LUISA

Learning Content Management System Using Innovative Semantic Web Services Architecture

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Industrial use case: Design and modelling of the specific (domain related) metadata and models

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EXECUTIVE SUMMARY

The LUISA project is exploiting the advantages of a Semantic Web Service Architecture to make richer and more flexible the processes of query and specification of learning needs in the context of Learning Management Systems and Learning Object Repositories.

The industry needs are exemplified by a use case proposed by EADS-FRANCE-IW.

A first version of the EADS industry scenario description has been provided in D6.1.2. It illustrates a way to reuse some existing heterogeneous and distributed data of an industry Human Resources department, that include not only *learning objects metadata repositories* (LOMR) but also *competency profiles* for working situations (job positions) and individuals. The intention is to connect and use this information so to enable the selection of appropriate *learning objects* with regard to some individuals *learning needs* that are defined considering the required competencies for performing a job.

This document describes in a first part the input data to be reused; then in a second part, the metadata and ontologies used for indexing and retrieving Learning Objects (LO) in the industry use case; and finally it describes how the ontologies are intended to be used or extended.

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Abstract (for dissemination)	The Industrial Use Case ontology (T6.2) is provided by EADS-FRANCE-IW illustrates a way to reuse some existing heterogeneous and distributed data of an industry Human Resources department, that include not only learning objects metadata repositories (LOMR) but also competency profiles for working situations (job positions) and individuals.. This document describes the metadata used for indexing the LOs and the ontologies used for selecting and combining LOs. It is the second and final version of D6.2. It provides updated versions of the metadata and the ontologies, and deeper explanations about how they are intended to be used.			
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1 INTRODUCTION

In essence, the LUISA technology aims at providing an advance brokering service to the users on internet in order to retrieve learning objects (LO) from distributed repositories, and to select and combine them according to specific goals or learning needs.

The basis for a LUISA implementation is semantic selection and combination of LO. In turn, the basis for semantic selection and combination of LO is a formal ontology for the associated inference engine.

This document describes the metadata used for indexing the LOs and the ontologies used for selecting and combining LOs. It is the second and final version of D6.2. It provides updated versions of the metadata and the ontologies, and deeper explanations about how they are intended to be used.

In a first part, we present the input data as initially provided by the Human Resource department. These data are essentially:

- a “training database” that is used for training management inside the enterprise,
- a “human resource database” that includes a competency referential relevant for describing the needed abilities (competencies & skills) in our context, and the measured “profiles” for specific job positions.

In a second part we detail the metadata and ontologies specified for the LUISA experimentation of our case:

- s-lom is a semantic version of IEEE-LOM
- GCS is a domain ontology to describe and measure competencies that can be used for various cases in LUISA
- Eads competencies is a small ontology that extends GCS to represent concepts and relations very specific to Competencies our case
- Eads training is a small ontology that extends s-lom to represent concepts and relations very specific to LO in our case
- Eads domain&discipline is a small local ontology that we use to represent a field of study classification in our context

Finally we describe how the ontologies are intended to be used in the LUISA prototypes.

2 THE REUSE OF LEGACY DATA

The EADS use case shall illustrate the advantages of a Semantic Web Service Architecture for retrieving and selecting LOs in the industry context. This is why we decided to propose a use case based on an analysis of the existing situation and processes in our context, and that reuse the related existing data.

We give below a very brief reminder of this use case. The reader shall read D6.1.2 for a detailed presentation.

2.1 Use case short reminder

In order to support continuous education of the employees, a training management process has been implemented within the enterprise. This process focuses on the management of the employees' training needs and history. It is supported by a training management tool. Each training request is captured and traced, if validated, until the corresponding training session has been hold. For each training course, a short description is captured, referenced and maintained. These memorized data are intended to be reused when dealing with a new training request.

In parallel, another process focuses on the management of competencies within the enterprise. Managers are in charge of defining the competencies they need to perform activities in their areas. An annual interview is organised between each employee and his or her manager, to define and negotiate an individual competence development plan in accordance with the employee job position. This interview is the place where new training requests can be formulated and send to the Human Resource department.

It is identified as a need that the retrieval and selection of "training course description" through the training database shall be linked to the skill and competence development target. Yet, training offer/selection processes are not integrated with other existing company systems such as competence management, HRMS (Human Resource Management Systems), or CMS (Content Management Systems) systems.

In this context, we decide to build the missing ontologies that could allow reusing and integrating these data: allowing the LUISA system to compute the user's Learning needs in term of competence gaps (between his or her profile and a target job position profile) and to retrieve appropriate learning resources within the current training course descriptions. The target population for the use case has been reduced to the engineers participating in an aircraft program, and the supporting IT teams dealing with the enterprise information and communication technologies.

2.2 Input for the industry use case LO: training courses descriptions

2.2.1 Functional granularity and Aggregation level

Following user needs and initial scenarios described in D6.1.2, we decided to reuse learning resources already existing in our context, that consist in

descriptions of “training courses” available in a training management database belonging to a Human Resource department.

This implies that we are targeting a specific *functional granularity* of LO: a course. Each individual LO of this granularity level may be the basis for a course.

From the *aggregation level* point of view (LO structure and composition), this *functional granularity* corresponds to the IEEE LOM Vocabulary fourth and “largest” aggregation level number 4. Below is a reminder of these four aggregation levels according to IEEE LOM [3]:

- Level 1 is defined as smallest level of aggregation, e.g. raw media data or fragments.
- Level 2 is defined as a collection of atoms, e.g. an HTML document with some embedded pictures or a lesson.
- Level 3 is defined as a collection of level 2 resources, e.g. a course; a 'Web' of HTML documents, with an index page that links the pages together or a unit.
- Level 4 is defined as the largest level of granularity, e.g. a set of courses that lead to a certificate. Level 4 objects can contain level 3 objects, or can recursively contain other level 4 objects.

Referring to The Aviation Industry CBT Committee (AICC) Metadata system [2], adapted from LOM to aviation industry training, this *functional granularity* level also corresponds to the fourth one called *Structure Training Package*.

Therefore the following definition of LO is used in the context of this document:

- the LO we want to select and combine are *Structure Training Packages* (STP) that may be used as a basis for one individual training course,
- the logic combination for LO is that of building a curricula or a learning program.

To any of these LO may be attached one or several digital resources such as power-point presentations, MSWord or .pdf or Excel documents, movies, picture or even executable programs, etc. having their own audience and functional role in a course. As underlined in D6.1.2 as a rationale for the initial scenario – LO competence driven selection & combination – these digital resources are currently managed independently from the training database, involving other actors and responsibilities (either internal or external), and there does not exist today any CMS integrated with the training management tool.

2.2.2 Input training data collecting procedure

This paragraph describes the procedure followed in order to collect a workable sample number of Training Courses descriptions (few hundred) for the purpose of using them for implementing the use case.

The procedure is given so the nature of the input data is made clear and the reader may judge its usability for the purpose of the use case.

Remark: in this section, terms in capitals refers to the database "objects" original labels: a *FORMATION* corresponds to a LO description, and a *SESSION* refers to an actually performed (classroom) lesson or course. Other "objects" labeled *PROJET*, *AXE DE FORMATION*, and *GROUPE DE FORMATION* roughly correspond to an internal field of study classification.

The data is extracted from the complete training management database where 5834 individual entries are currently stored. It has been agreed with the Human Resource Department to extract from the training history database a sample number of *FORMATIONS* and *SESSIONS* for a given population. This population has been defined as comprising users (*PERSONNE*) belonging to the two domains E (Engineering) and OI (Information System). The extraction concerns the time interval: 2004-01-01 to 2006-08-01.

The extraction process was performed by Airbus. The first stage of the procedure is to search for objects *PERSONNE* having attributes showing they belong to one of the two selected domains E and OI, and then search for the set of objects *SESSIONS* (links E-P) these *PERSONNE* are related to.

Since any *SESSION* shall be related to a *FORMATION* (relation E-D) it is then possible to extract the objects *FORMATION*. The list of *FORMATION* extracted using people training history is then used to retrieve the descriptive information attached to the *FORMATION* in the Training database.

This procedure has three advantages:

- it allows for defining a clear scope for the use case,
- it intends to ensure that a possible mapping will be possible with other data extracted from the competency management database and available for the same populations E and OI,
- the resulting sample LO reflects real needs from a user point of view :the procedure allows extracting any kind of training (technical, language, individual development, management, etc) that were actually followed by a population on a two and half year's period of time.

2.2.3 Input training data attributes and relationships

The classes diagram in (Figure 1) shows the input data structure. In this diagram, attributes' labels are intentionally left in French since the diagram represents the original data. But a dictionary is provided in the tables below and is used along with the LOM aligned metadata template build from this structure in Section 3.

Not all information in the original data will be used for building the use case metadata template: we select those metadata that we believe are (potentially) useful for the purpose of the use case. For example we won't use the *Starting date* or *End date* attributes that would have corresponded to a LOM *Life cycle - Date* metadata. But *cost* or *maximum capacity* (number of trainees) authorized for a course may become *selection* criteria in the long term. Conversely some

information such as *General - language* or G*eneral - Catalogue* will complete the final template while not provided in this initial data.

