D4.1

Full Prototype, Prototype of Services and Report

WP 400

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Abbreviations

a.m.	above mentioned
AS	Application Service
BC	Business Case
BEP	Best Enterprise Practice
BPEL	Business Process Execution Language
BPMN	Business Process Modelling Notation
CAD	Computer Aided Design
CLE	Collaborative Learning Environment
CM	Collaborative Model
CRA	Collaborative Reference Architecture
CRM	Customer Relation Management
CS	Core Service
CWE	Collaborative Working Environment
D	Deliverable
e.g.	exempli gratia = for example
EB	Executive Board
EC	European Commission
EE	Extended Enterprise
EJB	Enterprise Java Beans
EO	Extended Organisation
etc.	et cetera = and so on
EU	European Union
FP	Framework Programme
GUI	Graphical User Interface
i.e.	id est = that is
ICT	Information Communication Technology
IEEE	Institute of Electrical and Electronic Engineers
IntelLEO	Intelligent Learning Extended Organisation
IP	Internet Protocol
IPR	Intellectual Property Rights
KM	Knowledge Management
L(C)MS	Learning (Content) Management Systems
LE	Large Enterprises
LKB	Learning and Knowledge-Building
LMS	Learning Management System
LO	Learning Objects
LOCO	Learning Object Context Ontology
MSI	Management of Social Interaction
OEM	Original Equipment Manufacturer
PC	Project Coordination
PS	Project Start
PSS	Portfolio Software Solutions
QA	Quality Assurance
R&D	Research & Innovation
RCD	Reusable Competency Definition
RLO	Reusable Learning Object
RTD	Research and Technology Development
S&T	Scientific & Technical
SBK	Semantics-Based Knowledge
SBKM	Semantics-Based KM
SME	Small and medium-sized Enterprise
SOA	Service Oriented Architecture
STC	Scientific/Technical Committee
STREP	Small or medium-scale focused research project
SW	Software
TEL	Technology Enhanced Learning
UML	Unified Modelling Language
w.r.t.	with respect to
VET	Vocational Education and Training
WP	Workpackage
WPMT	Workpackage Managers Team
XML	Extensible Markup Language

Executive Summary

This document presents the brief description of the results of WP 400 and is a part of the deliverable D4.1 Full Prototype, Prototype of SW services and Report. The deliverable D4.1 in particular presents the work realised under tasks T420 to T460..

Actually the deliverable D4.1 are the software prototypes developed in the scope of the IntelLEO's full prototypes development.

The Full Prototypes are based on the Early Prototypes developed within WP 300 as deliverable D3.1 .

IntelLEO project aims to develop intelligent technologies to support learning and knowledge building (LKB) activities in Intelligent Learning Extended Organisation (IntelLEO). The objective is to explore the key project's hypothesis that the responsiveness of the LKB environments in an IntelLEO, aiming to enhance motivation of learners, proactively encouraging them to take part in LKB activities, can be radically enhanced by advanced technology exploiting a synergy between services for

- efficient management of collaborative LKB activities and access to and supply of shared content, and
- harmonisation of individual and organisational objectives.

The key means to enable exploitation of this synergy are Pedagogical Baseline and ontology-based extensible context representation, which includes learners, context and collaboration models. The approach of IntelLEO is to provide a set of generic so-called Core Services, both to support collaborative LKB activities and those for harmonisation of individual and organisational objectives. These Core Services can be combined with specific application services to support various scenarios for collaborative LKB activities in an IntelLEO.

The overall methodological approach that is followed in IntelLEO is a participatory design approach. In order to allow for on-time justification of IntelLEO concept and participatory design approach, an iterative prototyping approach was followed. Several iterations were planned with three major phases: (1) IntelLEO Concept definition, (2) Early Prototype development and (3) Final Prototype development. Therefore, first the so-called Early Prototype has been developed allowing testing of the IntelLEO basic concepts and getting feedback from the end-users. All the results coming from the Early Prototype served as a basis for the Full Prototype development. Therefore, D4.1 describes the results of the IntelLEO services development, taking into account all the previous development steps, the identified risks and the end-user feedbacks obtained during the testing sessions.

As the deliverable D4.1 are actually software prototypes, the objective of the present document is to provide an overview of the services functionality developed within the scope of the full prototype. The report includes mainly the examples of the most relevant GUIs of several modules developed.

In the scope of full prototype development the following services have been provided:

- The Ontology Framework with the basic set of ontologies and services to access it. The Ontology Framework is described in detail in D4.2. Implementation Framework (second version).

- All Core Services (with complete functionalities):
    - Human Resource Discovery
    - Working Group Composition
    - User Monitoring and Collaboration Traceability
    - Content/Knowledge Provision
    - Learning Path Creator
    - Organisational Policy
- The complete integration of IntelLEO services, and specific configuration for adapted deployment of the IntelLEO system for the different BC.

The services are developed to allow for an investigation of the key project hypotheses. In order to allow for investigation of the synergetic effects, the set of developed services have to fill-in the identified gaps in the existing solutions and provide several novelties. The Full Prototypes include several novel functionalities such as:

- The Organizational Policy service: the set of organizational policy services are basically used to fulfil needs and requirements at the organizational and administrative levels: specifying the organisational structure, harmonising the set of internal competences with the one of other organisation (e.g. university), setting incentives for competence management etc. The Full Prototype includes novel/upgraded functionality for Learning Management Module, Motivation Management Module, Privacy and security policy.

- The Learning Path Creator service: the Learning Planner service allows users to have ubiquitous access to their personal learning spaces where they can manage and attain their learning goals, composed of a set of competences, by receiving support from the social context of their IntelLEO, and also contributing back to it through sharing their learning experiences. All members of an IntelLEO, coming from various collaborative organizations, can use this service. The Full Prototype includes major updates of the view of goal progress and privacy and security policy issues as well as implementation of Learning Path Recommender and sharing of Learning Activities/Resources.

- The Content/Knowledge Provision: this service enables employees to upload different kinds of Knowledge Objects (KOs) into a knowledge repository, annotate them, and (re-)discover relevant KOs by performing semantic search over the knowledge repository. Hence, this service effectively serves as a content management system and semantic search engine within an IntelLEO. The Full Prototype included novel/upgraded functionality for the semantic search of learning resources, the measurement of semantic relatedness, user interface improvement and solution for addressing security policy issues. For Full Prototype an alternative CKP solution was also provided with all the above features.

- The main objective of the services to support collaborative LKB activities is to use extended and enriched ontological model to allow for a quick and context-aware recommendation of appropriate human resources and teams within the Extended Enterprise for collaborative LKB activities. The Full Prototype includes novel/upgraded functionality for viewing and management of User Groups, possibility for use of multi-criteria for Human Resources search and recommendation of Resources for the creation/extension of Working Groups. The main objective of the services for User Monitoring is to extend

contextual data through the monitoring of active and passive interactions with explicitly and implicitly interacted data to build and deduce a possible relevance and meaning of data to a user, and by this improve performance of other core services. The Full Prototype includes advanced functionality for definition of monitoring data (privacy issues), visualisation of the monitored information and collection of Collaboration Traceability Information.

The guidelines for the installation and the use of the main functionalities of the above described IntelLEO services are presented in the screencasts that are provided together with this report.

1 Introduction

This document presents the deliverable D4.1 Full Prototype of services and report, of the project IntelLEO, Intelligent Learning Extended Organisation. The deliverable D4.1 summarises the work realised under tasks T420 to T460, specifically for the full prototype, in workpackage WP400 Full Prototype Development.

IntelLEO aims at increasing motivation towards LKB in organisations, externalisation of tacit knowledge individually for personal development, participation in collaboration and knowledge combining practices in EO, and frequent harmonisation of individual- and organisational objectives when planning, conducting and reflecting about work practices.

Different business and organisations should be able to support their users in their LKB activities in Intelligent Learning Extended Organisations (IntelLEO). The IntelLEO framework to be developed in the scope of the project aims at proactively encouraging learners to take part in LKB activities within IntelLEOs by using advanced technology. The framework is exploiting a synergy between:

- services for efficient management of collaborative LKB activities and access to and
- supply of shared content
- services for the harmonisation of individual & organisational objectives.

Therefore, the project develops:

- a new Implementation Framework on how to exploit this synergy, taking into account the best learning practices in collaborative LBK activities for an IntelLEO
- an innovative ontological framework for learning context representation which includes learners, context and collaboration models, serving to achieve the targeted synergy
- generic and widely applicable synergetic services, fitting SOA principles, for managing collaborative LKB activities and contents within an IntelLEO as well as for . harmonisation of individual & organisational objectives

The overall methodological approach that is followed in IntelLEO is a participatory design approach. In order to allow for on-time justification of IntelLEO concept and participatory design approach, an iterative prototyping approach was followed. Several iterations were planned with three major phases: IntelLEO Concept definition, Early Prototype development and Full Prototype development.

Based on the proposed conceptual structure the implementation is separated into three Milestones: the laboratory prototype, the early and the full prototype. The Laboratory Prototypes served as functionality and proof-of-concept tests, to assess in a very early stage the possibilities and possible needs with e.g. user interactions. The RTDs further deliver a simplified but methodology- complete Early Prototype, which has been tested by the industrial partners. Further, the proof-of-concept for the full prototype has been expanded with enriched feature application and the business specific components, evolved throughout the early stages and tests. Finally, the Full Prototype has extended the previous Early Prototype by tailored key parts of IntelLEO to the specific business and overall requirements.

Whereas the Early Prototype conformed to the basic structure with simplified services, assembling the foundation for further more specific extensions and evolved by testing services, the Full Prototype implements the full feature-set of the IntelLEO methodology (ICT support for SECI within EO). The Early and Full prototypes have been developed in a strongly business and therefore end user driven cycle of design, implementation and evaluation. The analysis and evaluation during the development phases as well as the active assessment inspection ensures the desired feature implementation and minimises the project risks through continuous testing of all key elements.

This document serves to document the IntelLEO services development, i.e. Full Prototype of the core services. Then, it represents the documentation of the software developed in the scope of the project.

1.1 Document purpose

The objective of the present document is to provide an overview of the core services functionality developed within the scope of the full prototype according to the specification made in deliverable D2.3 IntelLEO Full Prototype Specification.

The deliverable D4.1 are software prototypes developed in the scope of IntelLEO's Full Prototype development, and this document provides a brief overview of the services. Also, it represents the Full Integration and the configuration required for the different systems deployed for each business case.

1.2 Document content

This document includes an overview of the functionalities covered by the IntelLEO Full Prototype. At the beginning, in section 2, an overview of the Full Prototype is provided and an explanation of how it will be deployed for the different Business cases and how it will be presented to end-users. Different functionalities are described for each service:

- Ontology Framework services in section 3
- Collaborative Learning Framework in section 4
- Content/Knowledge Provision in section 5
- Individual and Organizational Learning Framework in section 6.

After those specific sections, the integration aspects for the Core Services are presented in section 7.

The guidelines for the installation and the use of the main functionalities of the above described IntelLEO services are presented in the screencasts that are provided together with this report - see Section 2.1.

2 Presentation of the IntelLEO Full Prototype

The Full Prototype includes

- the functionalities of the core IntelLEO services,
- the integration and ontology framework to enable synergies among the IntelLEO services and with the end-users 'environments (e.g. tools, databases etc.).
- the different configuration of core services for BC specific deployments

2.1 Welcome page

The software developed in the Full Prototype are presented directly on the server in Atos used for the deployment of IntelLEO application, Users arrive on the "Welcome page" of the IntelLEO system. The objective of the "Welcome page" is to introduce and provide a quick access to the Full Prototype software. This page is available at the following URL:

(http://intelleo.atosresearch.eu/intelleo/welcome/index.html).

This page will be composed of three important parts:

- Introduction of the Full Prototype
- Presentation and tutorial of the Core Services in the form of screencasts showing the functionalities and any needed installation
- Link towards the software prototype

The following screenshot shows the "Welcome page":

Figure 1 - Welcome page of IntelLEO Full Prototype

2.2 Main functionalities

The following table provides an overview of the functionalities provided in the Full Prototype, as well as the list of functionalities that were implemented for the Early Prototype.

Before starting the Full Prototype development, the functionalities implemented in the Early Prototypes were tested, and new requirements have been formulated to implement the Full Prototype (Cf. D2.3 deliverable). Then, this table can express the efforts that were provided during the last period of development, in terms of the correction of the Early Prototype version and the new functionalities implemented.

Table 1 Overview of the functionality provided within Early and Full Prototype

No	Service	Early Prototype	Full Prototype
1	**HRD**	Preview User Profile Search Human Resources (with Competence criteria) within EO	Multi-criteria search of Human resources within EO (definition of criteria within EO) Privacy and security policy
2	**WGC**	Build a Working Group Preview the Working Group	View Working Group Status Manage Working Group Recommendation to extend WG
3	**LPC**	Managing Learning Goals Preview Learning Goals Document Learning Paths	View Goal Progress Learning Path Recommender Share Learning Activity/Resource Privacy and security policy
4	**CKP**	Upload learning resource Browse/View/Delete learning resource Annotation of learning resource with the concepts from domain ontology Tagging Keyword-based search	Semantic search of learning resources (ontologies included in the search criteria and results) User interface (configuration, options, search, filters, interaction with the search results) Measuring of semantic relatedness between tags and ontology concepts Privacy and security policy
5	**OP**	Competency Management Module (CMM); Interorganizational Management Module (IMM); Organizational Management Module (OMM); Learning Management Module (LMM) — partially designed;	Learning Management Module (LMM); Motivation Management Module (MMM); Privacy and security policy

No	Service	Early Prototype	Full Prototype
6	**UM**	Monitoring of user interaction with websites, especially MediaWiki and Elgg Parsing and indexing of document for extraction of basic data Basic version of definition of user preferences for monitoring data collection level (privacy issues)	Monitoring of user monitoring with several backend systems Advanced functionality for definition of monitoring data collection level (privacy issues) Collection of Collaboration Traceability information – monitoring of other IntelLEO services Visualisation of the monitored information (at end user's backend and social wave)

2.3 Deployment of the Full Prototype

The IntelLEO system has been implemented as a generic system thanks to the ontology framework. So, it is really easy to adapt it for different context. For this, different knowledge base could be produced to adapt the system usability in specific context.

Also, some specific tools can be connected to the IntelLEO system to respond to the BC needs. For example, Semantic MediaWiki has been selected in the BC1 by VW as a collaborative tool, and Elgg in the BC3.

Then, the IntelLEO system can be deployed in different contexts. In the scope of the project, we deployed 4 different systems. In the following, we present briefly the characteristics of each one:

- 01 - Web application for the BC1 :
    - Specific knowledge base for BC1 and full persistence mechanism
    - Full knowledge persistence mechanism
    - List of BC1 users (VW + ATB + TU Graz)
    - Functionalities focused on LPC and OP and HRD/WGC and UM
    - Tool environment based on MediaWiki

- 02 - Web application for the BC2 :
    - Specific knowledge base for BC2 and full persistence mechanism
    - List of BC2 users (FOS and INI)
    - Functionalities focused on CKP and HRD/WGC and OP and UM
    - Tool environment based on the web browser (especially Firefox)

- 03 - Web application for the BC3 :
    - Specific knowledge base for BC3 and full persistence mechanism
    - List of BC3 users (EOL and TLU)
    - Functionalities focused on LPC and OP and CKP and HRD/WGC and UM
    - Tool environment based on Elgg

- 04 - Web application for the IntelLEO demonstration (for the remote review)
    - Hosted by ATOS
    - Basic knowledge base (Linux competence)
    - Very simple knowledge persistence mechanism
    - Only few users creation
    - All functionalities available
    - Tool environment based on Elgg

3 Services of the Ontology Framework

Figure 2 illustrates the position and role of services of the IntelLEO Ontology Framework within the overall IntelLEO software architecture. As the figure suggests, these services serve as an intermediary between the IntelLEO ontologies and RDF repositories (i.e., RDF triple stores) on one hand, and the IntelLEO Core services on the other. Accordingly, it could be said that these services form a kind of middleware layer in the overall IntelLEO software architecture. Their main purpose is to hide the specificities of working with ontologies, RDF, SPARQL and other related technologies from the other services, primarily IntelLEO Core Services. The other services will simply work with 'regular' Java classes and interfaces (i.e., Java POJOs from the Application Domain Layer) and all the tasks related to the storage, retrieval and update of ontology instance data are handled by the services of the ontology framework.

