpenCyc (<http://www.opencyc.org>)"

endNonFunctionalProperties

concept Duration

description impliesType (0 1) LangString

value impliesType (0 1) _duration

concept DateTime

description impliesType (0 1) LangString

value impliesType (0 1) _dateTime

concept VocabularyItem

_ "http://www.cc.uah.es/ie/ontologies/LUISA#source" impliesType (0 1) _string

value impliesType (0 1) _string

concept oc_TimeInterval

nonFunctionalProperties

_ "http://purl.org/dc/elements/1.1#description" hasValue "TimeInterval as defined in OpenCyc (http://www.opencyc.org)"

endNonFunctionalProperties

concept oc_AdministrativeUnit

nonFunctionalProperties

_ "http://purl.org/dc/elements/1.1#description" hasValue "AdministrativeUnit as defined in OpenCyc (http://www.opencyc.org)"

endNonFunctionalProperties

concept vCard

nonFunctionalProperties

_ "http://purl.org/dc/elements/1.1#description" hasValue "vCard as defined by IMC vCard 3.0 (RFC 2425, RFC 2426)."

endNonFunctionalProperties

concept MetadataSchema

version impliesType (1 1) _string

schema impliesType (1 1) _string

concept MIMETYPE

nonFunctionalProperties

_ "http://purl.org/dc/elements/1.1#description" hasValue "MIME type based on IANA registration RFC2048:1996"

endNonFunctionalProperties

concept TechnicalRequirement

```
minVersion impliesType (1 1) _string
maxVersion impliesType (1 1) _string
name impliesType (1 1) VocabularyItem
type impliesType (1 1) VocabularyItem

concept oc_Microtheory

concept Relation
  kind impliesType (0 1) VocabularyItem
  resource impliesType (1 1) LearningObject

concept Annotation
  entity impliesType (1 1) vCard
  date impliesType (1 1) DateTime
  description impliesType (1 1) LangString

concept Classification
  purpose impliesType (1 1) VocabularyItem
  description impliesType (1 1) LangString
  keyword impliesType LangString
  taxonPath impliesType oc_Thing
  taxonomy impliesType (1 1) LangString
  taxonTerm impliesType TaxonId

concept oc_Thing
  nonFunctionalProperties
    _"http://purl.org/dc/elements/1.1#description" hasValue "oc_Thing as defined in OpenCyc
(http://www.opencyc.org)"
  endNonFunctionalProperties

concept TaxonId
  entry impliesType (1 1) LangString
  id impliesType (1 1) _string
```

Listing 16 LOM2WSML Ontology

6.4 Database schemas

This appendix shows the database schema created to store the user and university preferences according to the UHP needs for the current prototype. The schema is shown in Figure 11.

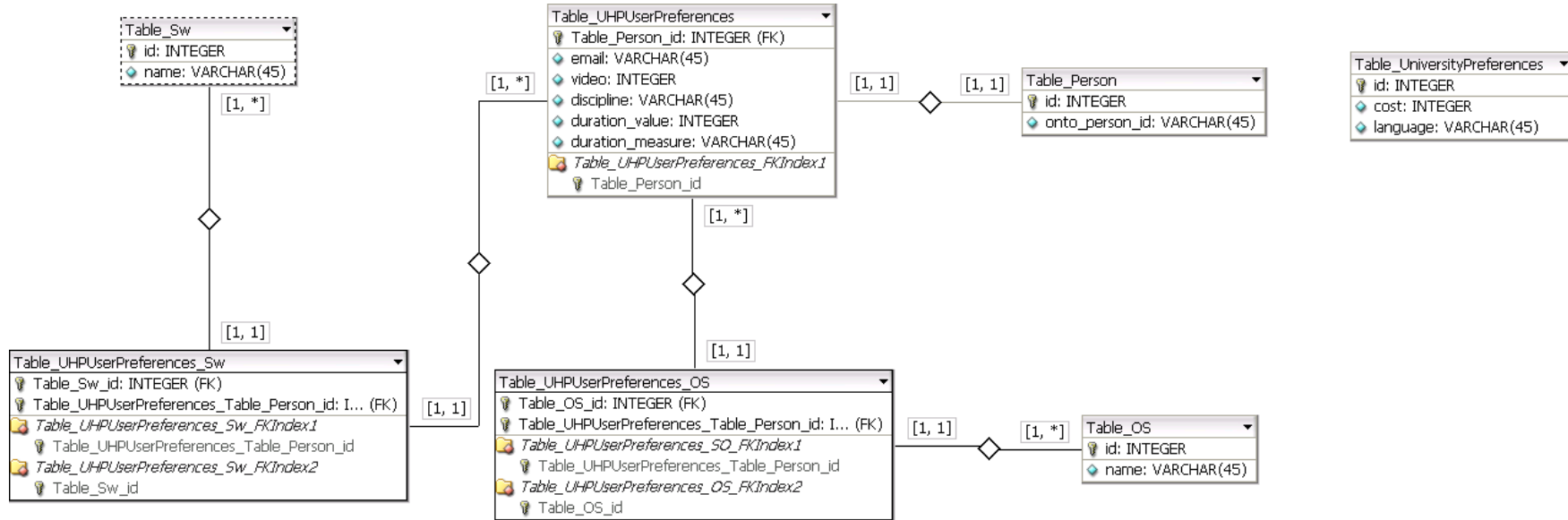


Figure 11: UHP Profile database (user and university preferences)