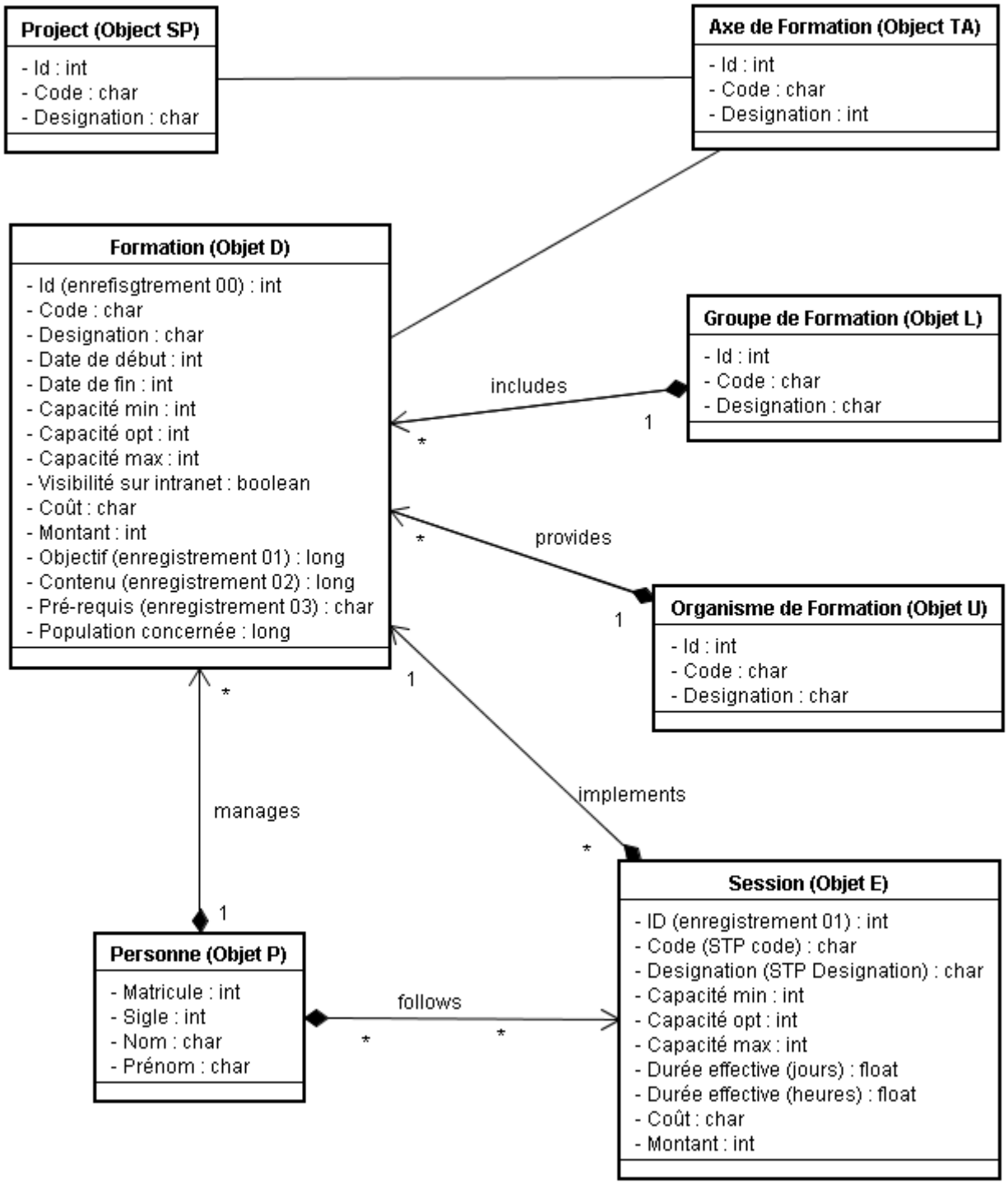

Figure 1 - Training data structure

The table below provides translations for attributes and “objects” names, and explanations about their meaning or some examples (extension). The intention is to identify which of these can be aligned with the data defined by LOM, to which we want to comply.

The Table 1 summarizes the input training data attributes.

Table 1 - input training data attributes

FORMATION (equivalent to LEARNING OBJECT)		
English	French	Explanations
Id	Identifiant Formation	numerical identifier for the LO
Code	Code Formation	composite sequence of characters used by training managers to refer to the LO
Designation	Désignation Formation	short label, usually in French language and abbreviated form
Validity starting date	Date début	LO edition management information
Validity end date	Date fin	
Min course capacity	Capacité min	number of trainees considered as a minimal for profitability or relevance of the course using the LO
Opt course capacity	Capacité opt	number of trainees considered as a optimal for profitability or relevance of the course using the LO
Max course capacity	Capacité max	number of trainees considered as a maximal for profitability or relevance of the course using the LO
Visibility (publishing)	Visibilité	Boolean value indicating if the LO is or not published on a intranet core catalogue
Cost category	Coût	Cost category that informs about financing modality
Cost amount	Montant	Cost per individual trainee
Objective	Objectif	Textual description of the educational objective of the learning object
Content	Contenu	textual description of the learning object content
Pre-requisite	Pré-requis	textual description of the learning object pre-requisite; this may be cross-references to other learning object, or mention of any requisite competence, skill or knowledge
Target audience	Population concernée	textual description of the target population within the enterprise; this may be mention of a profession or some activity

Three other “objects” named *AXE DE FORMATION*, *PROJET* and *GROUPE DE FORMATION* are related to *FORMATIONS*. These are used as categories for managing the training data and organising the training managers’ work. They can be roughly assimilated to an internal and quite specific classification of the field of study or the discipline to which the training course is related (although this correspondence is a bit approximate for what concerns the AXIS possible values, as shown below).

Each category has the same set of attributes attached: a numerical identifier, a code and a designation. Sample examples of designations (in French) are given Table 2 for extensional definition.

Table 2 – Classification criteria related to Fields of study

AXIS [complete set of values]

Comptabilité Gestion Finance Achat Commerce
Culture générale
Informatique
Juridique Administratif
Langues
Management et Dévelopement personnel
Qualité méthodologique et gestion de projet
Technique

PROJECT [sample set of values]

achats logistique
aéronautique
allemand
anglais
bureautique
commercial
comptabilité analytique
comptabilité générale
concurrent engineering
culture d'entreprise
documentation
économie générale de l'entreprise
électricité électronique
fabrication
génie civil
gestion analyse financière
gestion contrôle de gestion
industrialisation
informatique métier

GROUP [sample set of values]

accoustique vibration
achat
achats contrats

administration
aérodynamique
architecture
assemblage
autovérification
base de données
bâtiment
calcul de structure
CAO/GDT
circulation et navigation aérienne
composites
contrôles non destructifs
cursus acheteurs
dessin
dessin industriel

In the database, a *PERSONNE* and a *FORMATION* have no direct link. A *FORMATION* is related to as many *SESSIONS* that have been organized for the given formation. The management of employees' training history allows the linking of a *PERSONNE* and all the SESSIONS this PERSONNE actually registered or took.

Another link between the learning object (*FORMATION*) and a person (*PERSONNE*) is used to express a specific user role for training data management. In LOM this information shall be expressed using a *Life cycle – Role* and *Life cycle – Entity* annotations.

Finally, some duration information is attached to the *SESSION* "object", in

Table 3. (*SESSION* code and designation are inherited from the object *FORMATION*).

Table 3 - 'SESSION' reusable attributes

English label	French label	Explanations
Course Id	Identifiant Session	numerical identifier for the course
Code	Code	Inherited : composite sequence of characters used by training managers to refer to the LO
Designation	Désignation	Inherited : short label, usually in French language and abbreviated form
Duration in days	Durée effective (jours)	*Self explaining*
Duration in hours	Durée effective (heures)	*Self explaining*

2.2.4 One example

One example of (French) annotated input Training course description is given below.

ID	80126391
Code	T1AA053
Designation	**INGENIERIE DES SYSTEMES**
ID group	80001612
group Code	T1AA
group Designation	Circulation et navigation aérienne
Cap min	7
Cap opt	8
Cap max	10
Day duration	2
Hour duration	16.00
Training Organism ID	80011829
Training Organism Code	115239
Training Org. Designation	AMIS ENSAE-ENSTA (STE.DES...)
Intranet visibility	1
Learning outcomes	. Connaître l'apport spécifique de l'Ingénierie des Systèmes (I.S) en tant que démarche de conception globale d'un système, par rapport aux autres méthodes couramment utilisées en démarche projet . Appréhender les méthodes et les processus sur lesquels elle repose et l'organisation souhaitable pour sa mise en place.
Content	L'ingénierie des systèmes et le management de projet • Rappel de quelques définitions et analyse de situation • Les principaux acteurs d'un projet et leurs différentes responsabilités • La conduite de projet - principes et méthodes • Le processus traditionnel de conception • L'Ingénierie des Systèmes en tant que méthode de conception, son apport pour une prise en compte globale des objectifs et des contraintes. • Les normes standards (EIA 632, IEEE 1220, ECSS E10 ...) Les méthodes couramment utilisées • L'analyse fonctionnelle • La Conception à l'Ecoute du Marché (CEM) • La Conception pour un Coût Objectif (CCO) • La Sûreté de Fonctionnement (SdF) • Le Soutien Logistique Intégré (Sli)... L'ingénierie des systèmes : Méthodes et Processus • L'identification du besoin, la capture et la validation des fonctions et des exigences, les différents points de vue • Le Cahier des Charges Fonctionnel (CdCF) et la Spécification Technique de Besoin (STB)

	• La transformation du problème en solution • Les représentations et la structuration des solutions (allocations, solutions fonctionnelles, physiques) • La validation et les vérifications : la matrice de contrôle et de vérification • La réalisation et le transfert vers l'utilisation • La bonne gestion de l'information et la traçabilité • Le contrôle et le suivi des travaux L'intégration de l'Ingénierie des Systèmes dans la démarche projet • Les plans de déroulement des travaux et les plans d'ingénierie • Les différentes arborescences, établissement, gestion • La gestion de la configuration La mise en place d'une organisation performante • Fixant les responsabilités • Définissant les modalités de travail • Facilitant les échanges d'information • Utilisant les possibilités de l'informatique.
prerequisite	Niveau : Base
Target audience	EXCLUSIVEMENT RESERVE EYYSI Le stage permet de comprendre les apports d'une démarche d'ingénierie des systèmes et d'appréhender les principes à observer pour la mettre en place. Il constitue un préalable très utile pour les candidats qui désirent se perfectionner en I.S. et en démarche systémique.

2.3 Input for the industry use case Learning Needs specification: competence referential

2.3.1 Conceptual model for competencies

This section gives a *conceptualization*[1] of competency related concepts in our context.

We follow a bottom-up approach: the conceptual model is created on the basis of the existing Human Resources database schema and documented thanks to the related Human Resources materials. This modelling phase is needed prior encoding. Modelling stages includes in the following order:

1. Collect *informal definitions* from documentation or interviews.
2. Distinguish between *definitions* and *comments*

[1] The modelling primitive are as follow:

- Conceptualisation: a system of properties.
- Property: the meaning (*significance)* or *intension* of an expression such as « be a position », « exhibit a competency ».
- Concept = a unitary property. Two concepts always having the same extension are identical
- Relation = an n-ary property ($n \geq 2$).

3. Explicit properties (note: as we choose WSML encoding, it is no use to further formalize essential properties or conditions categories such as necessary and/or sufficient).
4. Structure *comments*

2.3.2 Rational

In this use case we want to investigate how the LO selection and combination could be found on *competency requirements* in our context. The assumption is that the *learning needs* in an organizational context are related to those *competency requirements*.

Learning needs specification surely closely depends of the LO functional granularity. For example specifying *learning needs* related to *atomic* LO such as an image or a math demonstration can not mean the same than specifying *learning needs* for a complete course.