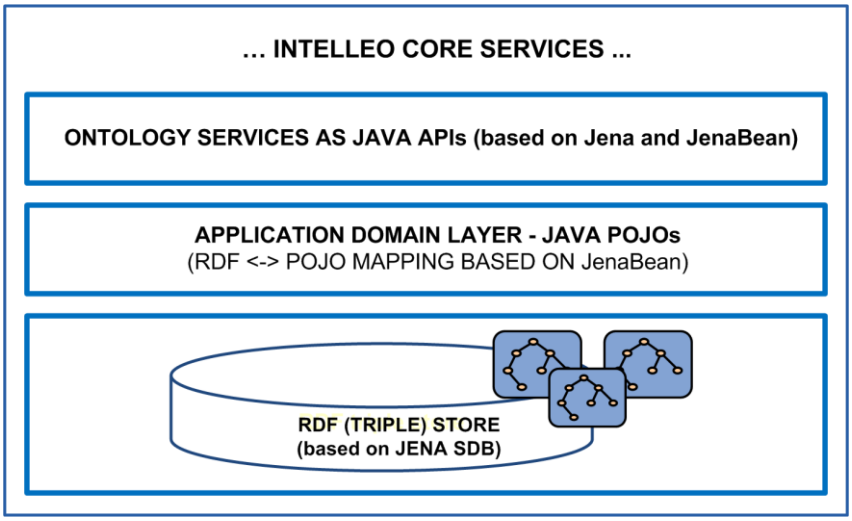


Figure 2 - Services of the Ontology Framework in the IntelLEO software architecture

All services of the Ontology Framework are implemented in Java and are accessible trough Java API. The implementation relies on Jena[1] and JenaBean[2] open source software frameworks. The former offers a rich Java API for working with ontologies and ontology instance data, whereas the latter facilitates bidirectional mappings between ontology-based data models and Java POJO (Plain Old Java Objects).

The primary functionality of these services is the support they offer for managing ontology instance data stored in the RDF repositories. This includes storage, retrieval, update, and deletion of RDF data. Specifically, these services allow for:

- retrieval of all the instances of the given type/class (defined by the provided Java POJO that corresponds to the desired ontology class);
- retrieval of a specific instance or a set of instances based on the given: 1) URI of the instance(s), or 2) SPARQL SELECT query;
- update of the ontology instance data based on the given SPARQL CONSTRUCT query (e.g., generation of new relationship(s) among certain instances)

[1] http://jena.sourceforge.net/
[2] http://code.google.com/p/jenabean

- storage/update/deletion of a specific ontology instance (i.e., all RDF triples related to that instance) based on the provided POJO instance to be stored/updated/deleted;

- storage/update/deletion of a set of ontology instances (i.e., all RDF triples related to the instances in the set) based on the provided collection of POJO instances to be stored/updated/deleted.

Besides these generic data management services, there are also data retrieval services customized to the data requirements of different IntelLEO Core Services. So, for example, there is a service that (upon request) can retrieve all learning goals of a certain user, or all users having a certain learning goal, or all events related to a certain learning goal, etc. To respond to such specific requirements of the IntelLEO Core Services, these services make use of the SPARQL query language which allows for the construction of very complex queries on top of RDF data. Specifically, based on the data requirements of the IntelLEO Core Services, the appropriate SPARQL queries are defined and 'wrapped' into Java methods, so that Core Services can access the required data through regular Java API calls.

To provide the described functionality, these services make use of the JenaBean framework. By enabling seamless bidirectional mapping between an RDF data model and Java POJOs, JenaBean enables developers to manipulate their data using the well known object-oriented data manipulation principles and practices. Although it offers a lot of advantages when working with RDF data, JenaBean also has some deficiencies that had to be resolved in order to make the services of the Ontology Framework fully operable and efficient.

One serious problem that was detected is that JenaBean does not maintain a session with an object it creates to represent a resource from the repository (as most of the Object Relational Mapping frameworks do). This issue caused several objects representing the same resource to exist simultaneously in the Java Virtual Machine (JVM), leading to potential 'dirty reads'[3] and memory leaks problems. This issue was resolved by using Google Guava[4] collection's MapMaker class which provides a map for storing weakly referenced objects which, if not referenced by any other class, will be disposed by the Java's Garbage Collector. So, our improved JenaBean framework is using MapMaker to store all JVM instances it creates and which, if not used by any part of the application, will be disposed.

Besides the management of ontology instance data, services of the ontology framework are also responsible for the creation of specific data models required by IntelLEO Core Services. This functionality is needed as the data model defined with the IntelLEO ontologies though required for the seamless data integration and running of very specific and complex queries, is not necessarily the exact data model required by specific data consumption services, especially those that are responsible for presenting data to the end users (i.e., handling user interfaces). Accordingly, there was a need to develop services that map the data stored in the RDF repository to the data models required by different IntelLEO Core services. These services have already been described in Deliverable D2.3.

[3] http://en.wikipedia.org/wiki/Isolation_(database_systems)#Dirty_reads
[4] http://code.google.com/p/guava-libraries

4 Collaborative Learning Framework

4.1 Human Resource Discovery CS

4.1.1 Introduction

Some prerequisite to connect the end-user to be connected in the IntelLEO web application.

First, if the user does not have an account, he should create a new one thanks the registration page. Basic information related to the user should be filled. (Services to retrieve existing resources of the user, i.e. the organisation).

Secondly, the user can login himself to start a session of the IntelLEO system. Then, he can have access to the different resources that have been defined by default or created by other users. Then, the user is logged in an can access to the different services of the IntelLEO system. In this section, we will be focused on the HRD and WGC services.

Finally, when he wants, he can leave the session with the logout action.

Now, we will describe the different windows that refer to the Human Resource Discovery. This corresponds to the different pages available in the window opened by clicking on the HRD-WGC (Cf. Figure 3).

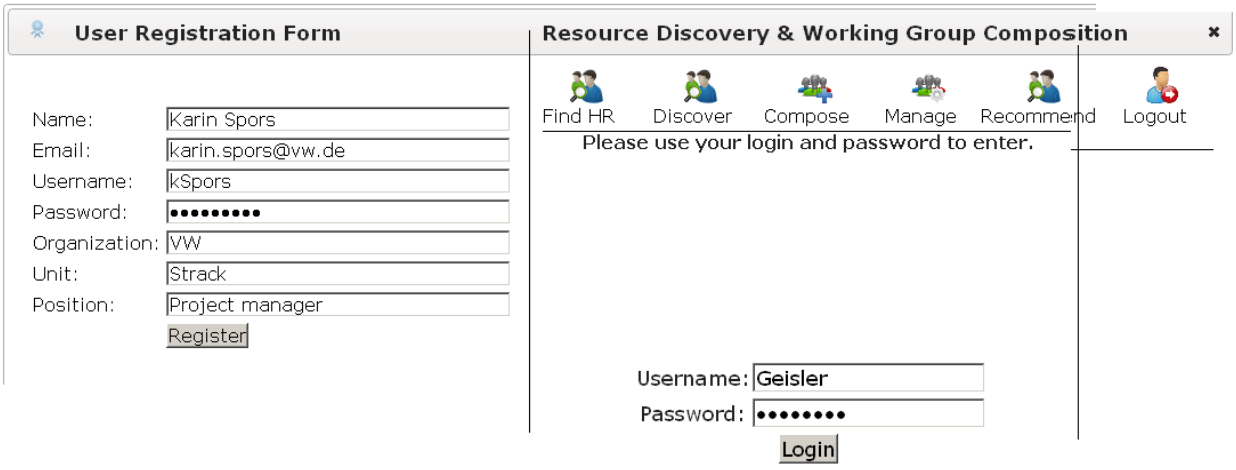


Figure 3 - Set of the main services to register / login / logout

4.1.2 View the User page

The first page of the HRD is the information page of the user. It contains several information about the current status, and about news that have recently appeared. A quick review of each part of this page is provided.

- Inbox: the inbox of the user corresponds to the different messages received by the users in terms of social networking. When the user is invited to join a working group, the corresponding message is available there.
- Competence: in this panel, the different competences achieved by the user or still in progress are listed.

- List of the Working Groups: also, the user can access to the current WG is belongs to. He can sort them according to the status (finished, in progress, no started).
- Documents: another panel group all the information related to the most relevant information handled by the user. Most commented, most tagged, etc.
- Schedule: finally, the user can consult his own calendar. There all the WG dates are listed and eventually the tasks planned by the group. But essentially, informal tasks.

An example of this page is provided in the following figure (Figure 4).

Figure 4 - Tabbed panel of the User Page

4.1.3 Find Human Resources

The second page is dedicated to the search person, social networks or organisations. This service aims to retrieve specific resources in the knowledge base. That's why, it implements many different SPARQL query templates that could be filled by the user. Of course, the SPARQL part is no visible by the user, but this part is covered by the UI sections. Then, the UI is organized in three different tab panels for each specific type of search: human resources, working groups, and organisations.

Only informative objective can motivates the user to use this service. But the result can be combine to follow a social activity (invite in WG, create a WG, contact people, etc.)

For every type of search, a basic search can be done by the user. It consists to select a type of information (i.e. between an expert, relevant partner, or working group initiator for the Person Type), and a name.

Also, an advanced search is possible. Instead selecting only a type (or concept) and value as described previously, the user can add different criteria to refine the search.

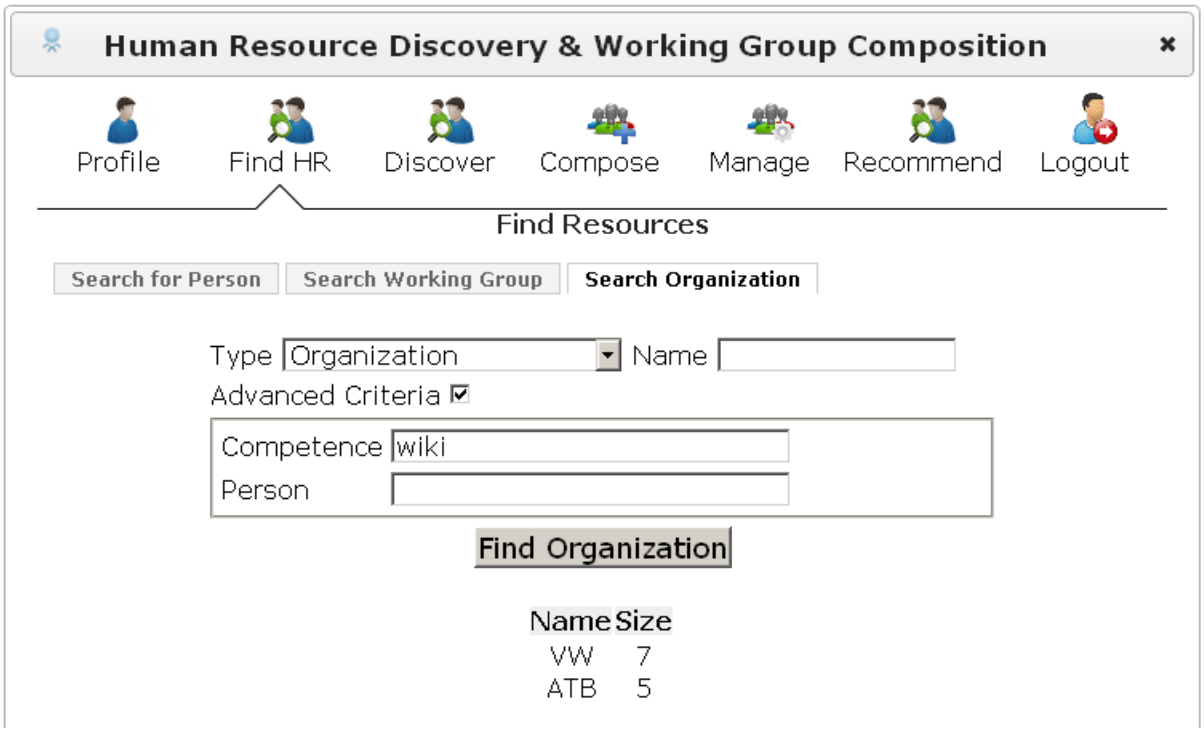


Figure 5 - Multi-dimensional search for human resources

For each type, the different possibilities of search will be described:

- Search for a person

The literal search can be started form a name value. Then, in the case of too much result, the user can select very different criteria to constraint more the query. One criteria level is the type of users looked for. The objective can be to retrieve an expert, a potential member, or a WG initiator.

The second level of criteria is the social network quality. Searched people could be outside, or inside the user organisation, or if this do not have importance both. For example, in a working group, it can be useful to create a group with a heterogeneous social network with people inside and outside the organisation. Finally, another criteria level is related to the relevant resources linked to the user. For example, this can refer to one competence achieved by the user, some tags mostly used, or a specific LP.

The following picture shows an example of filled query panel.

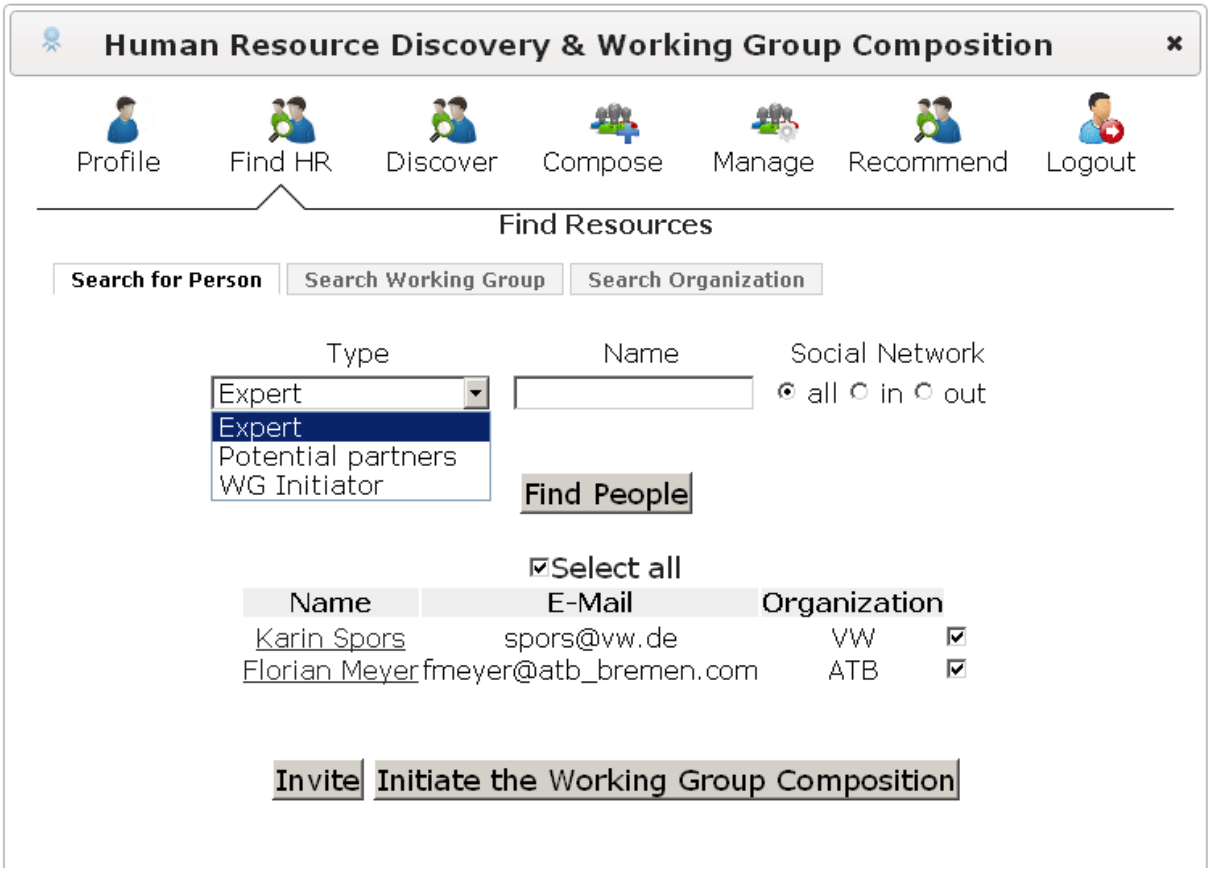


Figure 6 - Criteria to search for people

- Search for a Working Group

The simple query to retrieve a working group is to fill the free text with a label that could be in the group name or the description. Then, he can filter the results by adding more criteria. The first one is relation to the size of the group. It is very different to find a small group (less then 10 people) or to find a huge group or community (more than 100 people). In between, the user can retrieve an intermediate group called big group and that contains between 10 and 100 people. The second criteria contain two values to differentiate the formal group to the informal groups. The formal groups are created explicitly from the WGC, and the informal ones are based on implicit relation between people realized in the LPC. Finally, the last criterion is also related to the resource. One resource description can be used to refine the query. In the organisation case, three criteria have been selected:

- Person: select the name of person or several people to retrieve the WG they belong to.
- Competence: select one competence to retrieve all the WG they have targeted to achieve.
- Tags: select the tags that characterize the WG (especially in the WG description).