1. In the first case, the specification would depend on a theory of learning so *learning needs* (e.g. understand, memorize…) can be related to some pedagogical functional role *(illustrate, prove…)* this particular atomic LO may have as a component in a higher level LO.
2. But for what concern the kind of LO targeted here – a LO being a resource (package) needed to support a autonomous course (lesson) in a specific organisational context – we can consider expressing *learning needs* in term of *competencies*. Such approach is the one underlying some typical scenarios in the IMS specification (see [4]):
   - "A tutor or learner uses learning outcomes to search for appropriate resources in a repository, in order to build up a learning program.
   - In figuring out what course a learner wishes to enrol in, a learner and his/her adviser primarily think about learning outcomes the learner wishes to achieve, and they match these to the learning outcomes of the modules / courses/ learning programs being offered. (Possibly using learning needs assessments which help identify the learning outcomes / **competencies** which the learner possesses and lacks.) "

2.3.3 Warning

In the conceptual model below some concepts – *Activity* and *Task* – arise in many natural language definitions. (Note that in the approach of IMS specification [4] the term *competency* is used in a very general sense that includes skills, knowledge, tasks, and learning outcomes).

We choose not to integrate *Activity* and *Task* into the current ontology because doing so would have made more complex a lot the operations that shall make use of this ontology: resolving queries, specifying the selection and combination logics, as well as interactions with users. It would also imply the definition of non existing annotations (*Activities* and *Tasks* should be described in some referential) and the specification of a new annotation activity (compared with current processes in the

context). This is not in the scope of the LUISA project. On the other hand, evaluating the developed technology for this more complex and larger scale ACTIVITY ontology is a really attractive project.

2.3.4 Concept: **ABILITY FOR PROFESSION**

Natural language definitions

Ability for profession is a global qualification defined as a set or a composition of *Competencies* that an individual shall have to be able to perform the activities related to a profession in the organisation.

It is a stereotype definition of a needed set of competencies for a profession. These stereotype *profiles* are use by Human Resources Resource to characterize positions (several positions may refer to one profession) and could be used to annotate LO. That is why it is said: "Specific set of qualifications required at a *position*" (Optimize Skills).

Properties

ABILITY FOR PROFESSION is required by a PROFESSION

ABILITY FOR PROFESSION is exhibited by a PERSON

ABILITY FOR PROFESSION is measured by a PROFICIENCY LEVEL

Comments

In French "requis de compétences".

Qualifications are associated to *professions*: to perform the activities related to a profession requires some competencies, skills and knowledge and a specific expertise level. This as a whole is referred to by the concept *ability for competence*.

Same competencies, skills or knowledge may be required by several professions with variable expertise level.

The profiles are inherited by related *positions*, and then personalized.

The same comment applies to ability for competence related to *position*.

2.3.5 Concept: **COMPETENCY**

Natural language definitions

"A *competency* is the demonstrated ability of a *person* to apply *knowledge* and *skills*" (AP2080 [1])

A *competency* is the quality of being adequately well-qualified physically and intellectually and able to perform some activity.

In our context, the *competencies* exhibited in a *person* profile are considered valid (true) for a two year period starting from the date they have been validated. Validation arises normally yearly, during a mandatory *annual interview*.

Properties

COMPETENCY is exhibited by a PERSON

COMPETENCY is a component of ABILITY FOR PROFESSION

COMPETENCY is measured by a PROFICIENCY LEVEL

COMPETENCY is required at a POSITION

COMPETENCY requires 1 or n SKILLS and KNOWLEDGE

COMPETENCY has validity (Boolean). *This validity has duration (2 years, from the date it has been validated)*

Comments

Although this is not mandatory for using the available competencies data, *Competencies* may be related by different kind of relationships, especially a 'pre-requisite' relationship meaning that a competency may require another one, (or a skill).

From definitions collected it is not decidable if the concept "competency" shall be or not limited to skill and exclude knowledge. The both definitions are used [4]: "The word "competency" is used to include all classes of things that someone, or potentially something, can be competent in, although some communities of practice use the word with nuance, for example limiting its use to skill and excluding knowledge or understanding."

2.3.6 Concept**: FIELD**

Natural language definitions

A *Field* "groups the *Professions* and/or activities which are relevant to a *Function*" (AP2080)

Field is a classification category for *Professions*. It is useful as a mean for structuring a referential of stereotype *profession* profiles.

Properties

FIELD groups a set of PROFESSIONS

FIELD is part of a FUNCTION

Comments

In French and in our context: « domaine ; métier ».

2.3.7 Concept**: FUNCTION**

Natural language definitions

Function is a classification category for *Fields* and *Professions*. It is useful as a mean for structuring a referential of stereotype *profession* profiles.

A *Function* groups a set of *Fields* (Optimize skill)

Properties

FUNCTION groups a set of FIELDS

Comments

In French in our context: fonction, filière métier.

2.3.8 Concept: **KNOWLEDGE**

Natural language definitions

Knowledge refers to “What we have learnt (education, training, experience) and the information we possess” (Optimize Skills)

(Holsapple & Joshi, 2004) define *knowledge* as “what is conveyed by usable representations” referring to some discrete mental structures that can be represented in information artefacts.

Knowledge may be required by *skills*: knowledge about language for development for example. But while exhibiting the skill implies having the knowledge, the inverse is not true and having the knowledge does not imply having the skill.

Properties

KNOWLEDGE is exhibited by a PERSON

KNOWLEDGE is a component of 1 or n COMPETENCIES

KNOWLEDGE may be required by 0 or n SKILLS

Comments

Real data: in practice defining knowledge elements is time consuming and requires domain expertise and procedure. In our context, it has been demanded to nominated contacts in each *Function* to define the *competence*, *skills* and *knowledge* of its area. This has been performed to some extend only. For example, the Engineering Function did not define its skills yet; some skills instances appear among competencies.

In French: savoir ; élément de connaissance

2.3.9 Concept: **PERSON**

Natural language definitions

Human being

Properties

PERSON holds a POSITION

PERSONS have PROFESSION

PERSON exhibits COMPETENCIES, SKILLS, and KNOWLEDGE

Comments

Many other possible attributes may be considered as profile elements: preferred language, working location, department acronym…

2.3.10 Concept: **POSITION**

Natural language definitions

A *position* refers to a specific job position in an organisational context. This job position is usually – but not necessarily – held by an individual *Person*. A *position* can be vacant.

A *position* requires *competencies*. It inherits a *competency* profile from a stereotype *Ability for profession* it is related to; but this profile can be personalized by addition of other *competencies* or by 'neutralization' of some *competencies* by using the zero Proficiency level.

Properties

POSITION is hold by one PERSON

POSITION inherits one ABILITY FOR PROFESSION

POSITION requires 0 or n COMPETENCIES

Comments

Real data: in France *positions* have unstable labels: there is no explicit procedure to attribute a label to a *position*, and no standardization of labels has been performed. *Positions* labels are equivalent to *professions* ones. In Germany *positions* have identifier but no label.

2.3.11 Concept: **PROFESSSION**

Natural language definition

A *profession* is a 'reference' description for some activities. They are described by a competence profile called *Ability for profession*.

Professions are organised in a hierarchical classification using FIELD and FUNCTION concepts.

Properties

PROFESSION belongs to a FIELD

PROFESSION is associated to 0 or n POSITION

PROFESSION is similar to ABILITY FOR PROFESSION

Comments

No comments

2.3.12 Concept: **PROFICIENCY LEVEL**

Natural language definition

The *proficiency level* measures the degree of expertise in demonstrating *competencies*.

The *proficiency level* is a measurement scale needed to express expertise levels for *Competencies* exhibited by individuals, or required at specified positions.

« Set of 5 categories used to assess the level of competence, activities, skills and knowledge" (Optimize skill)

An integer measurement scale (values are 1 to 5) that corresponds to different expertise levels; meaning is specified as below:

	Levels				
	1	**2**	**3**	**4**	**5**
Knowledge	Adequate education	Limited k of the subject (processes, methods and tool)	Good level of K in all aspects of the subject (processes, methods & tools)	High level of K in all aspects of the subject (processes, methods and tools)	Extensive k of the subject, both internal to the company and external.
Skill	Ability to perform basic routines under permanent supervision	Ability to perform standard tasks under punctual supervision	Ability to perform tasks autonomously within a predefined framework	Ability to perform tasks in complex situations and leading changes or reengineering in Airbus	Ability to perform tasks in complex situations and leading changes industry-wide.

Properties

PROFICIENCY LEVEL measures ABILITY FOR PROFESSION

PROFICIENCY LEVEL measures COMPETENCY

PROFICIENCY LEVEL measures KNOWLEDGE

PROFICIENCY LEVEL measures SKILLS

Comments In French " niveau d'expertise"

Usage for gap specification process: a 0 level is used to personalize *position* profile, meaning that a *competency* or a *skill* is not required by a job position. Indeed, one can assume that two persons sharing a same Profession will actually perform similar but not identical activities at their respective *job positions*. Some *competencies* from the *Ability for profession* stereotype may be neutralized in a job position profile using a 0 level.

2.3.13 Concept: **SKILL**

Natural language definition

Skills refer to “the ability to perform some particular tasks” (Optimize Skills). *Skills* are acquired by training or experience. Most are technical and domain related, but some are generic (SK-QB-Negociation skills; SK-QB-Lead a meeting).

Skills may require some *knowledge* elements as prerequisite.

Properties

SKILL is a component for 1 or n COMPETENCIES

SKILL requires 0 or n KNOWLEDGE

Comments

Real data: in practice defining skills is a difficult and time consuming task. It has been demanded to some contacts in every Function” to define competence, skills and knowledge for the function. Depending on the “Functions”, this has been performed to some extend only. For example, the Engineering Function did not define its skills yet; but actually included some skills at higher competence description level.

Instances of skills from our data are: “Verify, calibrate, adjust devices”, “Select & monitor external laboratories”, “Follow contracts”, “Write system testability requirements”, “Present test to Customer”, “Use infra-red”, “Perform riveting on composite”, “Intercultural skills”…

3 ONTOLOGIES SPECIFICATIONS

3.1 Overview of the ontologies and relations

We share with the UHP academic use case two main ontologies that are the foundation for ontology design and implementation in LUISA:

- The GCS (General Competency Schema) ontology defines competency related concepts and allows the definition of a competency or a proficiency level measurement.
- The s-lom ontology is a semantic version of LOM, backward interoperable with the IEEE LOM format, but extended so to allow defining some LO metadata by referring to other ontologies such as:
    - a cultural place by referring to a Geographical zone defined in OpenCyc,
    - a competency by referring to a competency defined in GCS
    - a discipline by referring to a discipline defined in a discipline ontology

Additionally to these core ontologies, we built local ontologies to extend and personalize the concepts' description in accordance to our context specificities:

- eadsTraining ontology contains local concepts that allows us to reuse the input information extracted from the training database that couldn't be aligned with LOM
- eadsCompetency ontology contains local concepts that allows us to reuse the input information extracted from the Competency referential and competency profilme database that could be aligned with GCS
- eadsDomainDiscipline is a small local ontology that captures the classification categories related to the Field of study into the training database .