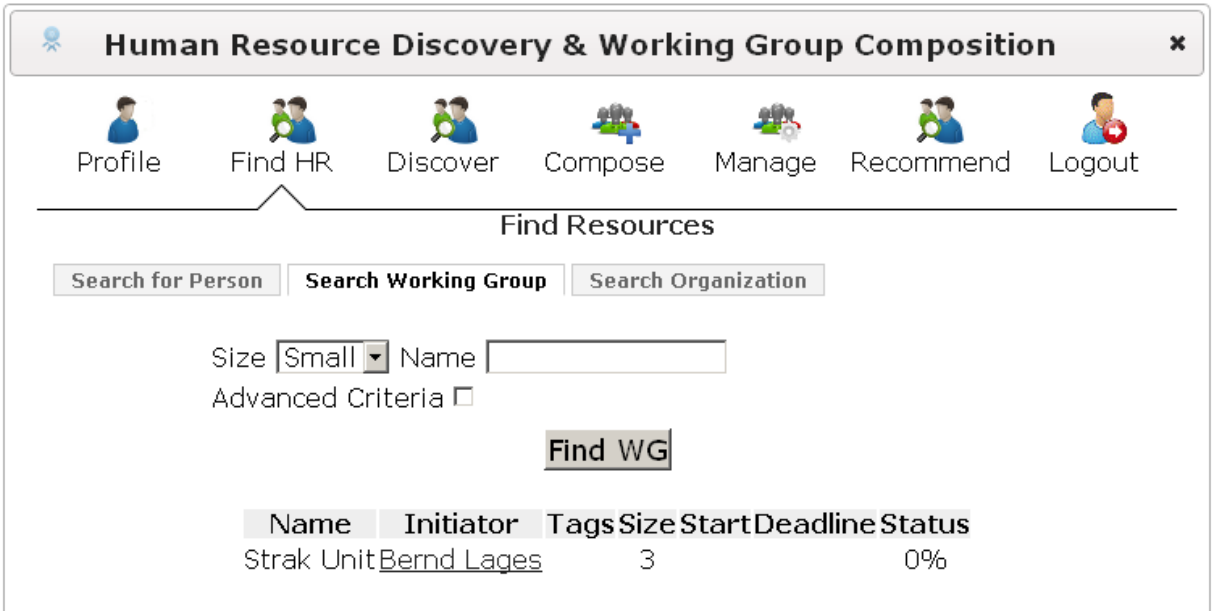


Figure 7 - Criteria to search for working groups

- Search for Organisations

In the case of the organisation, it is quite similar to the working group search. Keywords that are contained in the organisation name or description can be used as a simple query.

Then, as previous example, the query can be enriched with several criteria. The first one permits to differentiate the organisation to the Extended Organisation where the last one is a set of organisations that have regular activities together. The second criterion is related to the person that belongs to the organisations or EO.

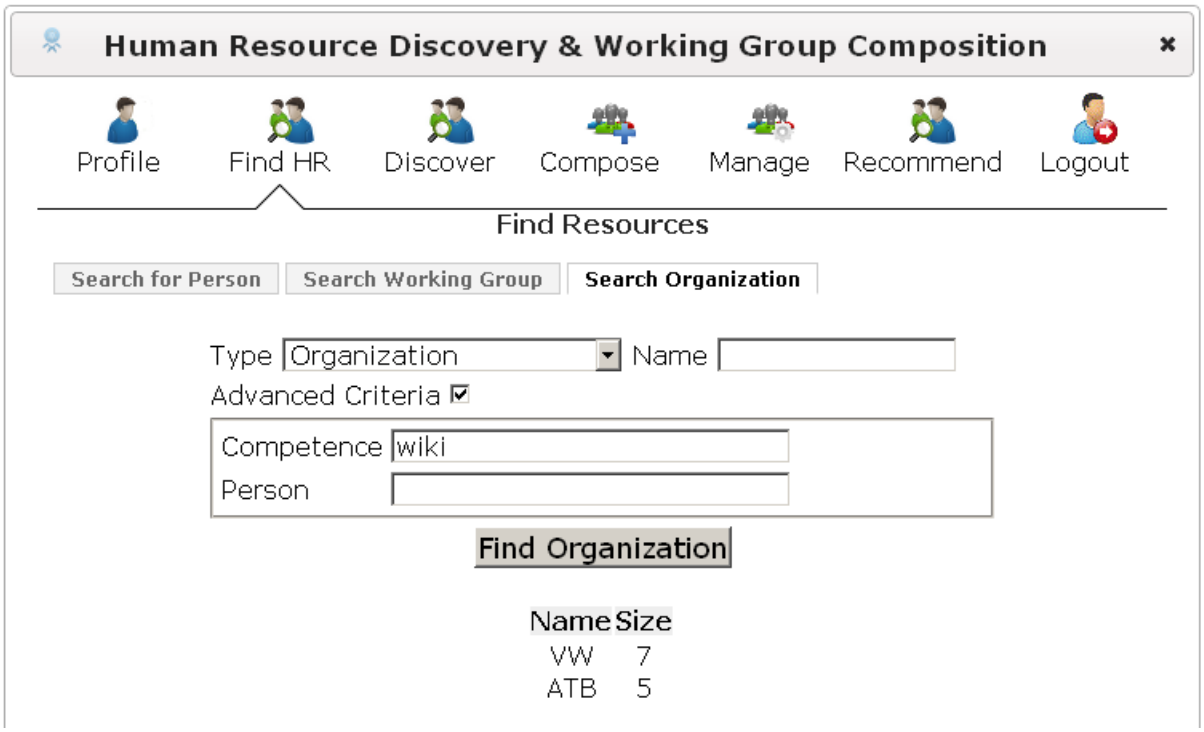


Figure 8 - Criteria to search for organisations

- Result handling (ranking and filtering)

According to the query (very open, or very restrictive), the system can return many results. The results are presented in a table with the different characteristics. Then, a sorting method can be applied on every characteristic. This kind of faceted information is very useful for the user to select the relevant information.

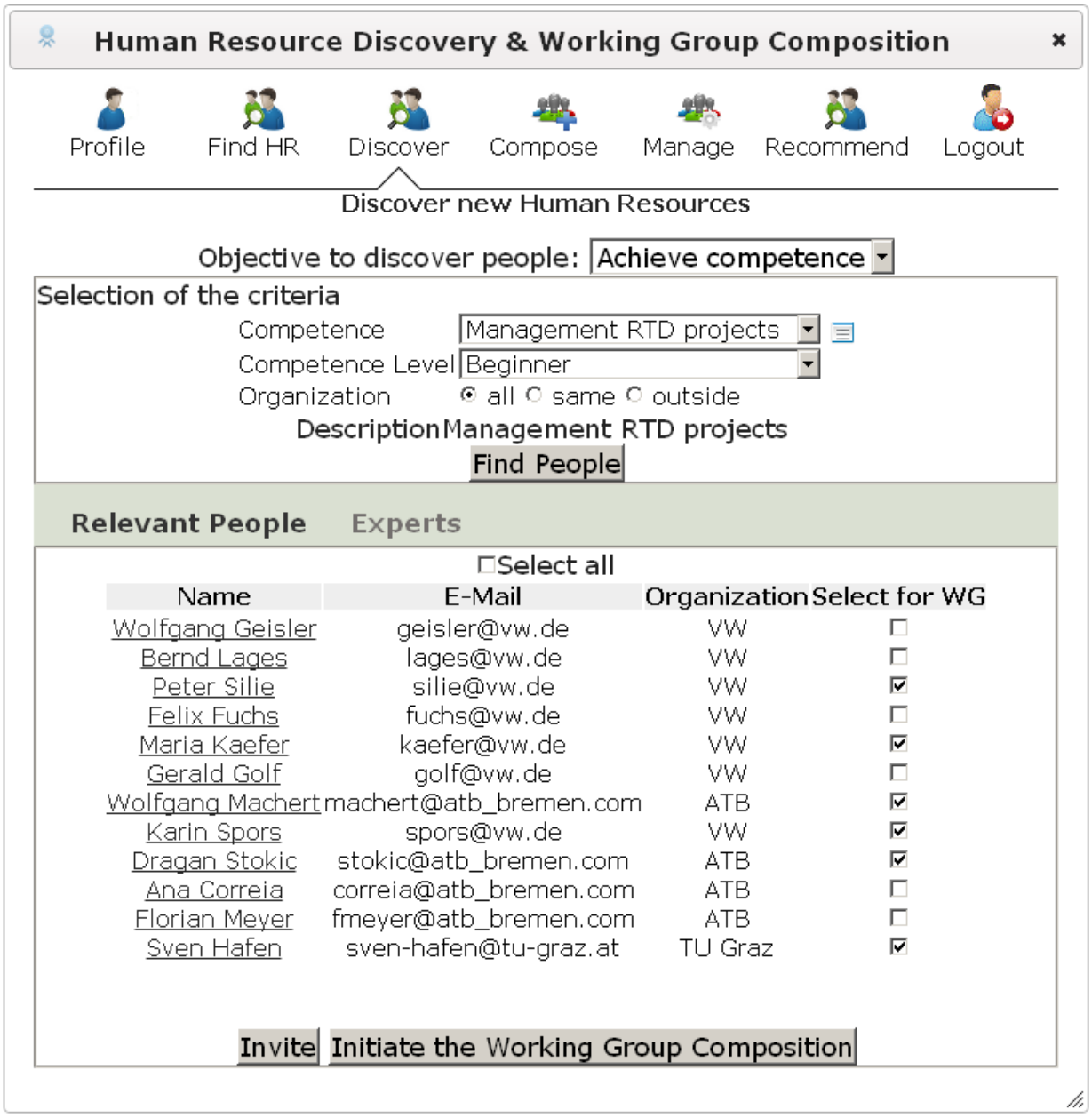


Figure 9 - Handling of the HR search

4.1.4 Discover Human Resources

The third service called Discover human resources is also a search service, but the objective to use this service is not only informative. The goal of the HR discovery is to build a working group where collaborative activities will be performed.

The final objective has an important impact on the HR search. Then, this objective is taken into account to search human resources and is considered as contextual criteria for the search. For the IntelLEO system, three contextual criteria have been defined for the Discover service:

- Contextualized activity (from search, LPC, and CKP)
- The different objective to create a WG can be selected in the Discover page or from another service. For example, if the user wants to achieve a competence from the LPC and

he wants to create a WG to work collaboratively on it, he can select it in the LPC and click on a menu entry called “Create a learning group”. Then, the system redirects the request from the LPC into the HRD. And activity focused on an objective (high integration with the WGC)

This mechanism is also possible from the CKP to create a WG based on the objective to “follow a topic”. Thus, with this kind of service integration, we can say that the HRD can be used as a contextualized tool because from a specific task performed by an IntelLEO service, it is possible to use the current information (or context) to realize a new task related to the previous one.

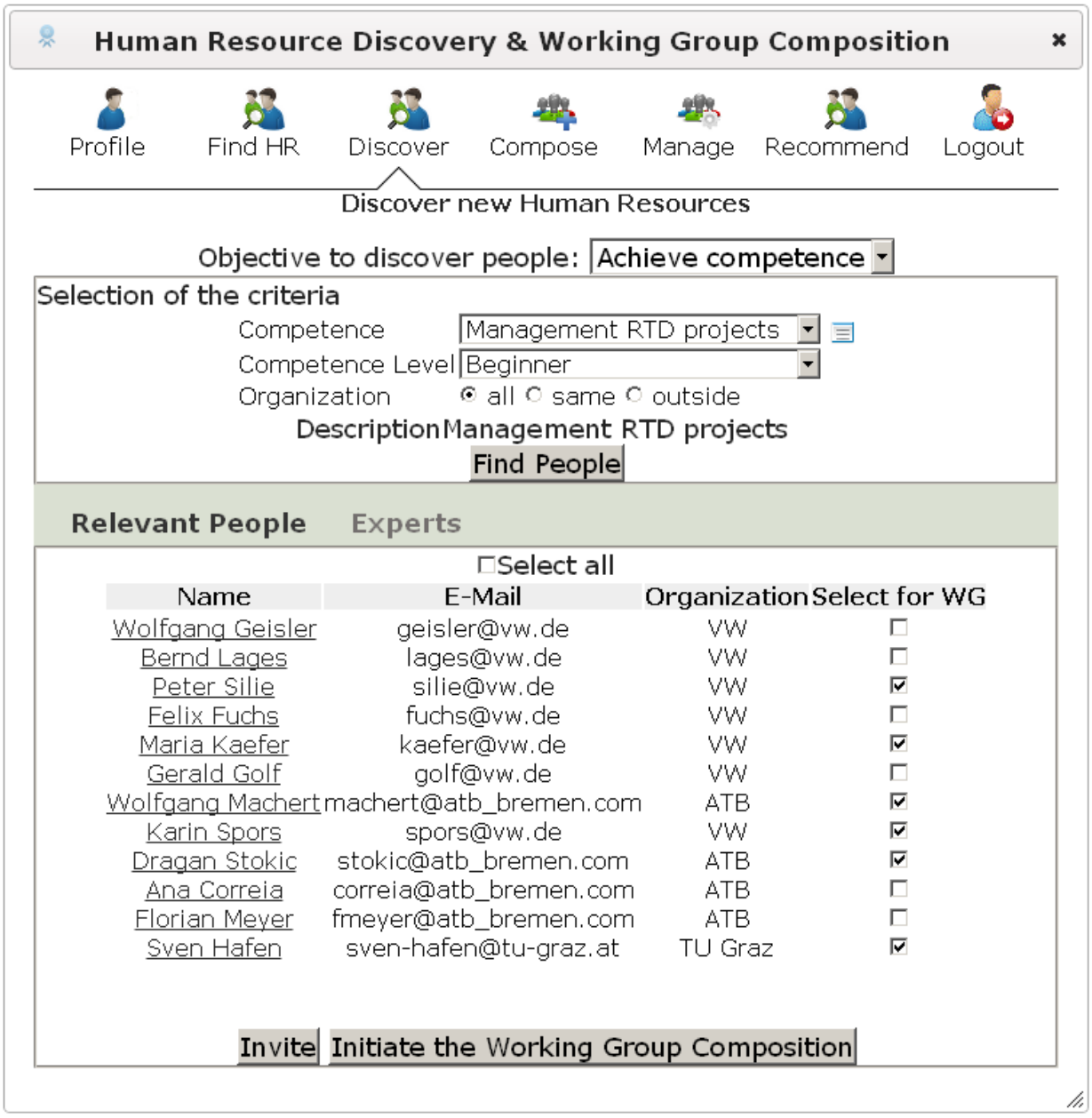


Figure 10 - Discover human resources

- User discovery (contextual search)

Introduced like this, we can say the Discover service is a contextualized search of human resources. So, in this case, one resource used in another context can be used as search criteria. If we get back to the example of the competence selected in the LPC, (for example, edit wiki con-

tent"), the user can click on it to start a HR discovery process in order to build a WG to achieve this competence. Then, this information is used as basic criteria to search relevant partners. This main criteria can be completed by other one to refine the request. For example, the target of the social network can be defined by selecting between 3 different options: people that only belong to my organisation, people that are only outside of my organisation and people that could be inside or outside of my organisation.

Also, a tree panel with the different competences can permit to see the hierarchical organization of the competences and to select a super competence in case nobody has been found, or a sub-competence in the case too many people are retrieved.

Figure 11 - Query editions to discover HR

- Selection of relevant partners and expert

Then, the user request is translated in SPARQL and the system project this query RDF repository to retrieve the matching triples.

The results are presented as a list of users. To different kind of users are retrieved: the relevant partners who are people that have the same objective ("to achieve the select competence" for example), and the experts who are people who already the user objective, and then they can help to achieve also. In the application, those results are displayed in two different tab panels.