The figure below gives an overview of five ontologies and the relations between them.

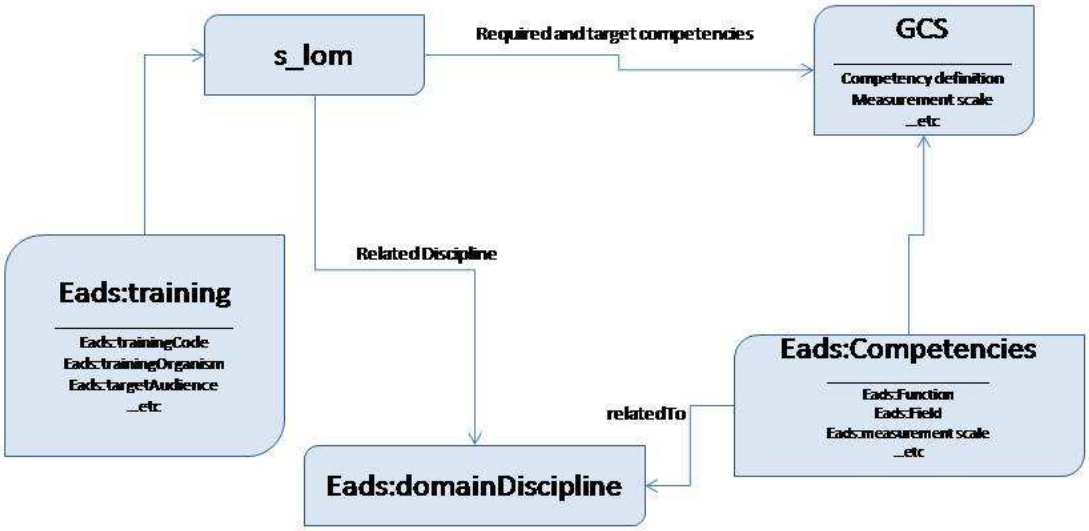

Figure 2 – relations between ontologies

3.1.1 User's profile

The LUISA querying process relies on several models including a user's profile. A user's profile includes:

- A preferred language and a working location that can be related to s-lom or eads:training
- A list of competencies linked to values expressing his/her level expressed thanks to GCS and eads:competencies
- A list of LO with which the user has already worked.

3.2 LO metadata for s-lom ontology

Based on the data structure presented above, alignment is possible with the LOM metadata template, which LUISA agreed to reuse. The table below lists those metadata that can (partially) be annotated on the basis of the collected data.

LOM	Name	Explanation	Example
1	**GENERAL**	THIS CATEGORY GROUPS THE GENERAL INFORMATION THAT DESCRIBES THIS LEARNING OBJECT AS A WHOLE.	
1.1	**Identifier**	A globally unique label that identifies this learning object.	ID: "80004204"
1.1.1	**Catalogue**	The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.	
1.1.2	**Entry**	The value of the identifier within the identification or cataloguing scheme	Code: "T1AE062"

LOM	Name	Explanation	Example
		that designates or identifies this learning object. A namespace specific string.	
1.2	**Title**	Name given to this learning object.	Designation : “filiere 28 : decouverte systèmes avion (eao) »
1.3	**Language**	The primary human language or languages used within this learning object to communicate to the intended user. NOTE 1:-An indexation or cataloguing tool may provide a useful default.	“fr” (default)
1.4	**Description**	A textual description of the content of this learning object. NOTE:--This description need not be in language and terms appropriate for the users of the learning object being described. The description should be in language and terms appropriate for those that decide whether or not the learning object being described is appropriate or relevant for the users.	Content : "Voici la liste des cours composant cette filière. Elle est classée par ordre logique d'apprentissage. - ATA29 Hydraulique : généralités - ATA29 Hydraulique : architecture - ATA27 Approche des commandes de vol. - ATA27 Les commandes de vol de l'A320 (…). EAO.
1.6	**Coverage**	The time, culture, geography or region to which this learning object applies.	Coverage Spatial location: (default:) – France coverage-Jurisdiction: Filiale St Nazaire
1.7	**Structure**	Underlying organizational structure of this learning object. **IEEE LOM Vocabulary:** • Collection: a set of objects with no specified relations • Mixed • Linear: a set of objects that are fully ordered. (e.g., with previous and next relationships) • Hierarchical: a set of objects whose relationships can be represented by a tree structure • Networked: a set of objects with relationships that are unspecified: • Branched • Parceled • Atomic: an object that is indivisible	(default) Collection
1.8	**Aggregation Level**	The functional granularity of this learning object. **IEEE LOM Vocabulary:** 1 - the smallest level of aggregation, e.g., raw media data or fragments. 2 - a collection of level 1 learning objects, e.g., a lesson. 3 - a collection of level 2 learning objects, e.g., a course. (a 'Web' of	(default) = 4

LOM	Name	Explanation	Example
		HTML documents, with an index page that links the pages together or a unit.) 4 - the largest level of granularity, e.g., a set of courses that lead to a certificate. Level 4 objects can contain level 3 objects, or can recursively contain other level 4 objects.	

LOM	Name	Explanation	Example
2	**LIFE CYCLE**	**THIS CATEGORY DESCRIBES THE HISTORY AND CURRENT STATE OF THIS LEARNING OBJECT AND THOSE ENTITIES THAT HAVE AFFECTED THIS LEARNING OBJECT DURING ITS EVOLUTION.**	
2.3	**Contribute**	Those entities (i.e., people, organizations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication	
2.3.1	**Role**	Kind of contribution. **Training organism:** can be assimilated to LOM content providers. **Training Manager:** "those that decide whether or not the learning object being described is appropriate or relevant for the users"	**Content Provider** **Training Manager**
2.3.2	**Entity**	The identification of and information about entities (i.e., people, organizations) contributing to this learning object. The entities shall be ordered as most relevant first.	Training manager: {ID, code, designation} {434343, Nicole, Dupont} Training org:{ID, code, designation} par ex. "80010430, 112898, AIRBUS FRANCE TOULOUSE"

LOM	Name	Explanation	Example
5	**EDUCATIONAL**	THIS CATEGORY DESCRIBES THE KEY EDUCATIONAL OR PEDAGOGICAL CHARACTERISTICS OF THIS LEARNING OBJECT	
5.1	**Interactivity Type**		(default) Expositive
5.2	**Learning Resource type**	**IEEE LOM Vocabulary:** • exercise • simulation • questionnaire • diagram • figure • graph • index • slide • table • narrative text • exam • experiment • problem statement • self assessment • lecture	Learning resources available in our case are mostly theory presentation to be used for classroom lectures (default) Lecture
5.5	**Intended End user**	The role for making use of the LO	Learner Author Teacher
5. 6	**Instructional context**	Physical characteristics of a training event that affect and are affected by the learning that takes place (location of a training, means of delivery, adaptability to simulate workplace…)	Training (or could be aicc:Classroom)
5.6	**Context**	The principal environment within which the learning and use of this learning object is intended to take place. NOTE:--Suggested good practice is to use one of the values of the value space and to use an additional instance of this data element for further refinement, as in ("LOMv1.0","higher education")	Corporate Training (default)
5.9	**Typical Learning Time**	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience. NOTE: The "typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange.	- day duration: 5 - hour duration: 38 Warning: in EADS database duration is float datatype instead of integer as in LOM.
	Competency level	A broad statement describing ability a person must have to utilize the LO Competencies are often categorized and scales are applied to show levels of ability.	Pre-requisite Competency, Skill, or knowledge
	Learning needs	Learning needs can be stated in many different ways and can be considered to be dependant on theories of learning to some extent. Among them, the concept of *competency* emphasizes the specification of external, observable behaviour oriented to performance in activities. In organizational contexts, this entails that competencies are oriented to describe performance in concrete work situations.	Outcomes in terms of: post-requisite Competency, Skill, and Knowledge

LOM	Name	Explanation	Example
6	**RIGHTS**	THIS CATEGORY DESCRIBES THE INTELLECTUAL PROPERTY RIGHTS AND CONDITIONS OF USE FOR THIS LEARNING OBJECT.	
6.1	**Cost**	Whether use of this learning object requires payment. **IEEE LOM Vocabulary:** • yes • no	(Default) no

LOM	Name	Explanation	Example
7	**Relation**	This category defines the relationship between this learning object and other learning objects, if any. To define multiple relationships, there may be multiple instances of this category. If there is more than one target learning object, then each target shall have a new relationship instance.	
7.1	**Kind**	Nature of the relationship between this learning object and the target learning object, identified by the field 7.2:Relation.Resource. Based on Dublin Core	"requires" or "isrequiredby" (For example, an exercise requires a link to a data file)
7.2	**Resource**	The target learning object that this relationship references.	
7.2.1	**Identifier**	A globally unique label that identifies the target learning object.	
7.2.1.1	**Catalog**	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	"EADS" (default)
7.2.1.2	**Entry**	The value of the identifier within the identification or cataloging scheme that designates or identifies the target learning object. A namespace specific string.	LO-00140
7.2.2	**Description**	Description of the target learning object.	

LOM	Name	Explanation	Example
9	**CLASSIFICATION**	THIS CATEGORY DESCRIBES WHERE THIS LEARNING OBJECT FALLS WITHIN A PARTICULAR CLASSIFICATION SYSTEM. TO DEFINE MULTIPLE CLASSIFICATIONS, THERE MAY BE MULTIPLE INSTANCES OF THIS CATEGORY	
9.1	**Purpose**	The purpose of classifying this learning object.	**- intended Audience** **- Discipline** **- Educational objective**
9.3	**Description**	Description of the learning object relative to the stated 9.1:Classification.Purpose of	**- intended audience: Target audience** **- Discipline: Group**

LOM	Name	Explanation	Example
		this specific classification, such as discipline, idea, skill level, educational objective, etc.	Shall indicate an identifier (num), a code (string) and a label **- Educational objective: Project** Shall indicate an identifier (num), a code (string) and a label **- Educational objective: Axe** Shall indicate an identifier (num), a code (string) and a label

3.3 EADS competency ontology

In this section, we provide the specification of the EADS competency ontology derived from GCS (see WSML code in appendices).

The CGS (Competency General Schema) covers most of the concepts necessary to formalize the EADS competence conceptual model, especially for what concern the formalization of a stereotype competency definition (figure 3) and its measurement using a particular scale of measurement, in relation with a particular job Position (figure 4). Therefore it was possible to populate the WSML implementation of the GCS using a sample EADS SQL competence database.

The GCS ontology is detailed in the LUISA deliverable D4.1.1 from which the following figures are borrowed.

Additional concepts needed to express local specificities are defined inside a local eadsCompetency ontology and related to GCS concepts.

3.3.1 What links to this ontology?

A **LO** description contains 2 metadata fields referring to the competency ontology. In our approach, a LO may be annotated with one or more instances of competencies (*and skills and knowledge*) in terms of learning outcomes or/and pre-requisites:

- Targeted competencies, which expresses the competencies reached after working with the LO and assimilating its content.
- Required competencies, which expresses the competencies required in order to work with the LO.

User profiles and job **position profiles** are described in an internal database, since the information is considered confidential. The database is accessed through the GUI for the EADS use case only:

- A **user profile** is a set of competencies associated with values representing the user level of mastering for each competency.

- A **jobPosition profile** is a set of competencies associated with values representing the required level of for each required competency at this position.

The **GUI** displays the **Competence gap** computed using the users' profile and his jobPosition profile in the case where the query targets the current position of the user. Or it can use or the competency ontology to display a competencies tree whose nodes can be selected by the user to formulate a query, in the case where the query targets a Profession different from the user's current job position.

3.3.2 CompetencyDefinition, CompetencyElement definition

The EADS competencies are instances of the GCS *CompetencyDefinition*.

Table 4: CompetencyDefinition (see D4.11)

competencyDefinition	Generic definition of a competency. It is related with neither specific job situation nor specific individual.	
	Attributes	A competency definition is completely defined if it is explicitly indicated and if the existence of all the elements (definitions) that compose the competency is a necessary and sufficient condition to describe the competency (*completelyDefined*).
		To acquire a competency definition it could be required to acquire other/s competency definition/s (*requires*).
		A competency definition can provide a more detailed description to an existing one (*details*).

The CGS allows us to formalize *CompetencyDefinitions* in our context, including *competencyElementDefinition* and especially Skills as described in our input referential. For example the competency ***CO-BO-Configuration Management in Service*** requires several *SkillElementDefinition* such as *SK-BO-Configuration Management Rules* or *SK-XI-Configuration Management Tools*:

CO-BO-Configuration Mgt in Service	CO-BO-000009
SK-BO-Configuration Management Rules	SK-BO-000001
SK-BO-Config Management Change Process	SK-BO-000004
SK-BO-Analysis of in service A/C config	SK-BO-000009
SK-XI-Configuration Management Tools	SK-XI-000060

Other relationships between Competencies are supported by GCS although not instantiated in our input data. The annotation process will make use of these relationships in order to demonstrate their possible use in querying LO.

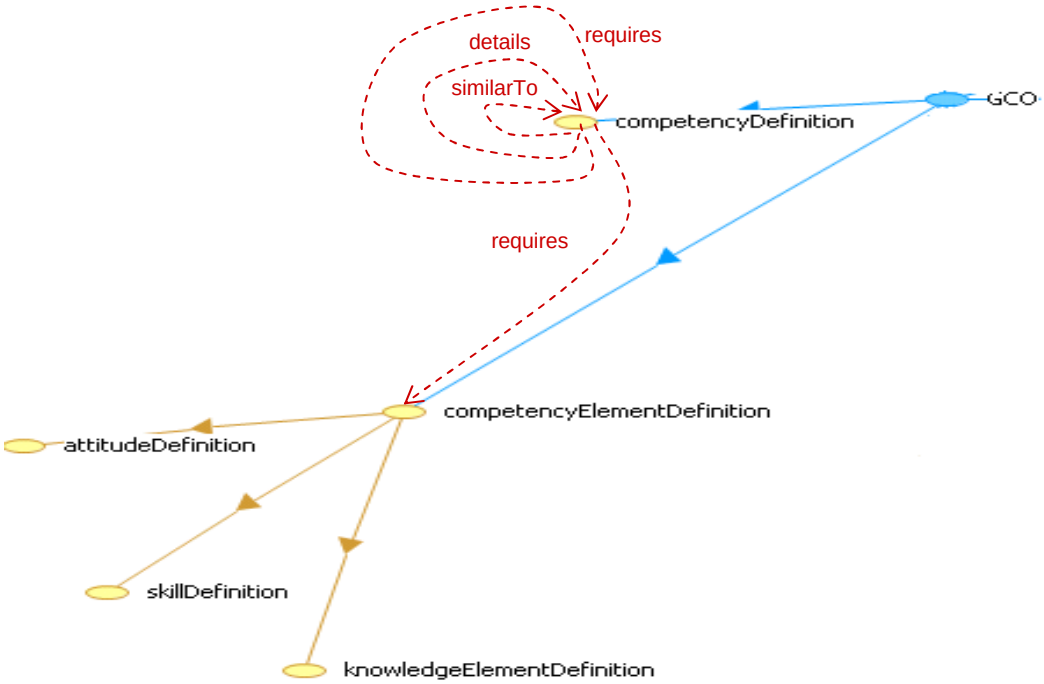

Figure 3 - relationships between competencies (D.4.11)

3.3.3 Processor and Person

In the industry use case, the users are employees, either Training Managers or Engineers. The users are instances of GCS *Person* which inherited from *Processor*.

Table 5: Concept of Person

processor	One that processes (human or software).	
	Attributes	isAbleToPerform competency

Table 6: Concept of Processor

person	Human being.

3.3.4 JobPositionDefinition and JobPosition

The GCS concepts of *JobPosition* and *JobPositionDefinition* can be reused as is. Each *JobPositionDefinition* requires a number of *CompetencyDefinitions*. This is a way to describe work situations in terms of required competencies.

Table 7: Concepts of JobPositionDefinition and JobPosition

jobPosition	An employment for which one specific professional profile is needed.

	Attributes	A specific job position is an instance of a job position definition (*instanceOf*).
jobPositionDefinition	The generic definition of an employment.	

3.3.5 Measurement and measurement scale

GCS also allows us to formalize the fact that a *CompetencyDefinition* is required at a job position in association with a given *measurement* using a given *measurementScale*.

Table 8: measurement (see D4.11)

measurement	A figure, extent, level or amount obtained by measuring.	
	Attributes	A measurement is obtained using a specific measurement scale (*scaleUsed*).
		A measurement has associated a specific value expressed in a given measurement scale (*currentValue*).
measurementScale	Something graduated when used as a measure or rule.	
	Attributes	instrumentUsed measurement instrument.

In our case, an integer measurement value (1 to 5) is used corresponding to a local way of measuring expertise levels (see section 2.3.12)

This is formalized using a specific *eadsProfessionDefinitionMeasurementValue* concept defined in a local additional eads:competencies ontology. This additional concept is related to CGS: an *eadsProfessionDefinitionMeasurementValue* being a subConcept Of GCS *measurement*.

3.3.6 Function, Field and Profession

In our context, competencies are categorized into a *Function - Fields - Profession* hierarchy. In this hierarchy a *Profession* belongs to a *Field*, and a *Field* belongs to a *Function*.

> For example: a "*Training manager" Profession* belongs to a "*Training" Field*, which belongs to a "*Human resources" Function*. This is a way to structure our big competence referential.

These concepts are formalized as specific local concepts *eadsFunction*, *eadsField* and *eadsProfession* related by a *belongsTo* relationship and defined in a local additional eads:competencies ontology.

The *eadsProfession* concept is related to CGS ontology since the concept *eadsProfessionDefinitionMeasurementValue* (sub concept of GCS *Measurement*) is required for an *eadsProfession* and measures a GCS *CompetencyDefinition*.

3.4 EADS Domain & Discipline ontology

An EADS LO can be classified according to the field of study it is related to.

Indeed, the existing data about the employees' training history and training courses were associated to some classification "objects" named AXIS, PROJET and GROUP that can be roughly assimilated to fields of study (see section 2.2.3 about input data description).

We intend to make use of this existing classification because it provides a mean to query the LOs not yet annotated with competencies (the input data being not annotated by competencies or skill), which can be a useful help for the annotator. Later, it will provide criteria that can be used in combination with competencies.

The original labels AXIS, PROJET and GROUP were not very explicit and thus were renamed respectively *eadsDomain*, *eadsDiscipline* and *eadsSpecialty*.

These concepts are organised inside a hierarchy thanks to a *partOf* relationship:

- an *eadsSpecialty* is part of an *eadsDiscipline*,
- and an *eadsDiscipline* is part of an *eadsDomain*.

For example, "*composite materials"* is an instance of *eadsSpecialty* that is part of the *eadsDiscipline* "*mechanics".* This last discipline is itself part of a "*Techniques"* eads*Domain*.

3.4.1 What links to this ontology?

Inside the local eadsTraining ontology, each **LO** is described with metadata called *Domain*, *Discipline* and *Specialty*. Instances are automatically populated from the EADS Training database. Examples of instances are described in section 2.2.3.

In addition the *eadsDomainDiscipline* ontology is related to the *eadsCompetencies* one. In our view some relationships might exist between instances of the following class:

- *Specialties* related to some *Profession*,
- *Disciplines* related to some *Field*,
- *Domains* related to some *Functions*.

For example the "*Configuration Management" Specialty* could be linked to the *Profession "AP-BO-Configuration Management Architect"*. But such relationships are not instantiated in the original data and shall be annotated manually for LUISA experimentation.

4 ILLUSTRATION OF THE USE OF THE ONTOLOGIES

In this section, we provide illustration of the foreseen use of previously described ontologies in the LUISA prototype.

4.1 Annotation phase

4.1.1 Pre annotating the LO

As already said, the case reuses a huge quantity of pre-existing data. We built a SQL database using extracts from the original training database and competence database. Thanks to a transformation programme provided by UAH, the WSML implementations of the ontologies can be automatically populated from this SQL database.

This was a way to pre-annotate LOs with known instances of metadata coming from the training database such as: catalogue, entry, title, language, description, domain, discipline, specialty, cost, duration, etc.

4.1.2 Further annotating the LO

Every LO metadata were not instantiated in the original input data: a further annotation phase is required. This annotation is manual. Its concerns particularly the annotation of the two LO metadata fields referring to the competency ontology:

- *Targeted competencies*, which expresses the competencies reached after working with the LO and assimilating its content.
- *Required competencies*, which expresses the competencies required in order to work with the LO.

During the annotation phase, the ontologies can be used in the annotation tool eLUISA. eLUISA is based on SHAME, a flexible annotation tool that makes use of ontologies and configuration files called Annotation Profile. These annotation profiles serve at defining as many annotation interfaces as wanted, by selecting some concepts inside ontologies and configuring the set of metadata to be edited (see D3.4.2 deliverable).

eLUISA can fill some elements of the interface with instances coming from the ontologies. For example the *Targeted competencies* of an LO can show a dropdown listbox automatically filled with instances of the competency ontology. If many instances of competencies exist, then the annotation tool will provide a visualisation of instances by showing them organized through the Function – Field – Profession hierarchy for example.