Figure 12 - Results selection to initiate a working group

- Query refinement

If the different results do not satisfy the user expectation, he has the possibility to refine the query. In this case, he can change the criteria previously selected to refine his request. Then, he should re-click on the search button to trigger the new request and get the new results.

- And finalization functionalities

Finally, when the system returns relevant list of potential members, the user can select some of them to initiate the WG. When the relevant list is selected, the user has two different possibilities:

The first one consists to create a new working to realize collaborative activities. In this case, he should click on the “Initiate the working group” and he will be automatically redirected towards the WGC service. There, he will be able to describe the working group he wants to build.

Also, the user has the possibility to use the discover service to invite people in existing WG he already created. Then, the working group can be extended thanks to the HRD.

4.1.5 Recommend Human Resources

The last functionality of the HRD is the recommendation part. This service provides contextual recommendation of people. Contextual recommendation means that according to one or several criteria of the work environment of the user, the system can select relevant person to work exchange or build new knowledge.

- Mechanism to compute the similarity

The HR recommender is based on algorithms that compute the similarities between different kinds of resources.

The recommender system can provide recommendations based on one contextual dimension (social network, tags, competences), but it can also combine several dimensions.

Firstly, the mechanism of the mono-criteria recommendation is presented, and the mechanism of criteria combination will be described.

- Mono-criteria for similarity

The principle of the recommendation algorithm based only on one dimension calculates all the occurrences of the selected used by the user, and do it for the other users. Then a comparison between the most relevant resources is done for all the users and provide the list of the people who are using also the similar resources.

- Combination of criteria (Design pattern)

In the case of the multi-criteria combination, the score obtained for each dimension can be combined with another one. Based on the design partner mechanism, two or several criteria could be combined, and this is the average that is displayed to the user.

Then, people could be recommended regarding on dimension or a combination of dimensions.

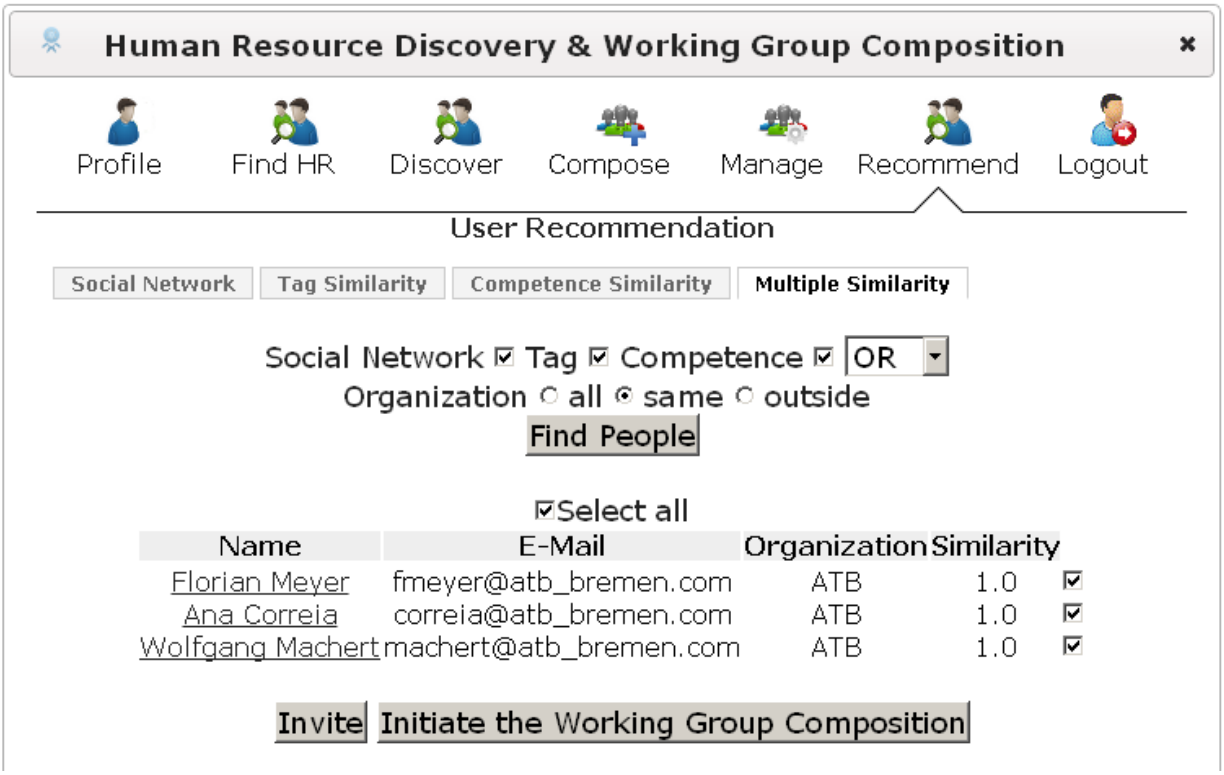


Figure 13 - Recommendation of human resources

4.2 Working Group Composition CS

4.2.1 Compose the Working Group

As explained before, the WGC is based on the results of the HRD service. The task related to the group composition consists to invite people that could have the same objective to work together. Then, the HRD permits to find relevant partners, and the WGC allows to organize them in a group to start collaborative activities.

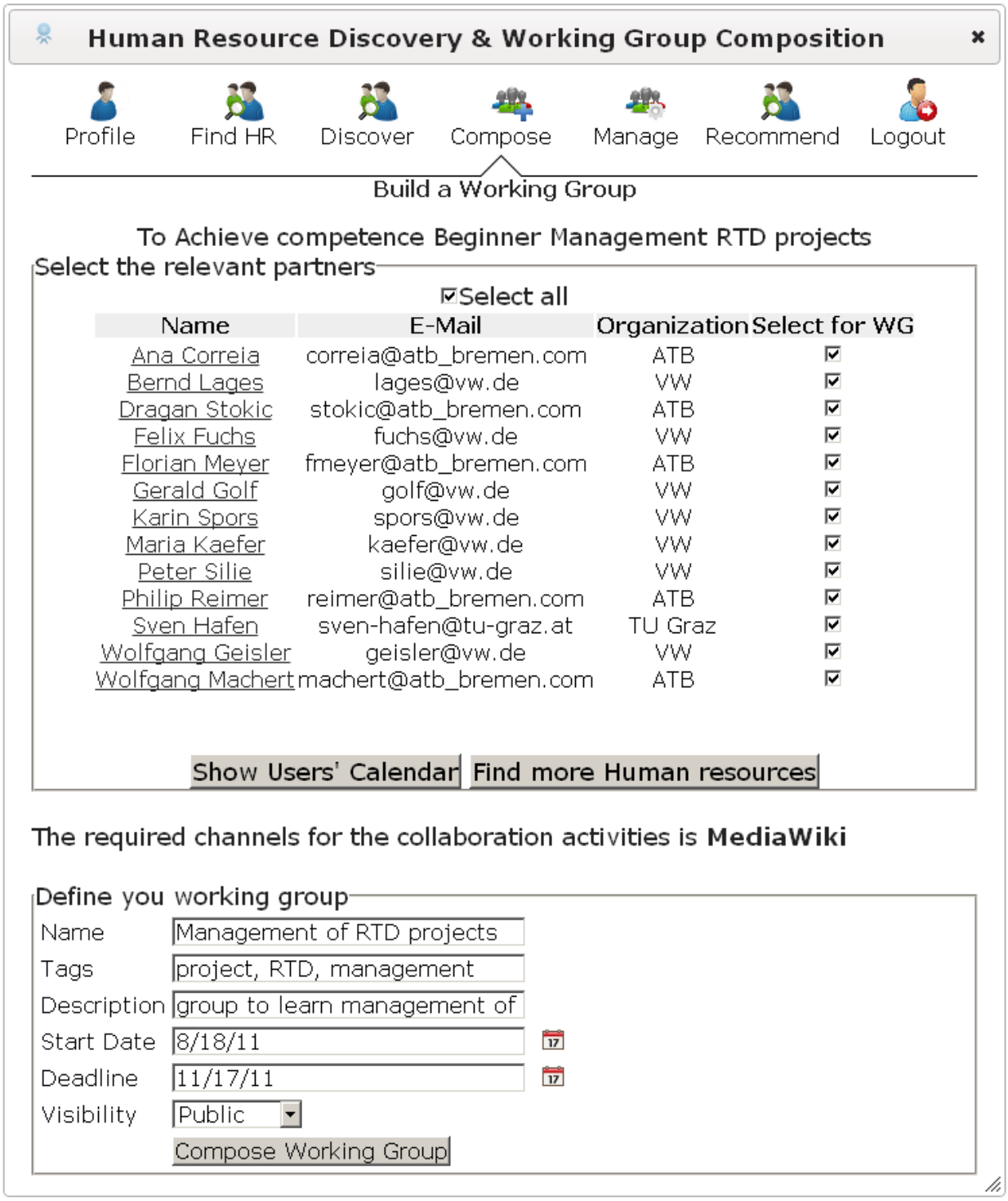


Figure 14 - Build a Working Group

So, regarding the HRD results, two options are possible. If the results are not satisfying the expectation of the users (for example, not enough people), the user has the possibility to refine the query. In this case, he should click on the button called "Find more Human resources" and he will be automatically redirected towards the HRD where he will be able to find more relevant partners.

The second option is when all expectations of the user are satisfied and he can start the process to compose the new WG. In the "Compose" page, he has the main tasks required to create the new WG.

The first task consists to select the list of people that will be invited to join the WG. From the list obtained in the HRD, the definitive selection of future group members can be done.

Figure 15 - Selection of the potential partners

The second task is related to the description of the working group. Different fields should be filled to have the possibility to create the new group. Important information to describe the WG is the name, some tags, and a description. Moreover, a timeframe is required to specify the start date of the group, and the possible end of the project.

Before the start date, people will be able to join or not, and the group initiator will be able mange/organize the group. Before the end date, the entire objective should be completed.

Then, when the WG is fully completed, the user can click on the button called “Compose the Working Group”. This action implies the creation of the temporary group of people and sends a invitation message to every potential member. Also, the user who created the WG is registered as the initiator of the WG. Then, he will have specific rights to manage the WG (Cf. Group management section in page 29).

In the system, two different periods have been defined for the WG composition.

The first one corresponds to the creation period. It starts when the user initiate the WG and finishes when the group activities really starts. During this period, the potential members have receive the email message and they can accept or reject the invitation. If they accept, they will be automatically added in the group list, and they will be able to participate to the group activities.

If they reject the invitation, they will be removed from the member list of the group.

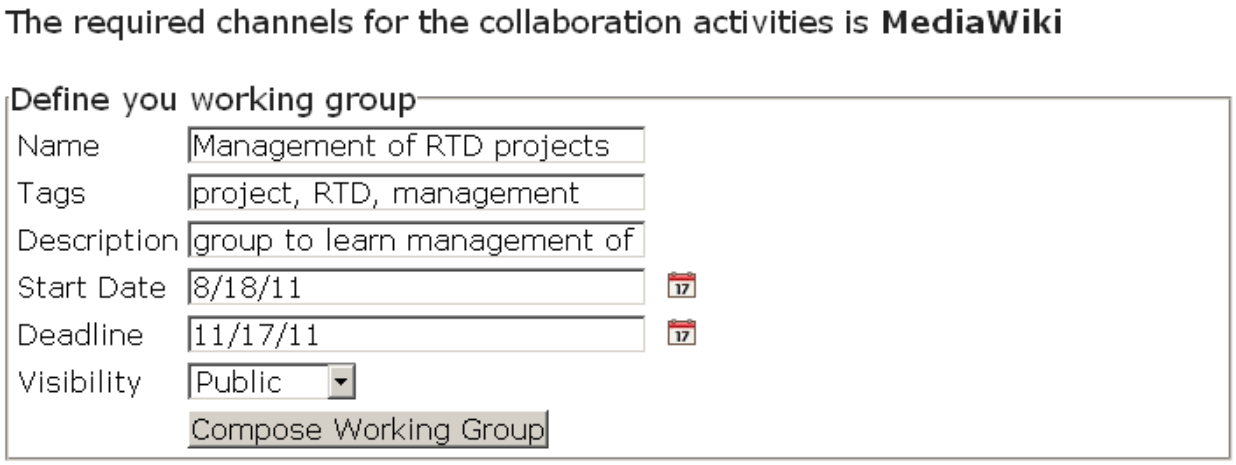


Figure 16 - Description of the working group

The group newly formed is a very structured group with one initiator and specific goals to be achieved. It also exists an informal way to build groups, but in an informal way. In the LPC, it was implemented the possibility to create informal groups based on the sharing activities of the learning goals. If people have shared one learning goal, and they are doing some changes on it, it will affect other persons. This can be considered as a collaborative development of learning goals that are performed inside informal groups.

4.2.2 View the Working Group

When the WG is created, the system displays the user page with the "Working Groups" tab panel open. The new group has been added to the user list of groups. Then, the user can click on it to see the group details.

There, the user can see the general information of the group (name, schedule, the criteria selected to create the new group, etc.) and the list of the members, and especially their acceptance status.

From this page, the user can go back to his user page or to go in the group management page if he is the initiator of the selected group as it is described in the next paragraph.

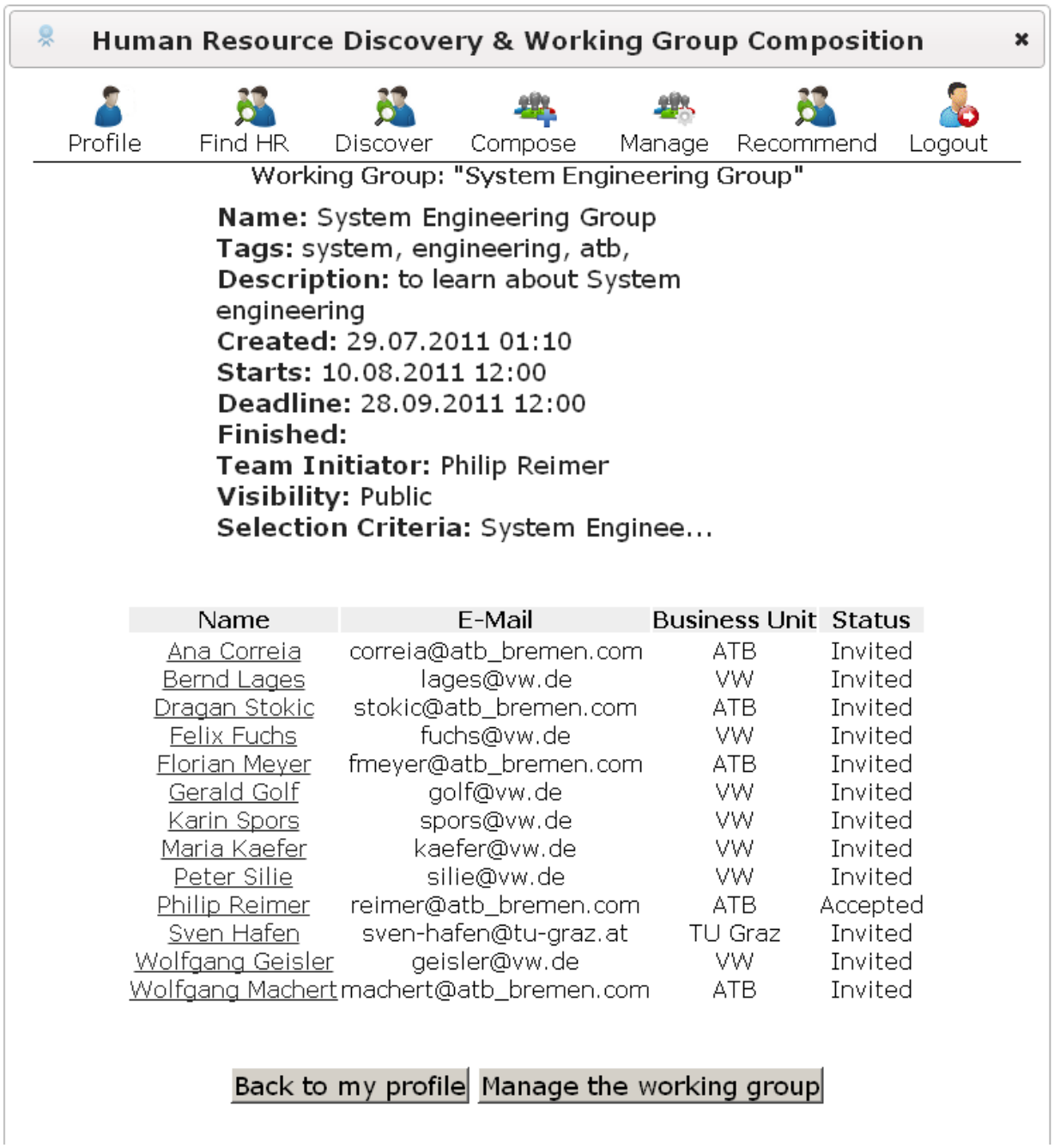


Figure 17 - Preview of the WG

4.2.3 Manage the Working Group

The management page is dedicated to organize and modify some elements of the working group. This section is especially important for the people who already created a working group with the IntelLEO system. Three kinds of management are available.

The first tab panel is dedicated to the members' management. After selecting one working group, the initiator can go to this page to modify the list of the group members. If people are not active in the WG, the initiator can decide to remove him.

But from the HRD, he has the possibility to invite people. For example, he found an expert that could help to achieve learning goals, the initiator can invite him to join the group. With the same mechanism, the expert will receive the invitation message and will be able to accept or reject it.

Figure 18 - Management of the members of the group

In the project management tab panel, the group manager can modify the timeframe to postpone the deadline for example, if the objectives to be achieved are delayed.

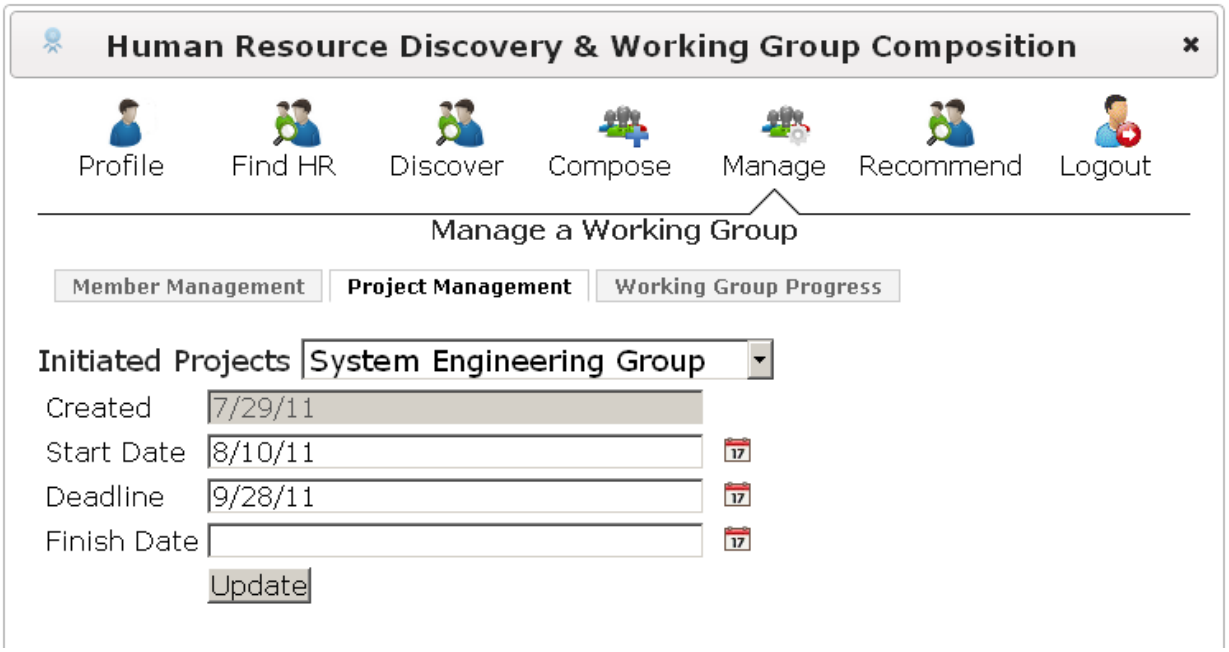


Figure 19 - Modification of the group schedule

Finally, the last functionality of the group management is an information service that provides the current status of the different WG of the user.

Also, it is possible to filter the group display according their current status (Future, Started, and Finished).

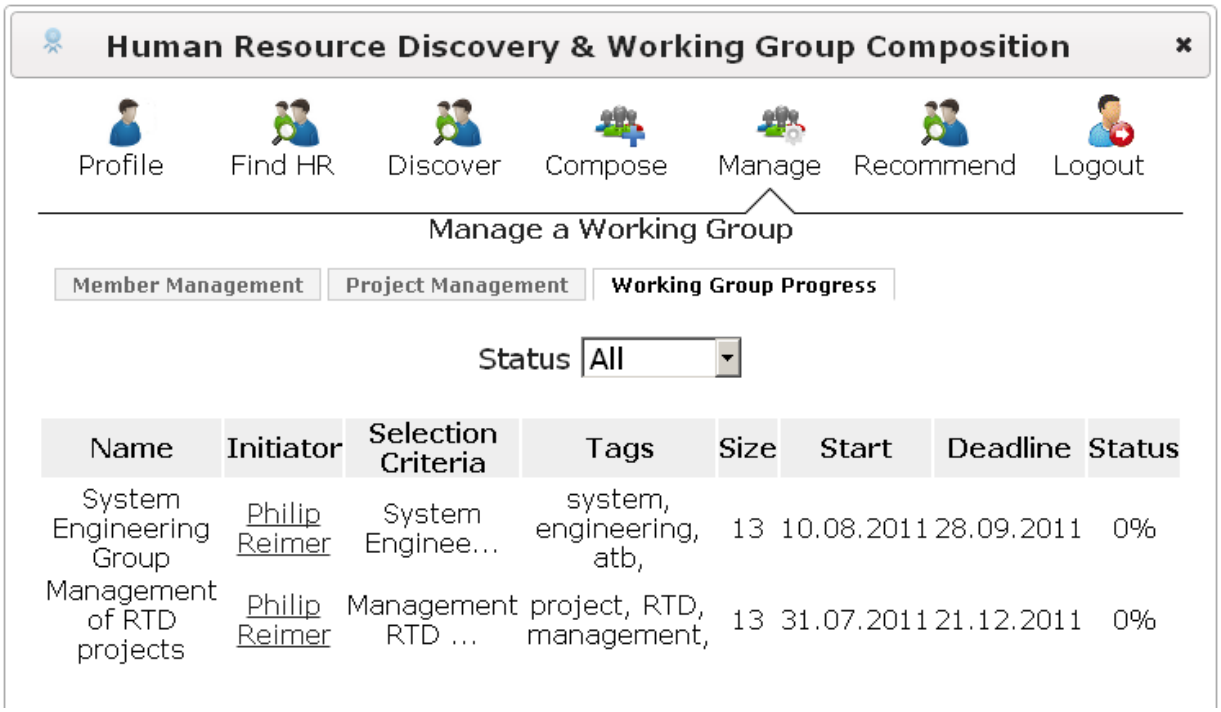


Figure 20 - Status of the working groups

4.2.4 Integration with external tools

The WGC has an impact on the knowledge base, but also he has an impact on the external tools used by the user. In the different context of BC, different tools have been selected to realize the individual or collaborative activities. The environment tool is pre-configured at the beginning of the session and depends on the different BCs. For each BC, the tool will be introduced and the actions realized from the WGC will be described:

- In the BC1, the selected tool is MediaWiki. This is an edition tool to create collaboratively new content. Then, in this context, when the WGC is solicited to create an new WG, it also create a new wiki page. All the members have the link of this page and are able to add content there. This page is accessible from the WG page.
- In BC2, this is the classic web browser that is used. In this context, the search of innovative information and the annotation of those resources are very important.
- Finally, in the BC3, this is the Elgg tool that is used to organize the e-learning activities (group, classes, resources).

4.2.5 Back to the HR recommendations to update the WG

At the end, we presented all the service that can be used to retrieve and to organise collaborative acclivities with them. As the HRD, the WGC is integrated with external tools, and every functionality is ubiquities to be used when it is really required. This is especially true for the HR recommender that was presented with the HRD. This functionality can be used whenever the group or the user needs to find and collaborate with more people.

The different dimension to get relevant HR recommendations will not be detailed here (Cf. section 4.1.5), but this the button invite available there, it is possible to add new member in the selected WG (of course if the person has accepted the invitation).

4.2.6 Synergies with other services

Table 2 – Synergy of the HRD/WGC service with the other IntelLEO services

No	Service Functionality	Main innovation	Synergy among other services
1	Find Human Resources	Retrieve specific resources in the knowledge base	LPC, CKP
2	User Discovery	Allowing users to discover human resources based on contextualized activity	LPC, CKP
3	Recommend Human Resources	Recommendations based on contextual dimensions (social network, tags, competences)	LPC, CKP, UMCT
4	Working Group Composition	Group composition to work together. Creates new wiki page and new Elgg group element for collaboration between group members	External tools

4.3 User Monitoring and Collaboration Traceability CS

The user monitoring and collaboration traceability service has the following main functionalities developed:

- Monitoring of website to extract information on the use of resources by a user
- Monitoring of IntelLEO services main activities
- Possibility for the user to see the monitored information both from the end user environment as well as from the IntelLEO services
- Functionality to allow each user to define to what extent her/his activities should be monitored

4.3.1 Monitoring of website

The User Monitoring and Collaboration Traceability (UMCT) service implements functionality to monitor a website, in particular a MediaWiki and Elgg systems. The UMCT service functionality has no user interface, it works in the background of the legacy system, in this case MediaWiki and Elgg, and does the monitoring of a specific set of interactions that the user has with the MediaWiki or Elgg in question. At the moment these interactions include:

- open a page,
- create a page,
- edit a page,
- upload a document,
- bookmark a page or
- delete a page.

This set of interactions may be extended and may vary according to the system being monitored and the use of the monitored data.

The information is collected by an extension installed on the MediaWiki (or Elgg) side and passed to the UMCT web service where the activities performed by the user are then saved in the ontologies repository.

The main objective of these services is to extend user profiles through the monitoring of active and passive interactions with explicitly and implicitly interacted data to build and deduce a possible relevance and meaning of data to a user, and by this improve performance of other core services.

4.3.2 Monitoring of IntelLEO services main activities

The functionality that monitors the IntelLEO main activities records certain events occurring during the use of IntelLEO services, such as the creation of a learning goal, addition of a competence to a learning path or the creation of a learning group by a certain user. This functionality is further detailed in section 6.1 as the social wave is also part of the LPC and is most visible there with respect to the reuse of the monitoring data by the users.

Also this functionality has as a main objective to build and deduce a possible relevance and meaning of data to a user.

4.3.3 Visualisation of the monitored information

The monitored data may be visualised in two different ways:

- In the social wave panel in the LPC (see section 6.1)
- In the end-user environments – at the moment MediaWiki and Elgg.

4.3.4 Definition of monitoring level

In the Full Prototype of the User Monitoring and Collaboration Traceability service, it is possible for the user to define in a fine-grained way what information the service is allowed to collect for the user in question (see Figure 21). On a first level the user may choose between the three options:

- Everything – all user interactions with the system will be monitored and stored with relation to the user
- Custom – the user can define for each specific activity if this activity shall be stored or not
- Nothing – no user interaction of this user with the system will be stored

Furthermore, the user can select for each of these settings, if the monitored data shall be stored in anonymised form, i.e. the activity or event will be recorded but without connecting it to the particular user.

When choosing "Custom", the user has the possibility to choose for every activity and event that is being monitored, if this should be recorded or not (see Figure 21). The respective activities and events are:

- Create or edit a page/document
- Delete a page/document
- Restore a page/document
- Subscribe to a page for changes
- Upload a document
- Search for a page/document
- Log in/Log out

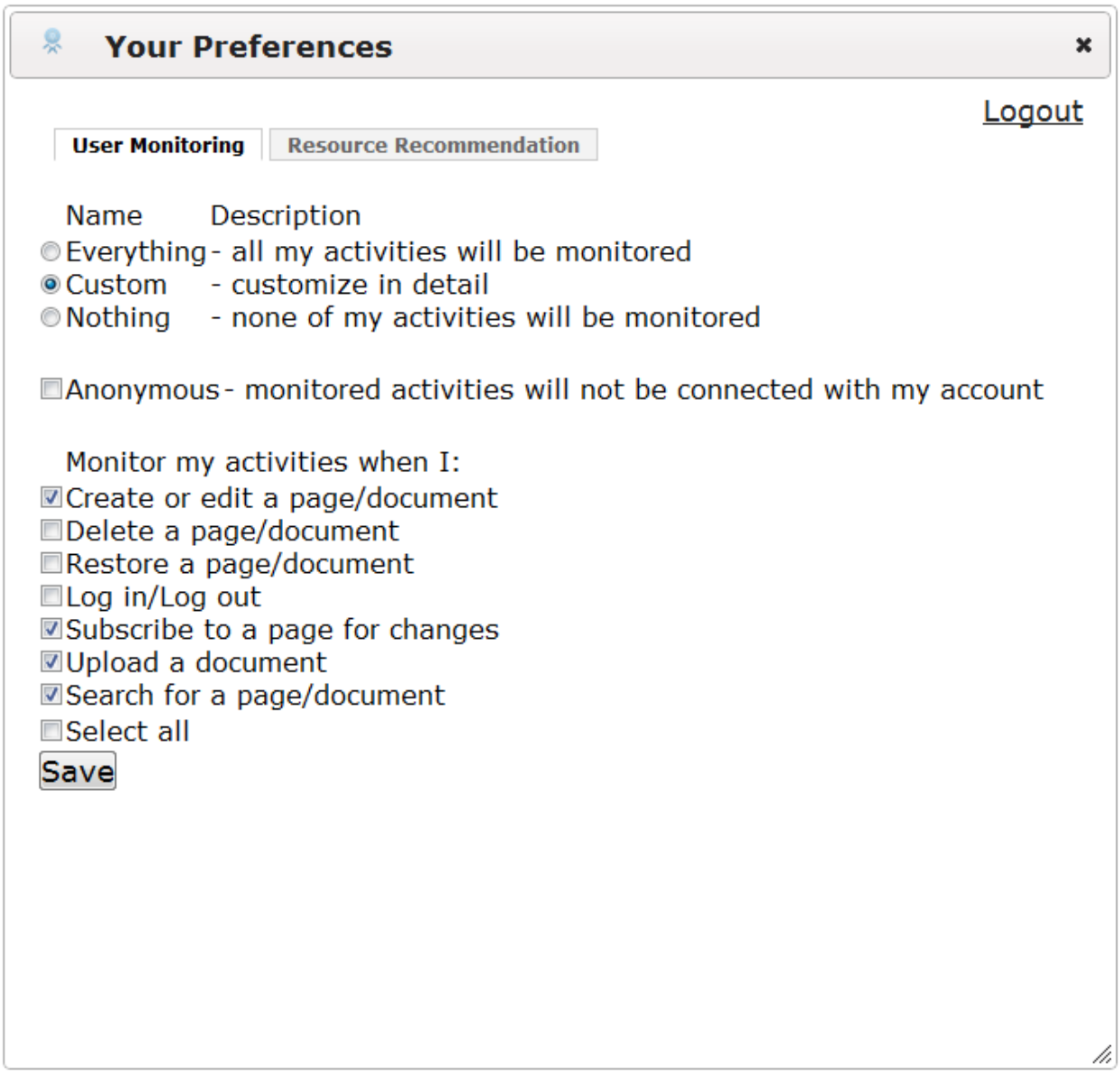


Figure 21 - Panel for definition of the user preferences with regard to the information to be monitored

4.3.5 Synergies with other services

Table 3 – Synergy of the UMCT service with the other IntelLEO services

No	Service Functionality	Main innovation	Synergy among other services
1	**Monitoring of website**	• The user's interactions with her/his everyday environment are monitored and used for improvement of information provided to the user, i.e. to better provide resources and knowledge to a learner, which is relevant to his situation and requirements. • the service does not rely on system events or states but directly monitors user interactions with	LPC

No	Service Functionality	Main innovation	Synergy among other services
		the environment.	
2	**Monitoring of IntelLEO services main functionality**	The user's interactions with IntelLEO services are monitored and used for improvement of information provided to the user, i.e. to better provide resources and knowledge to a learner, which is relevant to his situation and requirements.	LPC, HRD, WGC, CKP
3	**Visualisation of the monitored information**	See section 6.1 – Social Wave and Analytics	LPC
4	**Definition of monitoring level**	The user may provide in a very detailed form what activities and events can be monitored, if this monitoring should be made anonymous or not or even if nothing is to be monitored.	-

5 Content/Knowledge Provision

5.1 Content/Knowledge Provision CS

5.1.1 Introduction

Content/Knowledge Provision service aims at locating and retrieving appropriate learning and knowledge objects and making them accessible either to members of an IntelLEO (i.e., to end-users) or to other IntelLEO services, taking into account the specifics of the user's learning context. Based on somewhat different requirements coming from the three business cases in this project, two implementations of the Content/Knowledge Provision Service are provided in the full prototype. The first one is tightly coupled with the other core services. The second one is more standalone.