4.2 Querying phase

The primary scenario is summarized as follows:

1. Identification & gap calculation
    - When a user logs in, LUISA identify the user so it can query his/her profile (Obviously, user competence profile is never public information), know his/her position and compute the competency gap
2. LUISA displays the competency gaps

- Gaps show the competencies or skills required in a job position profile but that do not appear in the user profile or that appear in the user profile but with a too low proficiency level.

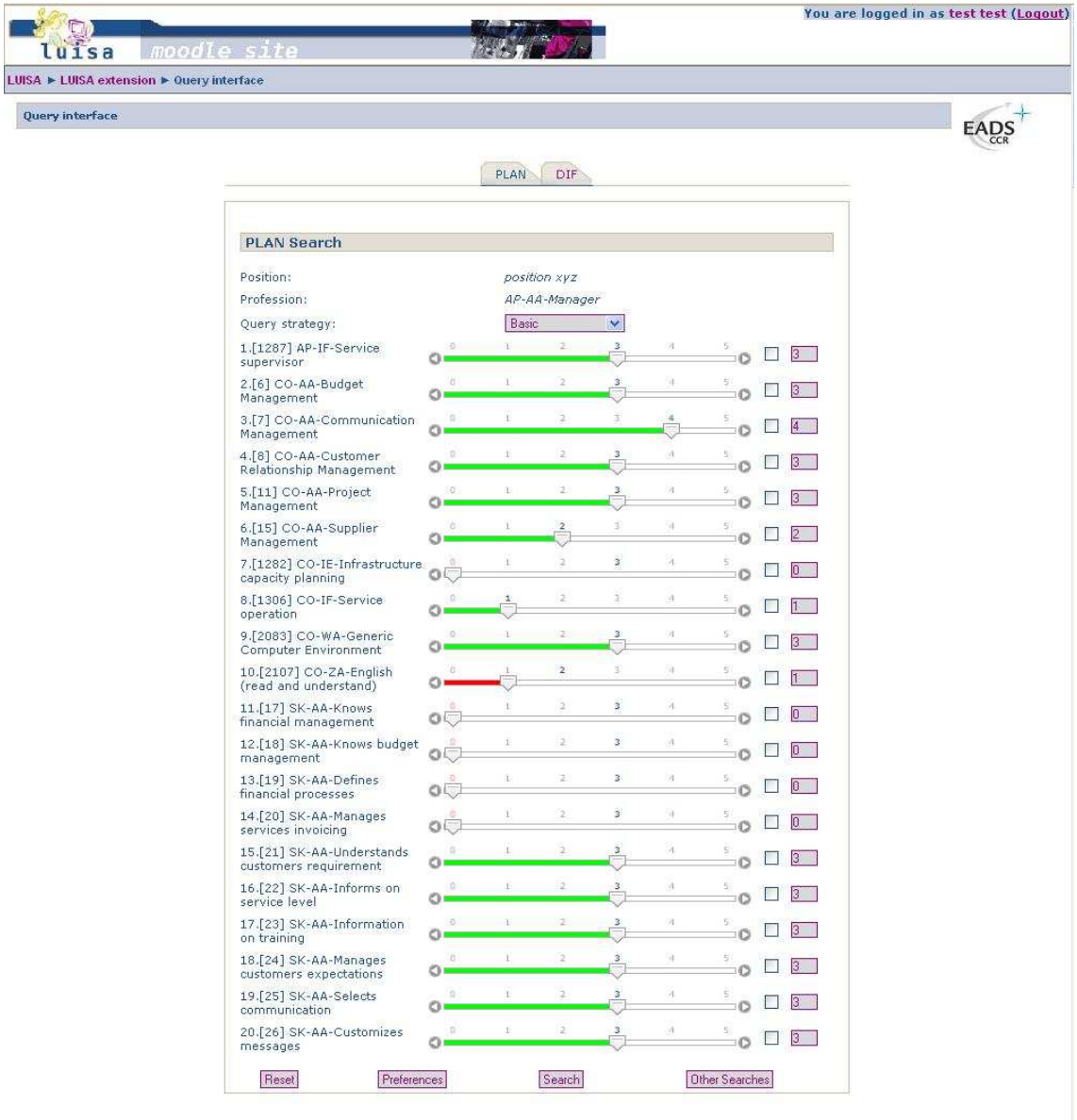

Figure 4 – Query interface (draft)

3. Query

Two different kinds of queries are distinguished.

The first one can be called “profile-based query”: the user asks for LOs which suit the specific competency needs (gaps) as defined with regard to his position profile:

- The Learner may select one Co from the displayed competency gaps list,

- or he may ask for a global query: what will best fit his/her current gaps? This is actually a more complex query that requires various gaps specification and reasoning that are detailed in deliverable D6.3.

The second one allows the user to select another Profession (not related to his current job position): the user asks for LOs which suit some competency needs that must be defined with regard to another Profession.

This second type of query supposes that the GUI displays the *Competencies* and *Skills* related to the target *Profession.* These relations are described inside the populated EADS competencies ontology. Competence gap shall be recomputed for this new context.

(Note that the relation linking the *competencies* and *skills* to *professions* in the ontology is not measured by any proficiency level. *Professions* are conceived as stereotyped set of competencies. Therefore the gap computation for this second type of query shows only the competencies or skills required in a profession profile but that do not appear in the user profile.)

4.3 Competency driven selection of LOs

We proposed several strategies for gap computation according to some user's preferences called PLAN and DIFF which are detailed in D6.3 deliverable (Use case implementation). Various ontology-based relaxing constraints can then be defined according to these strategies.

4.3.1 PLAN and DIFF user's preferences

In short, PLAN preference targets priority learning needs defined as negative gap with regard to the user's current job position:

negative gap = (User current level – user required level < 0)

Meaning that the user shall gain level

while DIFF preference targets non priority learning needs such as zero gap or even positive gap with regard to the user's current job position, or even competencies related to another Profession:

zero gap = (User current level – user required level = 0)

Meaning that the user has the correct level

positive gap = (User current level – user required level > 0)

Meaning that the user has a better level than required

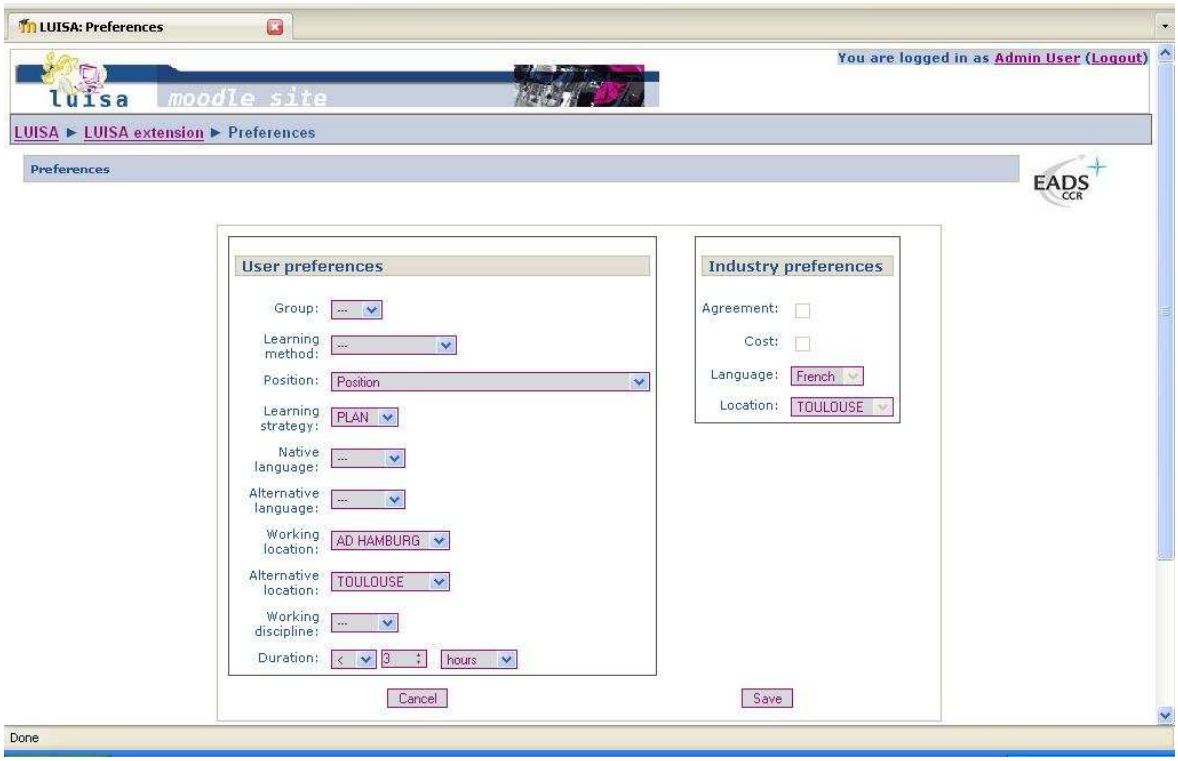

Figure 5 – Preference interface (draft)

4.3.2 Gap computation strategies according to preferences

Several strategies for gap computation are specified. These strategies are summarized as follow:

- PLAN = (only negative gaps in current profile are processed)
  - All negative gaps
  - "Weak Field" = only negative gaps from the weakest FIELD
  - Hole in my Profile= only highest negative gaps
  - "Job specific CO"= only negative gaps for CO that do not belong to the profession stated in the job position profile

- DIFF
  - complete profile = any gaps are processed
  - another Profession|Competency that can be selected through browsing the referential

4.3.3 Ontology-based relaxing constraints

The system can make use of the ontologies to relax constraints. The proposed algorithms are the following:

- if PLAN QUERY:
  - for any Competencies, either CO or SK with negative gaps in the profile
    - search LO annotated with this CO|SK as an outcome (*TargetedCompetency*)

        - rank resulting LO to best fit the profile

    - If no answer

        - search LO annotated with *CompetencyDefinitions* or *CompetencyElements* CO|SK although not measured by levels (no level info available) – again target those competencies CO|SK with a negative gap into the profile
        - rank the results using the max number of common CO or SK between the LO outcome and the Profile required CO

        - If no answer then :
            - Decompose *CompetencyDefinition* into *CompetencyElement* and redo (rank better the LO that shows the max number of *CompetencyDefinition* AND *CompetencyElements* than targeted in the query)

            - If no answer then:
                - search if there is LO annotated with similar CO|SK than those targeted in the query
                - And search LO annotated with a *Specialty* linked to the *Profession* to which the CO is related to inside the referential
                - *(NOTE: beware do not use here the Profession appearing in the user's profile but the one related to the CO into the referential: indeed we can well use CO or SK that do not belong to the profession to describe a specific position – the so-called specific COs)*

            - If no answer then:
                - Relax other User's preferences (e.g. *preferred language, preferred location*...)