The Content/Knowledge Provision Service provides three major functionalities (use cases):

- bookmark/upload knowledge objects into a designated repository
- manage (view/browse, update, delete) uploaded knowledge objects
- perform semantic search of knowledge objects repository

5.1.2 Content/Knowledge Provision User Interface

The two versions of the Content/Knowledge Provision service (CKP) implemented in the full prototype exemplify running the service from within a Mozilla Firefox Web browser. The first version, Figure 22, enables running the service from the so called IntelLEO toolbar. To do this, all one needs to do is install a Web browser add-on for interacting with CKP and, indirectly, the other IntelLEO services; it is done in a couple of mouse clicks. The add-on is represented in the IntelLEO toolbar with three buttons – *IntelLEO*, *Upload*, and *Resources*. (The toolbar can be easily hidden/shown at any time, using the browser's Tools/Options menu.)

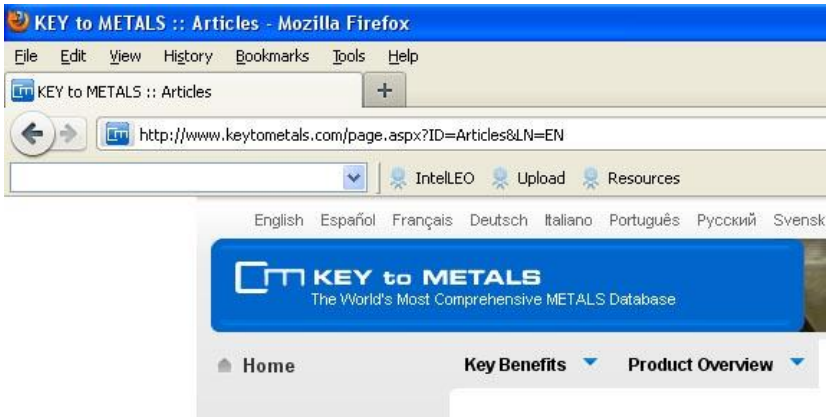
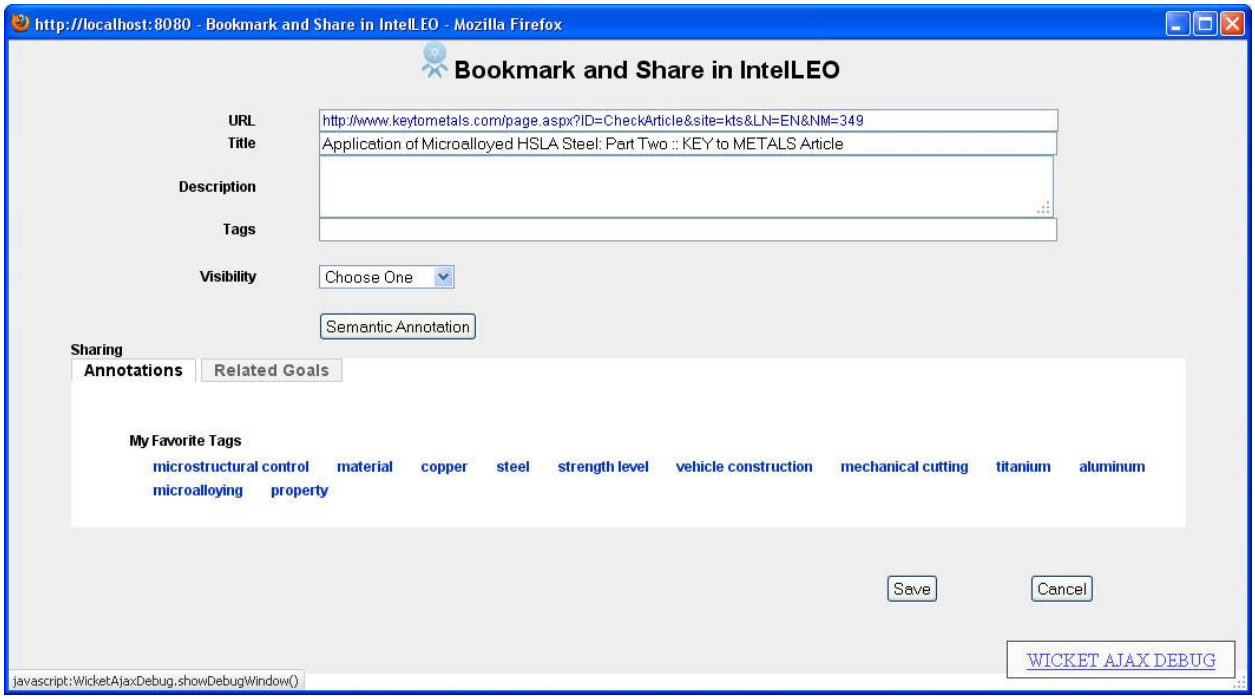


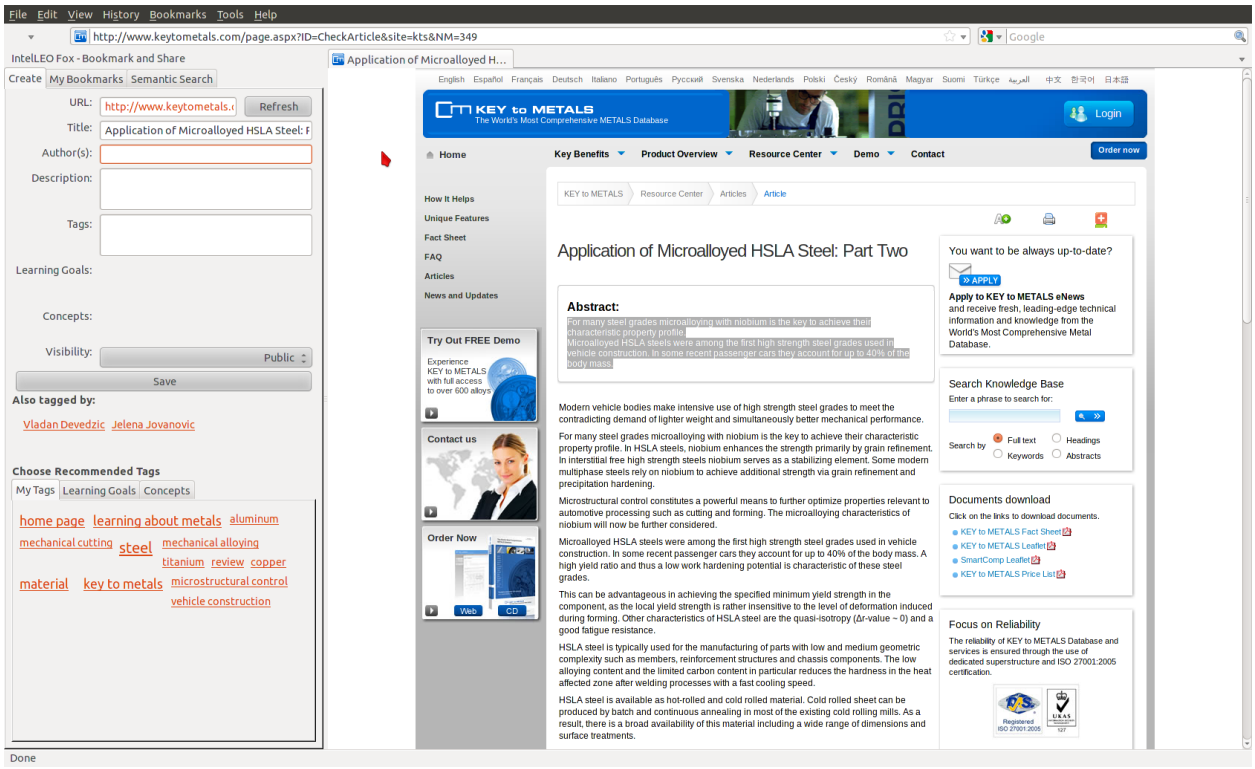
Figure 22 - IntelLEO toolbar

5.1.3 Bookmarking and uploading knowledge objects

Assume that a knowledge/learning object/resource (e.g., a Web document) pertaining to BC2 is shown in the browser, Figure 22. Clicking the *IntelLEO* button opens the dialog shown in Figure Figure 22a. Alternatively, when the second (standalone) version of CKP is used, the user opens it as a browser sidebar, Figure 23b.



(a)



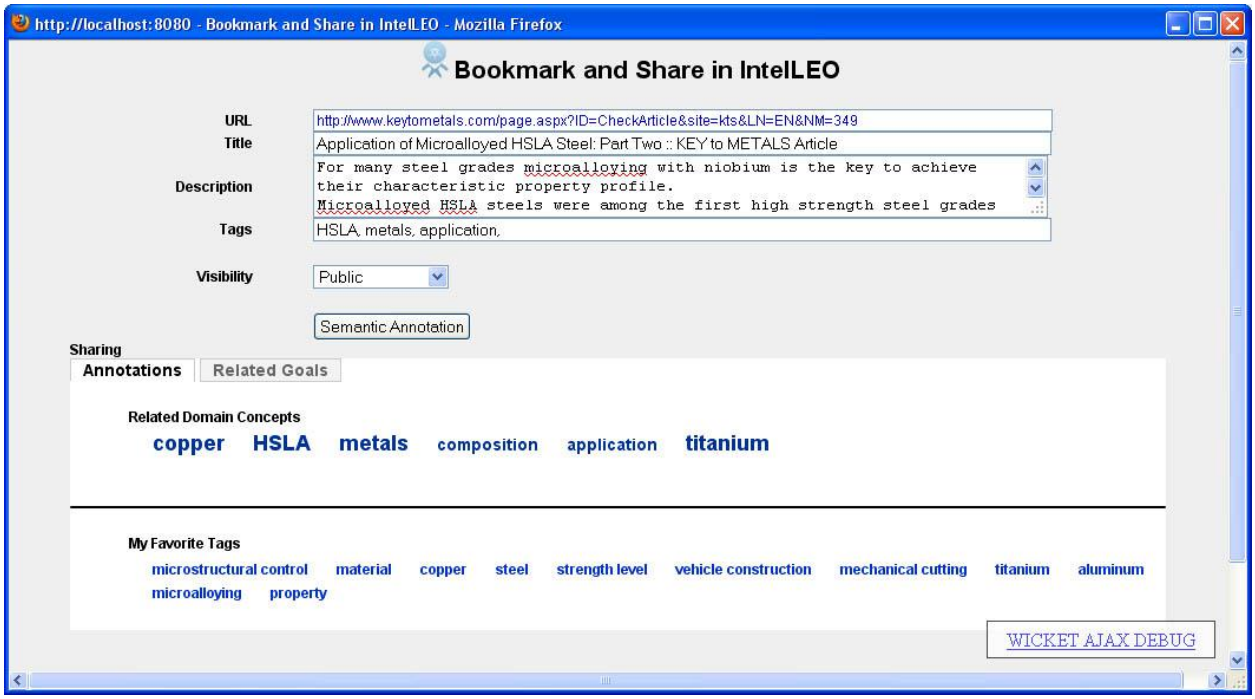
(b)

Figure 23 - a) Bookmarking/Uploading learning resources by interacting with the IntelLEO toolbar b) Bookmarking/Uploading learning resources by interacting with the CKP sidebar

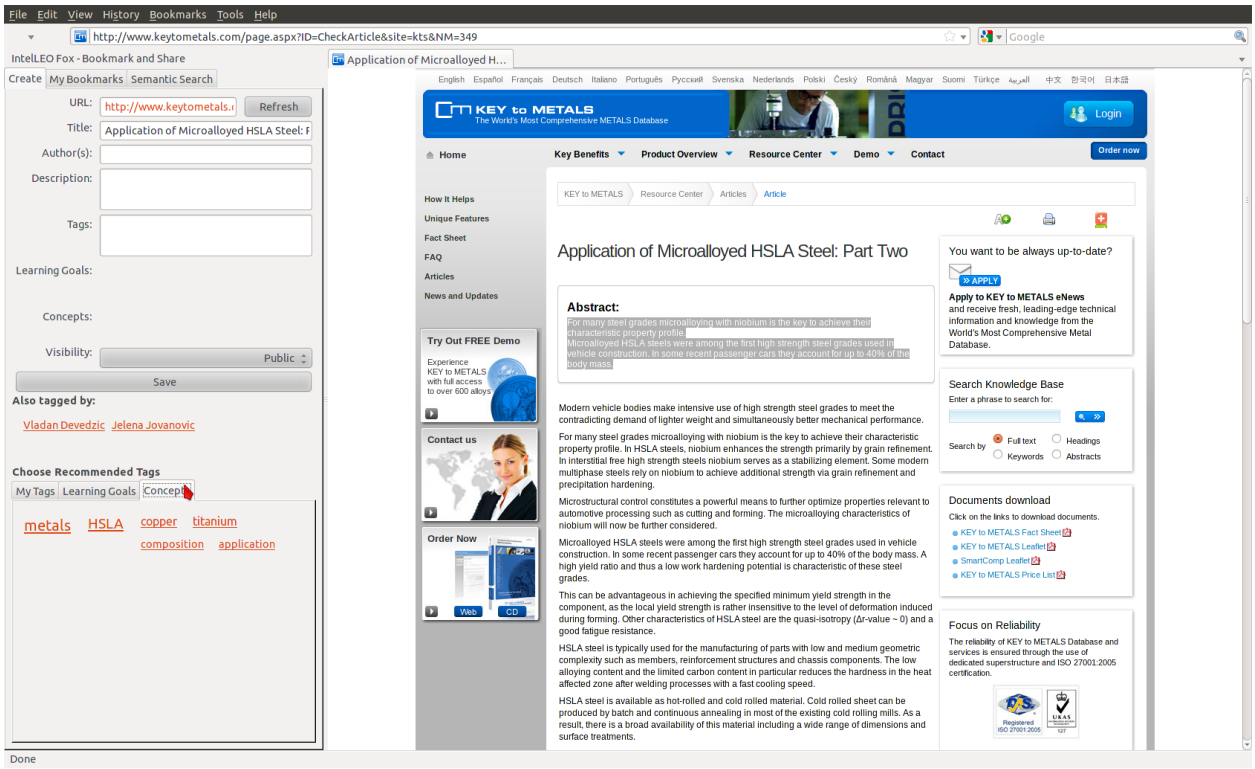
There are three types of available annotations for the learning resource (knowledge object) to be annotated:

- metadata corresponding to commonly used vocabularies (Title, Author(s), and Description in Figure 23)

- concepts from the domain ontology; these are extracted automatically when the *Semantic Annotation* button is clicked (Figure 24a), or when the *Concepts* tab is clicked in case of Figure 24b (the domain ontology used in the examples is the *Metals* ontology from BC2)



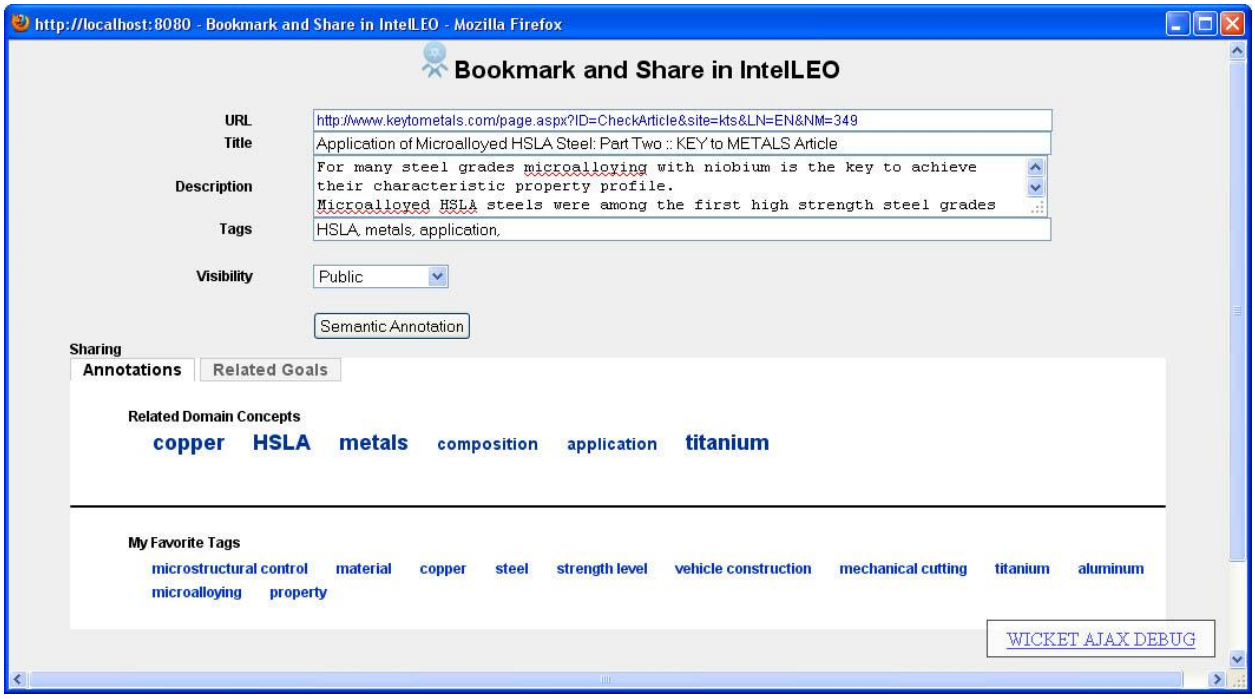
(a)



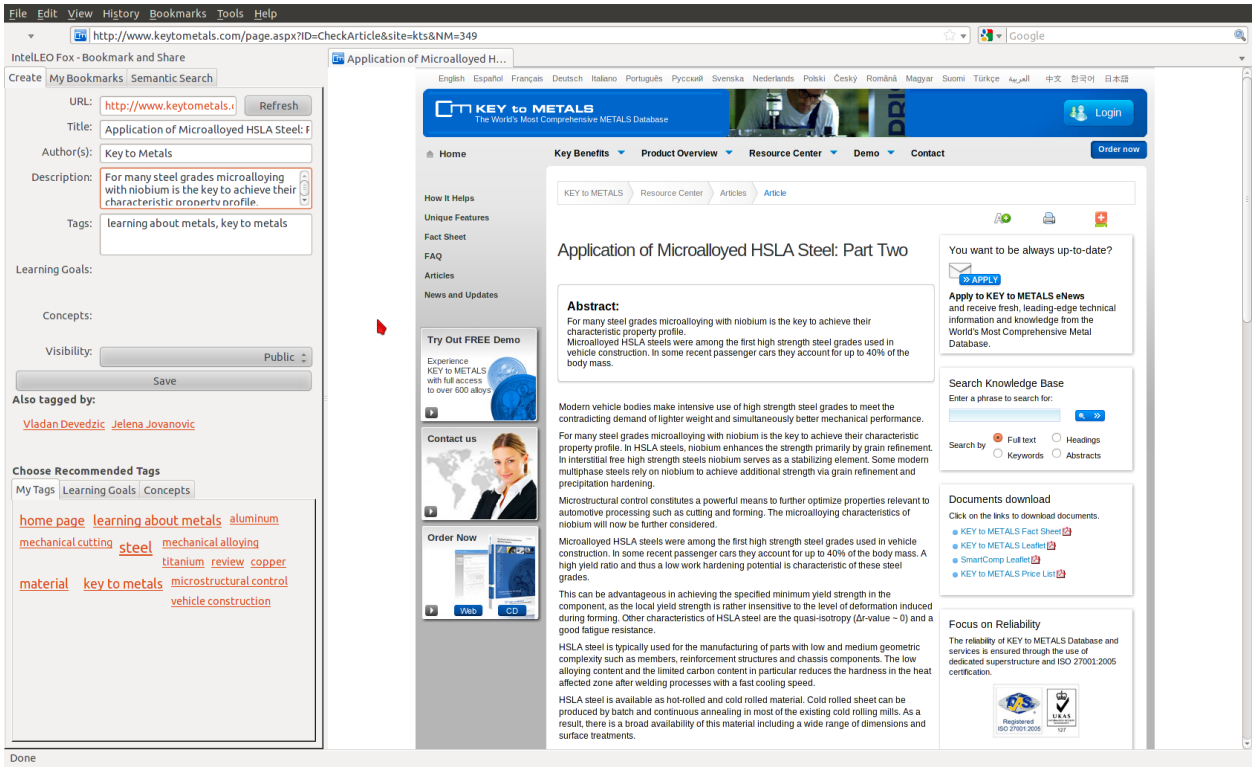
(b)

Figure 24 Annotation with concepts from domain ontology a) using the IntelLEO-toolbar version of CKP b) using the CKP sidebar

- user-defined tags (these are stored in the repository as instances of the ann:Tag class and are entered directly or by clicking them in *My Favorite Tags / My Tags*), Figure 25



(a)

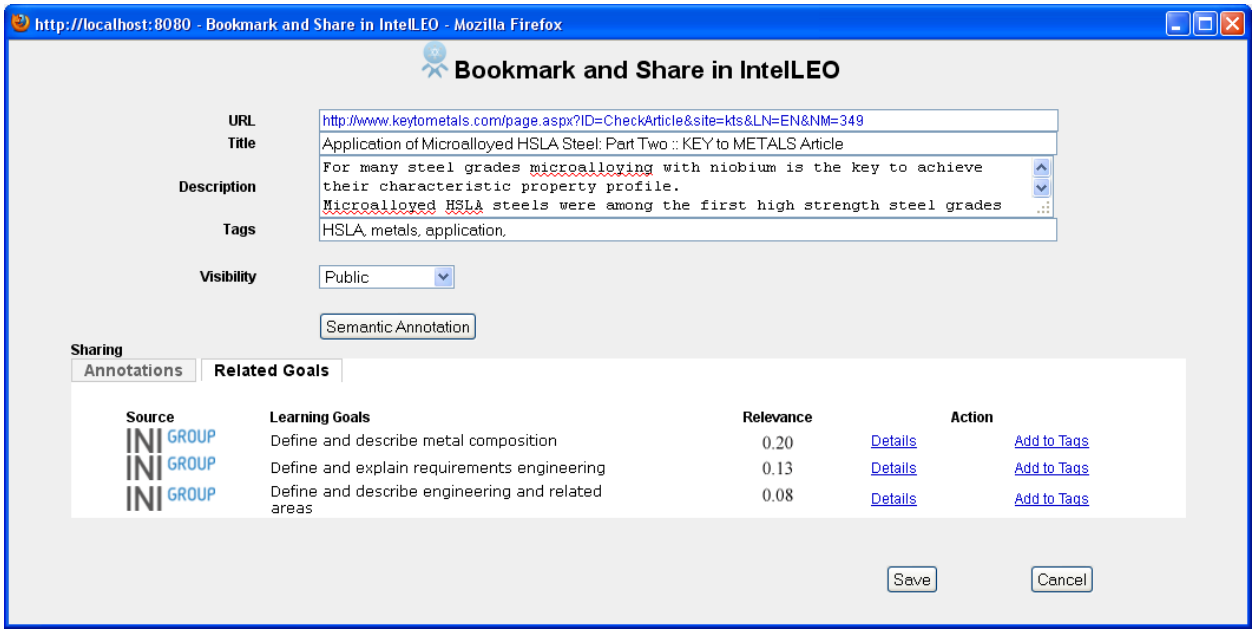


(b)

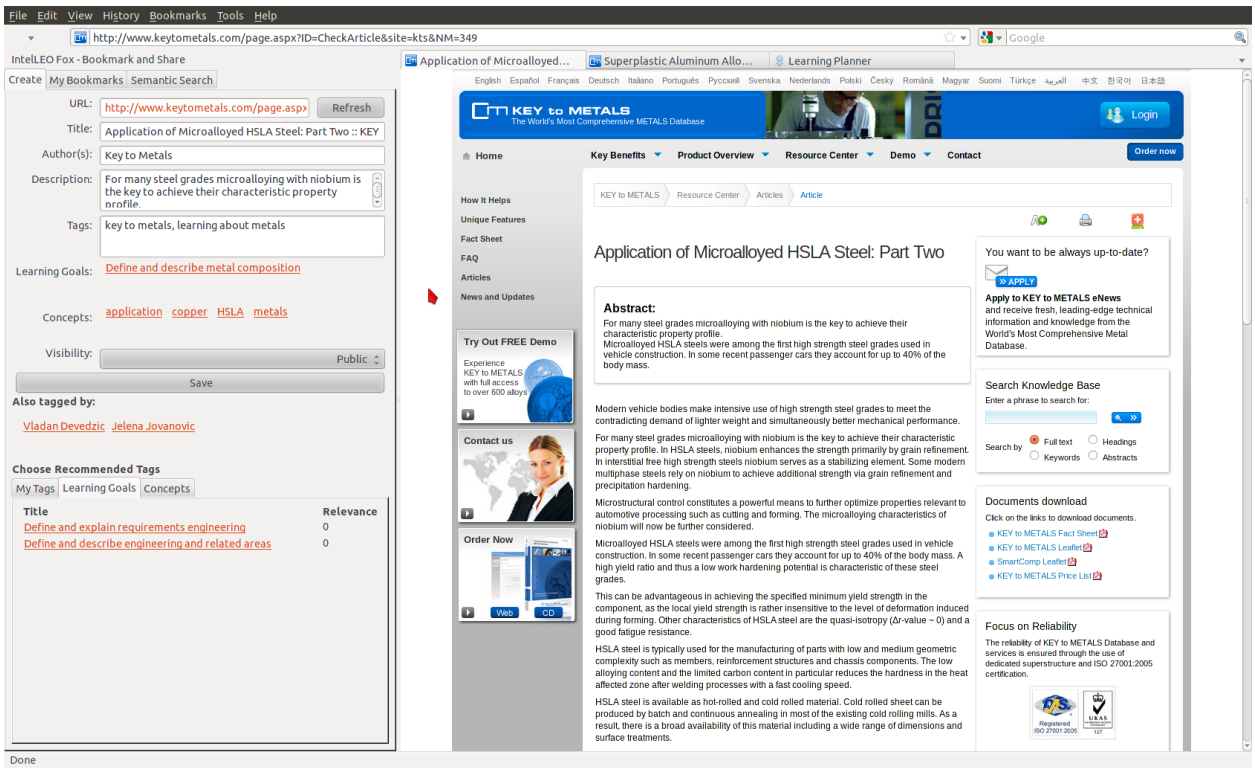
Figure 25 - Tagging a learning resource a) using the IntelLEO-toolbar version of CKP b) using the CKP sidebar

Clicking the *Related Goals* tab (Figure 25a) or the *Learning Goals* tab (Figure 25b) lists the learning goals associated with that learning resource, Figure 26. The *Source* column (Figure 26a)

shows the user or the organization that has originally set up the corresponding learning goal shown in the same line as the source, in the *Learning Goals* column. The *Relevance* column shows on the 0 to 1 scale how relevant is the learning resource being annotated to the specific learning goal. In Figure 26b, the user's learning goal with the highest *Relevance* factor is shown in the upper part of the sidebar; the other learning goals are shown in the lower part of the sidebar.



(a)



(b)

Figure 26 - Tagging a learning resource a) using the IntelLEO-toolbar version of CKP b) using the CKP sidebar

The *Action* column (not shown in Figure 26b; can be seen if the sidebar is extended to the right) includes two links: *Details* and *Add*. By clicking *Details*, the user can reveal details about the learning goal (including the set of target competencies and learning activities), Figure 27. These come directly from the Learning Planner (the LPC service), where the corresponding learning goal is seen "in context", i.e. along with the other learning goals set by the organization or by a specific user. By clicking *Add to Tags*, the title of the corresponding learning goal gets included in the *Tags* field and the learning resource being bookmarked gets tagged with that learning goal's title.

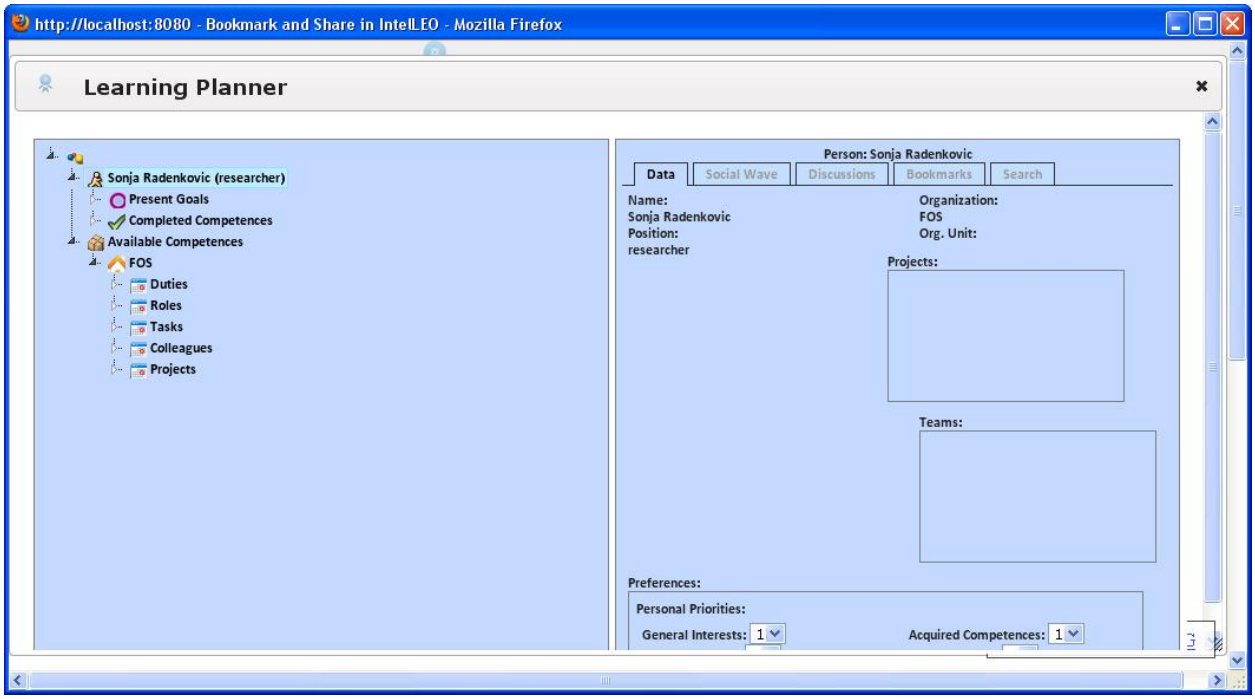


Figure 27 - Clicking Details takes the user to the Learning Planner (LPC service)

The bookmarking/uploading process is completed by clicking the *Save* button in Figure 23-Figure 26; it saves all the data (annotations) relevant for the corresponding resource in the repository. At a later stage, the user may decide to update (edit) the same bookmark (resource); see section 5.1.1.2.2. The same dialog will appear, this time for an already bookmarked resource, allowing the user to make the necessary changes (e.g., add tags) and save them.

In the cases presented in Figure 23a-Figure 26a the resource being bookmarked is bookmarked for the first time. However, if someone else from the organizations involved has already bookmarked the same resource, the CKP window will also show the *Also Tagged By* section where the current user is shown and there is a possibility to see who else has bookmarked the same resource. In Figure 28, the current used is Sonja Radenkovic, and *Discover Related People* helps find those other users who have bookmarked the same resource and thus are related by being interested in that same resource. Clicking *Discover Related People* brings up a dialog like the one shown in Figure 29, thus putting the user in direct interaction with the HRD and WGC services.