- if DIFF PROFILE-BASED QUERY:
    - for any Competencies or Competency element selected in the profile whatever gap is concerned
        - search LO **annotated with this CO|SK as an outcome**
        - rank resulting LO to best fit the profile

    - If no answer

- search LO annotated with competency-definitions or elements CO|SK although not measured by levels (no level info available) – again target those competencies CO|SK with a negative gap into the profile
- rank the results using the max number of common CO or SK between the LO outcome and the Profile required CO

- If no answer then :
  - Decompose *CompetencyDefinition* into competency element and redo (rank better the LO that shows the max number of *CompetencyDefinition* AND *CompetencyElements* than targeted in the query)

  - If no answer then:
    - search if there is LO annotated with similar CO|SK than those targeted in the query
    - And search LO annotated with a *Specialty* linked to the *Profession* to which the CO is related to inside the referential
    - *(NOTE:* beware do not use here the *Profession* appearing in the user's profile but the one related to the CO into the referential: indeed we can well use CO or SK that do not belong to the profession to describe a specific position – the so-called specific COs)

  - If no answer then:
    - Relax other User's preferences (e.g. *preferred language*)

- if DIFF 'OTHER PROFESSION | COMPETENCY' QUERY:
  - if a Profession has been chosen, decompose Profession into typical Competencies and Skills (information available into the ontology)
  - search LO annotated with the selected competency-definitions or elements CO|SK
  - rank the results using the max number of common CO or SK between the LO outcome and the Profile required CO

  - If no answer then :

- Decompose *CompetencyDefinition* into *CompetencyElement* and redo (rank better the LO that shows the max number of *CompetencyDefinition* AND *CompetencyElements* than targeted in the query)

- If no answer then:
  - search if there is LO annotated with similar CO|SK than those targeted in the query
  - And search LO annotated with a *Specialty* linked to the *Profession* to which the CO is related to inside the referential
  - *(NOTE: beware do not use here the Profession appearing in the user's profile but the one related to the CO into the referential: indeed we can well use CO or SK that do not belong to the profession to describe a specific position – the so-called specific COs)*

- If no answer then:
  - Relax other User's preferences (e.g. *preferred language*...)

4.4 Querying distributed LORs annotated with different Discipline ontologies

In order to take full advantage of LUISA technology we shall be able to query distributed LO repositories possibly annotated using various ontologies.

Ontology-mapping is a difficult problem that is actually explored by many works like [Kalfoglou & Schorlemmer 2005] [Gasevic 2006]. But in the present case, EADS and UHP being the two use-case partners of the LUISA project, we use ontologies of competencies extended from the same general schema GCS. This allows an easier illustration of a search over repositories using EADS and UHP ontologies of competencies that can be achieved through simpler instance mapping. Below is proposed a short list of competencies instances mapping agreed between UHP and EADS:

About\Ontologies[2]	UHP-GCS (uhpGcs.wsml)	EADS-GCS (eadsCompetenciesOntology.wsml)
Windows	b1	eadsCompetencyDefinition_2082
Word	b4textprocessor	eadsCompetencyDefinition_2076
Excel	b4spreadsheet	eadsCompetencyDefinition_2077
Powerpoint	b5	eadsCompetencyDefinition_2078
Outlook	b6	eadsCompetencyDefinition_2080
MS Project	b7	eadsCompetencyDefinition_2075

A LUISA service will be required to compute a request usable for querying simultaneously both LOR-EADS and LOR-UHP. This service makes use of an intermediate Web Service containing the “links” created manually.

[2] UHP instances must be preceded by: http://www.uhp-nancy.fr/ontologies/LUISA#

EADS instances must be preceded by: http://eads.org/competencies#

5 REFERENCES

[1] AP2080 (issue B) Airbus Reference Language.

[2] AICC. *Aviation Industry Metadata Description* – Draft version 1.6, January, 2006.Retrieved April, 2006 from http://www.aicc.org/

[3] IEEE. Draft Standard for Learning Object. IEEE 1484.12.1-2002

[4] IMS Reusable Definition of Competency or Educational Objective - Best Practice and Implementation Guide- Version 1.0 Final Specification. October 2002.

[5] Learning Technology Standards Committee of the IEEE, "Draft Standard for Learning Technology— Reusable Competency Definitions," 13 May, 2004.

[6] Monceaux, A.; Guss, J. “Training Management System for Aircraft Engineering: indexing and retrieval of Corporate Learning Object”, ESWC’06 proceedings.

[7] Monceaux, A.; Guss, J. User needs and initial scenarios. LUISA deliverable D6.1. 2006.

6 APPENDIX

6.1 GCS ontology populated with EADS instances (extract)

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://www.cc.uah.es/ie/ont/gcs#"
,
     wsmostudio _"http://www.wsmostudio.org#",
     rdfs _"http://www.w3.org/2000/01/rdf-schema#" }

ontology gcs\-ont
     nonFunctionalProperties
          wsmostudio#version hasValue "0.6.0"
     endNonFunctionalProperties

concept episode

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

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

concept processor
     name impliesType  (1 1) _string

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
     label impliesType  (1 1) _string
     description impliesType  (0 1) _string

concept competencyElementDefinition
     conforms impliesType  (1 *) competencyDefinition
     label impliesType  (1 1) _string
     description impliesType  (0 1) _string

concept knowledgeElementDefinition subConceptOf competencyElementDefinition
     prerrequisite impliesType knowledgeElementDefinition

concept attitudeDefinition subConceptOf competencyElementDefinition

concept skillDefinition subConceptOf competencyElementDefinition
     prerrequisite 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
     label impliesType  (1 1) _string

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

concept knowledgeElement subConceptOf competencyElement

concept attitude subConceptOf competencyElement

concept skill subConceptOf competencyElement

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

concept jobPositionDefinitionMeasurementValue subConceptOf measurement
     jobPositionDefinitionInvolved impliesType  (1 1) jobPositionDefinition
     competencyDefinitionScaled impliesType  (1 1) competencyDefinition

concept competencyElementProcessorMeasurementValue subConceptOf measurement
     scaledProcessor impliesType  (1 1) processor
     measuresCompetencyElement impliesType  (1 1) competencyElement

concept competencyDefinitionMeasurementValue subConceptOf measurement
     measures impliesType competencyDefinition

concept skillDefinitionMeasurementValue subConceptOf measurement
     measures impliesType skillDefinition
```

6.2 Local EADS Competencies ontology

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://eads.org/competencies#", wsmostudio
_"http://www.wsmostudio.org#" }
```

```
ontology eadsCompetencies
     nonFunctionalProperties
          wsmostudio#version hasValue "0.6.0"
     endNonFunctionalProperties

     importsOntology
            _"http://eads.org/trainings"

concept eadsProfessionDefinitionMeasurementValue subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#measurement"
     requiredFor impliesType  (1 1) eadsProfession
     measures impliesType  (1 1)
_"http://www.cc.uah.es/ie/ont/gcs#competencyDefinition"

concept eadsFunction
     nonFunctionalProperties
          _"http://purl.org/dc/elements/1.1#description" hasValue
"Part of a classification tree {Functions - Fields - Professions} used
by Human Resources within the organisation"
     endNonFunctionalProperties
     label impliesType  (1 1) _string

concept eadsCompetencyDefinition subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#competencyDefinition"
     nonFunctionalProperties
          _"http://purl.org/dc/elements/1.1#description" hasValue "
Profession are described by typical Competencies or Skills in eads
referential"
     endNonFunctionalProperties
     belongsTo transitive  impliesType eadsProfession

concept eadsSkillDefinition subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#skillDefinition"
     nonFunctionalProperties
          _"http://purl.org/dc/elements/1.1#description" hasValue "
Profession are described by typical Competencies or Skills in eads
referential"
     endNonFunctionalProperties
     belongsTo transitive  impliesType eadsProfession

concept eadsQualitativeProficiencyLevel subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#measurementScale"
     nonFunctionalProperties
          _"http://purl.org/dc/elements/1.1#coverage" hasValue
"qualitative proficiency level shall be part of a closed vocabulary:
{not_required; has_notion; has_basis;masters;is_expert}"
     endNonFunctionalProperties

concept eadsSkillElement subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#skillDefinition"
     hasPrerequisiteSkill impliesType eadsSkillElement

concept eadsPerson subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#person"
     hasID impliesType _integer
     hasTrainingHistory impliesType
_"http://eads.org/training#eadsTraining"
     hasSite impliesType _"http://eads.org/training#eadsLocation"
       hasOrgAcronym impliesType _string
```

```
concept eadsJobPosition subConceptOf
_"http://www.cc.uah.es/ie/ont/gcs#jobPosition"
     hasPositionID impliesType _integer
     hasPositionDesignation impliesType _string

concept eadsProfession
     nonFunctionalProperties
          _"http://purl.org/dc/elements/1.1#description" hasValue
"Part of a classification tree {Functions - Fields - Professions} used
by Human Resources within the organisation"
     endNonFunctionalProperties
     label impliesType  (1 1) _string
     belongsTo transitive  impliesType eadsField
     isAssociatedTo impliesType
"http://www.cc.uah.es/ie/ont/gcs#jobPositionDefinition"
     isAssociatedTo2 impliesType eadsJobPosition

concept eadsField
     belongsTo impliesType eadsFunction
     label impliesType  (1 1) _string

instance not_required memberOf eadsQualitativeProficiencyLevel
instance has_basis memberOf eadsQualitativeProficiencyLevel
instance has_notions memberOf eadsQualitativeProficiencyLevel

instance masters memberOf eadsQualitativeProficiencyLevel
instance is_expert memberOf eadsQualitativeProficiencyLevel
```

6.3 s–lom extract populated for EADS LOs (extract)

```
instance eadsId_80079271 memberOf lomIdentifier
     catalog hasValue "eads"
     entry hasValue "80079271"

instance lssName_training_80079271 memberOf langStringSingle
     hasCharacterString hasValue "JURIDQIQUE ACHATS- NATIONAL INTERNATIONA"
     hasHumanLanguage hasValue ocFrenchLanguage

instance lsName_training_80079271 memberOf langString
     langStringSingle hasValue lssName_training_80079271

instance lssDes_training_80079271 memberOf langStringSingle
     hasCharacterString hasValue "1. LA FORMATION DU CONTRAT EN GÉNÉRAL, DU
CONTRAT D'ACHAT EN PARTICULIER        2. LES CLAUSES INDISPENSABLES A TOUT
CONTRAT COMMERCIAL         3. L'INTERPRÉTATION DES CONTRATS ET LES DÉRIVES
POSSIBLES :     ? Transfert de propriété  ? Transfert de risques       4. LES
CLAUSES SPÉCIFIQUES AFFÉRENTES AU TRANSFERT  DE PROPRIÉTÉ ET DE  RISQUES (les
incoterms, les notions de propriété industrielle et  intellectuelle)        5.
LES CLAUSES RELATIVES AUX PRIX      6. LES DIFFICULTÉS D'EXÉCUTION DU CONTRAY
? Les retards de livraison  ? La conformité  ? Les vices de conformité / vices
cachés  ? Les mesures de sauvegarde  ? Les exonérations de responsabilité
7.  LES  DIFFICULTÉS  ET  LES  MESURES  À  PRENDRE,  EN  CAS  DE  PROCÉDURES
COLLECTIVES, À L'ÉGARD DU FOURNISSEUR        8. LE CONTRAT DE PRESTATION DE
SERVICE      9. LES RÈGLES PROPRES À LA SOUS-TRAITANCE      10. LES CONDITIONS
GÉNÉRALES D'ACHAT ET LES IMPLICATIONS INTERNATIONALES    ? Détermination de la
loi applicable  ? La convention de Vienne     "
     hasHumanLanguage hasValue ocFrenchLanguage
```

```
instance lsDes_training_80079271 memberOf langString
     langStringSingle hasValue lssDes_training_80079271

instance eadsId_80082259 memberOf lomIdentifier
     catalog hasValue "eads"
     entry hasValue "80082259"

instance lssName_training_80082259 memberOf langStringSingle
     hasCharacterString hasValue "LA NAVIGATION DE L'AVION AED043"
     hasHumanLanguage hasValue ocFrenchLanguage

instance lsName_training_80082259 memberOf langString
     langStringSingle hasValue lssName_training_80082259

instance lssDes_training_80082259 memberOf langStringSingle
     hasCharacterString hasValue "L'AVION ET SON ENVIRONNEMENT  LA GESTION DU
TRAFIC AERIEN   LA TECHNOLOGIE DES SYSTEMES EMBARQUES DE NAVIGATION   LES
SYSTEMES TERRESTRES ACTUELS DE POSTIONNEMENT  L'UTILISATION DES SYTEMES DE
NAVIGATION  LES AUGMENTATIONS DU SYSTEMES GPS  LE PROJET GALILEO  L'EVOLUTION
DE LA NAVIGATION DE L'AVION  LA PLATEFORME AEROPORTUAIRE     APPLICATION SUR
SIMULATEUR "
     hasHumanLanguage hasValue ocFrenchLanguage

instance lsDes_training_80082259 memberOf langString
     langStringSingle hasValue lssDes_training_80082259

instance eadsId_80083547 memberOf lomIdentifier
     catalog hasValue "eads"
     entry hasValue "80083547"

instance lssName_training_80083547 memberOf langStringSingle
     hasCharacterString hasValue "INTRODUCTION AUX RESEAUX"
     hasHumanLanguage hasValue ocFrenchLanguage

instance lsName_training_80083547 memberOf langString
     langStringSingle hasValue lssName_training_80083547

instance lssDes_training_80083547 memberOf langStringSingle
     hasCharacterString hasValue "0     "
     hasHumanLanguage hasValue ocFrenchLanguage

instance lsDes_training_80083547 memberOf langString
```

6.4 Local EADS training ontology

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://eads.org/training#",
                  wsmostudio _"http://www.wsmostudio.org#",
                  rdfs _"http://www.w3.org/2000/01/rdf-schema#"
                   }

ontology _"http://eads.org/trainings"
     nonFunctionalProperties
          wsmostudio#version hasValue "0.6.0"
          _"http://purl.org/dc/elements/1.1#description" hasValue "subconcepts
of lomLearningObject"
     endNonFunctionalProperties

importsOntology
            {_"http://eads.org/competencies#eadsCompetencies",
_"http://www.cc.uah.es/ie/ont/cLom#cLom-ont",
_"http://eads.org/domainsDisciplines"}
```

```
concept eadsTraining subConceptOf
_"http://www.cc.uah.es/ie/ont/cLom#cLomlearningObject"
     hasOutcomeKnowledge impliesType
_"http://www.cc.uah.es/ie/ont/gcs#knowledgeDefinitionMeasurementValue"
     hasOutcomeSkill impliesType
_"http://www.cc.uah.es/ie/ont/gcs#skillDefinitionMeasurementValue"
     hasTrainingCode impliesType _string
     hasTrainingOrganism impliesType eadsTrainingOrganism
     hasPrerequisiteTextualDescription impliesType _string
     hasPrerequisiteCompetency impliesType
_"http://www.cc.uah.es/ie/ont/gcs#competencyDefinitionMeasurementValue"
     hasPrerequisiteKnowledge impliesType
_"http://www.cc.uah.es/ie/ont/gcs#knowledgeDefinitionMeasurementValue"
        hasPrerequisiteSkill impliesType
_"http://www.cc.uah.es/ie/ont/gcs#skillDefinitionMeasurementValue"
        hasPrerequisiteAttitude impliesType
_"http://www.cc.uah.es/ie/ont/gcs#attitudeDefinitionMeasurementValue"
     intendedAudienceFunction impliesType
_"http://eads.org/competencies#eadsFunction"
     intendedAudienceField impliesType
_"http://eads.org/competencies#eadsField"
     intendedAudienceProfession impliesType
_"http://eads.org/competencies#eadsProfession"
     intendedAudienceDescription impliesType _string
     learningObjectiveDescription impliesType _string
     hasOutcomeCompetency impliesType
_"http://www.cc.uah.es/ie/ont/gcs#competencyDefinitionMeasurementValue"
     hasOutcomeAttitude impliesType
_"http://www.cc.uah.es/ie/ont/gcs#attitudeDefinitionMeasurementValue"
     hasDomain impliesType _"http://eads.org/domainsDisciplines#eadsDomain"
     hasDiscipline impliesType
_"http://eads.org/domainsDisciplines#eadsDiscipline"
     hasSpeciality impliesType
_"http://eads.org/domainsDisciplines#eadsSpeciality"

concept eadsTrainingOrganism
     hasOrgCode impliesType _string
     hasOrgID impliesType  (1 1) _integer
     hasLabel impliesType _string

concept TrainingManager subConceptOf
_"http://eads.org/competencies#eadsPerson"

concept TrainingDuration
     hasHourValue impliesType _integer
     hasDayValue impliesType _float

concept eadsLocation
     nonFunctionalProperties
          _"http://purl.org/dc/elements/1.1#description" hasValue "instances
are eads subsidiaries = environment within which the learning and use of a LO
is intended to take place"
     endNonFunctionalProperties
        isLocatedInto impliesType
_"http://www.cc.uah.es/ie/ont/lom2wsml#ocGeographicalRegion"

instance AMIS_ENSAE_ENSTA_STE_DES memberOf eadsTrainingOrganism
nonFunctionalProperties
    rdfs#label hasValue "AMIS_ENSAE_ENSTA_STE_DES"
endNonFunctionalProperties
     hasOrgID hasValue 80014189
     hasLabel hasValue "AMIS EBSAE ENSTA STE DES"

instance _"http://eads.org/training#AIRBUS_FRANCE-TOULOUSE" memberOf
eadsTrainingOrganism
```

```
nonFunctionalProperties
    rdfs#label hasValue "AIRBUS_FRANCE-TOULOUSE"
endNonFunctionalProperties
     hasOrgID hasValue 80010430
     hasLabel hasValue "AIRBUS FRANCE TOULOUSE"

instance ORCHESTRA_CONSULTANTS memberOf eadsTrainingOrganism
nonFunctionalProperties
    rdfs#label hasValue "ORCHESTRA_CONSULTANTS"
endNonFunctionalProperties
     hasLabel hasValue "ORCHESTRA CONSULTANTS"
     hasOrgID hasValue 80014189

instance Toulouse memberOf eadsLocation
nonFunctionalProperties
    rdfs#label hasValue "Toulouse"
endNonFunctionalProperties

instance Bremen memberOf eadsLocation
nonFunctionalProperties
    rdfs#label hasValue "Bremen"
endNonFunctionalProperties
```

6.5 Local EADS DomainDiscipline populated ontology (extract)

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://eads.org/domainsDisciplines#"
,
     wsmostudio _"http://www.wsmostudio.org#",
     rdfs _"http://www.w3.org/2000/01/rdf-schema#" }

ontology _"http://eads.org/domainsDisciplines"
     nonFunctionalProperties
          wsmostudio#version hasValue "0.5.5"
     endNonFunctionalProperties

     importsOntology
            _"http://eads.org/competencies#eadsCompetencies"

concept eadsDiscipline
     hasLabel impliesType _string
     partof impliesType eadsDomain
     disciplineTitle impliesType eadsDisciplineVocabularyItem
     linkedToField impliesType _"http://eads.org/competencies#eadsField"

concept eadsDomain
     hasLabel impliesType _string
     domainTitle impliesType eadsDomainVocabularyItem
     linkedToFunction impliesType _"http://eads.org/competencies#eadsFunction"

concept eadsSpeciality
     hasLabel impliesType _string
     SpecialityTitle impliesType eadsSpecialityVocabularyItem
     partof impliesType eadsDiscipline
     linkedToProfession impliesType
_"http://eads.org/competencies#eadsProfession"

concept VocabularyItem

concept eadsDisciplineVocabularyItem subConceptOf VocabularyItem

concept eadsDomainVocabularyItem subConceptOf VocabularyItem

concept eadsSpecialityVocabularyItem subConceptOf VocabularyItem
```

```
     hasName impliesType  (1 1) _string

instance _"http://eads.org/domainsDisciplines#aéronautique" memberOf
eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "aéronautique"
     endNonFunctionalProperties

instance Technique memberOf eadsDomainVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "Technique"
     endNonFunctionalProperties

instance _"http://eads.org/domainsDisciplines#mécanique_matériaux" memberOf
eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "mécanique_matériaux"
     endNonFunctionalProperties

instance industrialisation memberOf eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "industrialisation"
     endNonFunctionalProperties

instance concurrent_engineering memberOf eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "concurrent_engineering"
     endNonFunctionalProperties

instance _"http://eads.org/domainsDisciplines#électricité_électronique"
memberOf eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "électricité_électronique"
     endNonFunctionalProperties

instance documentation memberOf eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "documentation"
     endNonFunctionalProperties

instance fabrication memberOf eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "fabrication"
     endNonFunctionalProperties

instance SAP memberOf eadsDisciplineVocabularyItem
     nonFunctionalProperties
          rdfs#label hasValue "SAP"
     endNonFunctionalProperties
```