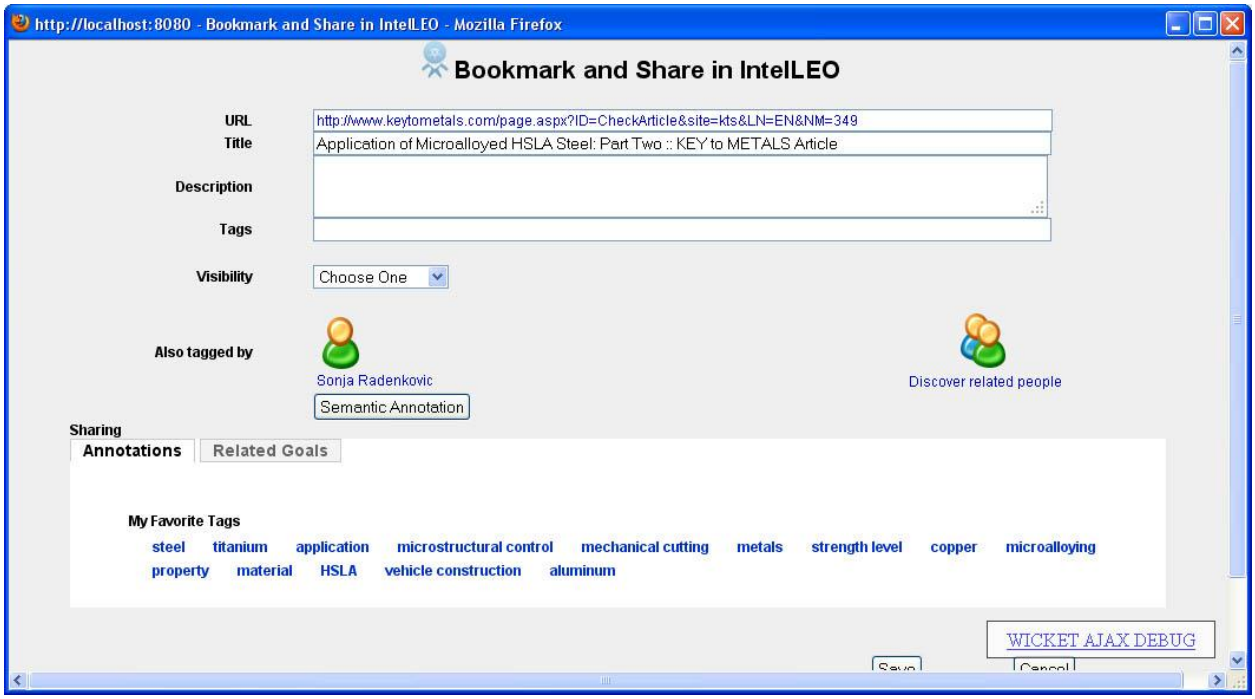


Figure 28 - Bookmarking a resource that other users have already bookmarked

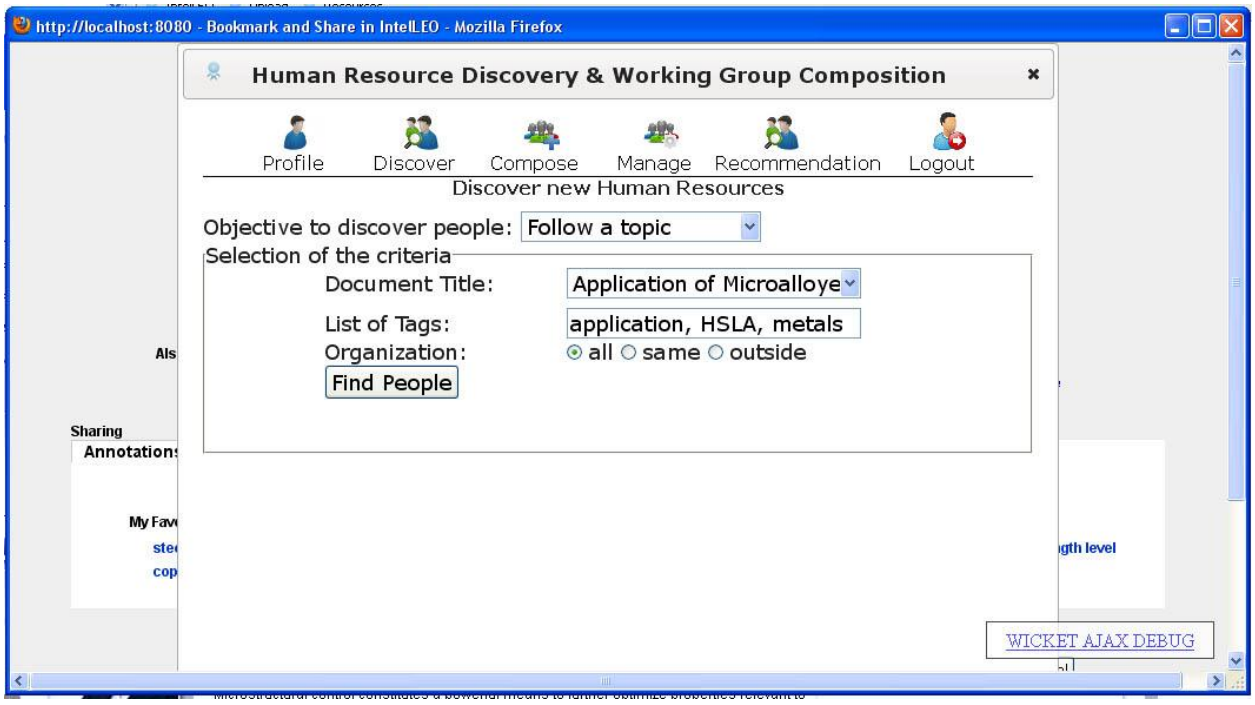


Figure 29 - Interacting with the HRD and WGC services from CKP

In the cases presented in Figure 23b-Figure 26b the resource being bookmarked is not bookmarked for the first time. If it was, the *Also Tagged By* section would be empty.

If the *Upload* button is clicked in the IntelLEO toolbar instead of the *IntelLEO* button, the dialog will be much the same as the one in Figure 23a, but the resource being bookmarked will be also physically copied to the repository (if the *IntelLEO* button is clicked, only the resource description will be stored there). This is especially useful when the user wants to upload some of her/his local resources, Figure 30 (the user can click *Browse* to select and upload a document from her/his local folders), although other resources (e.g., those coming from the Internet) can be also uploaded physically (to do that, the user clicks the *Upload* button).

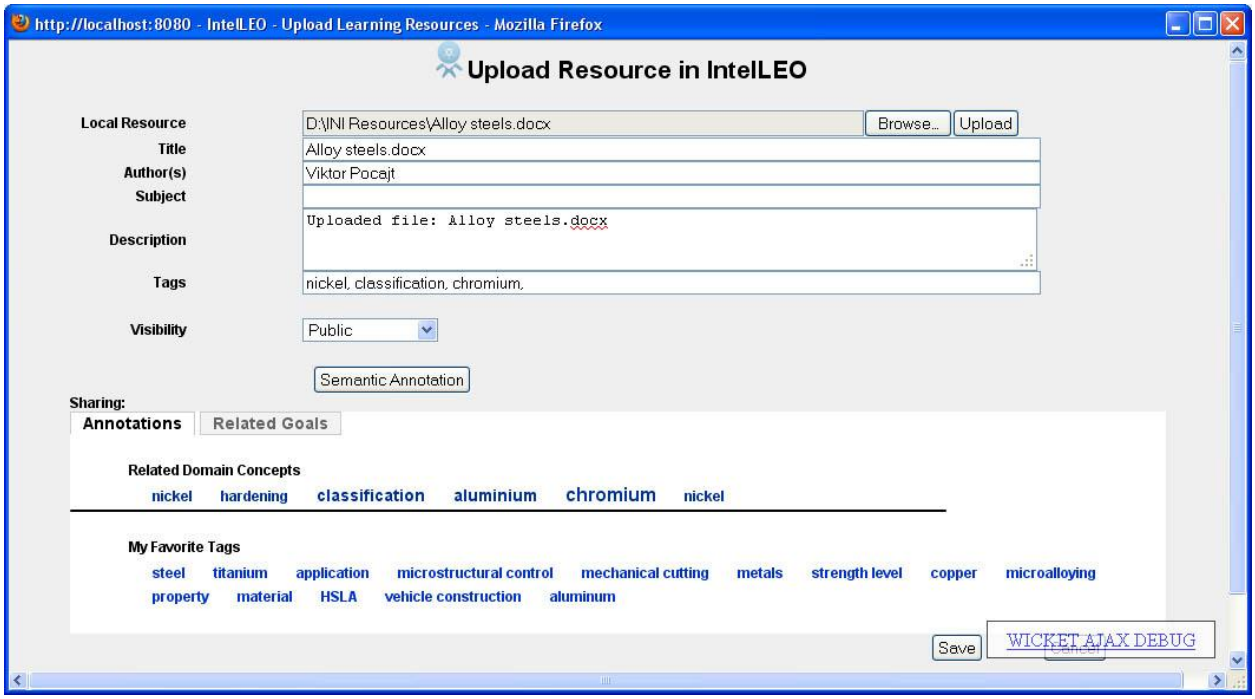


Figure 30 - Uploading a local file to the repository

In case of using the standalone version of CKP, a copy of the resource being bookmarked is always physically uploaded to the repository along with the resource description.

Technically, each time the user bookmarks/uploads a resource (or updates an existing one), the Upload event (as an instance of the a:Upload[5] class) is triggered and a new Content Unit (instance of the alocom-core:ContentUnit[6] class) is created to be subsequently initialized and stored in the repository. The Human Resource Discovery service is automatically invoked in the background to provide the data related to the User that performs the bookmarking/upload (instance of the um:User[7] class). The Content/Knowledge Provision service sends a request to the User Monitoring Service to provide the metadata to instantiate the metadata parts of the corresponding ContentUnit. The metadata are represented using the Dublin Core Terms vocabulary (dct:title, dct:description, dct:subject), as well as foaf:maker (for authors) and ann:hasTag[8] (for tags). However, the user can extend this tag list manually.

5.1.4 Managing knowledge objects

Managing the knowledge objects/resources already bookmarked/uploaded in an IntelLEO knowledge repository includes browsing/viewing the repository and the individual knowledge objects/resources, updating the bookmarks, and deleting them. Updating the bookmarks often includes additional manual annotation. In the IntelLEO services, annotation of knowledge objects refers to describing the uploaded knowledge objects with metadata (DC terms and the like), concepts from the domain ontology (semantic annotation), and tagging.

Annotation with the concepts from the domain ontology is typically performed automatically, using the KIM semantic annotation platform [KIM_2010]. Still, the resource provider can also perform this kind of annotation manually. Describing a knowledge object with properties from

[5] The *a* prefix indicates that this concept originates from the Activities Ontology

[6] The *alocom-core* prefix indicates that this concept originates from the ALOCoM Core Ontology

[7] The *um* prefix indicates that this concept originates from the User Model Ontology

[8] The *ann* prefix indicates that this concept originates from the Annotations Ontology

the DC Terms vocabulary is done by the User Monitoring Service (upon a request from the Content/Knowledge provision service). It instantiates the metadata parts of the corresponding ContentUnit. Tagging is done manually, during the process of bookmarking/uploading a learning resource (and also when updating it), by adding the tags that additionally describe the learning resource.

All these kinds of annotations are formally defined in the Annotations ontology.

Browsing/Viewing and deleting the knowledge objects is illustrated in the section below.

Working with her/his tool such as an Internet browser, the user can access her/his bookmarks stored in the repository by clicking the *Resources* button in the toolbar (Figure 22). This brings the dialog that allows the user to browse/update/delete the bookmarks, Figure 31. Clicking a resource in the *Learning resource* column opens the bookmarked resource, Figure 32. The user can delete a resource (knowledge object) by clicking its garbage bin icon, and additionally annotate and update it by clicking the corresponding *Update* button, Figure 33.

Interaction with bookmarked resources in the standalone version of CKP is similar and begins with clicking the *My Bookmarks* tab in the CKP sidebar (Figure 23b-Figure 26b).

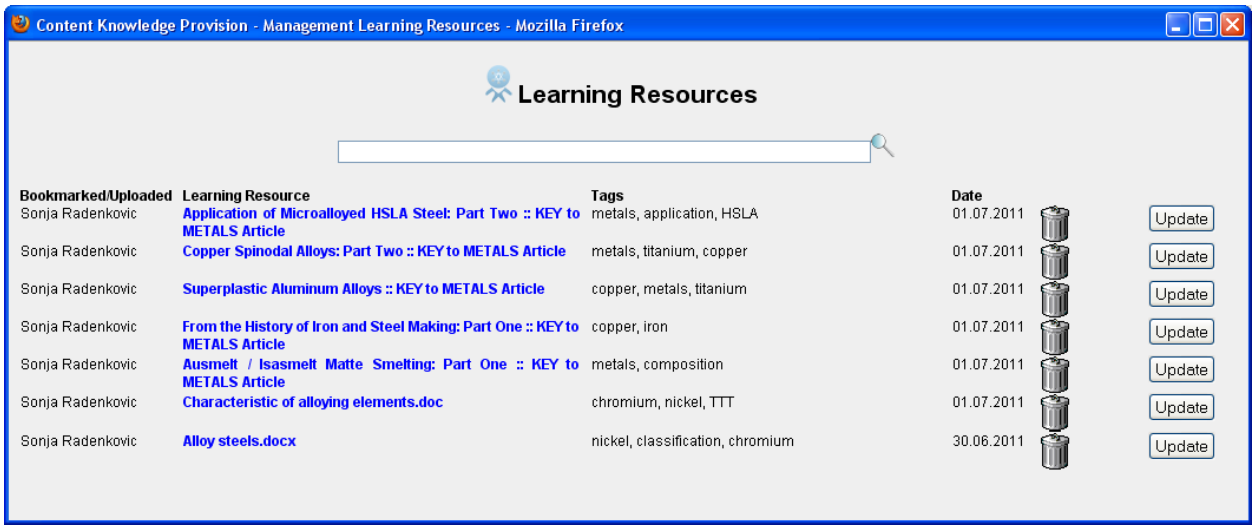


Figure 31 - Browse/View knowledge objects

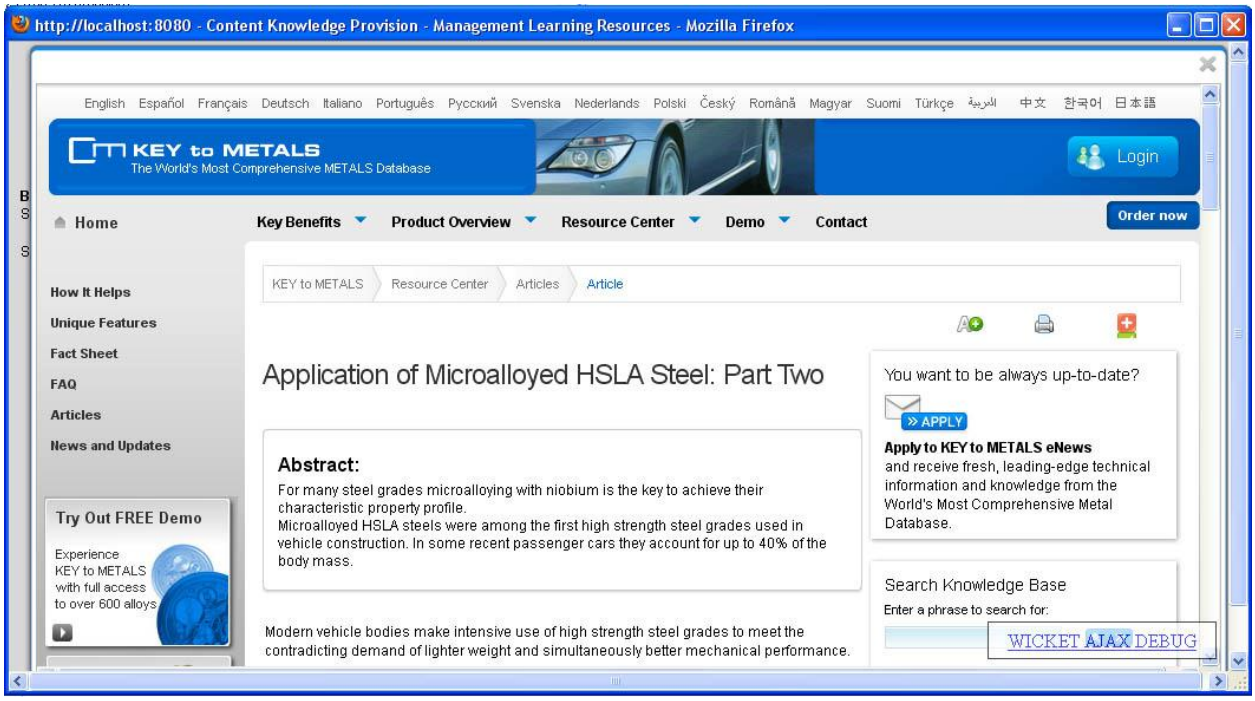


Figure 32 - Opening a bookmarked resource

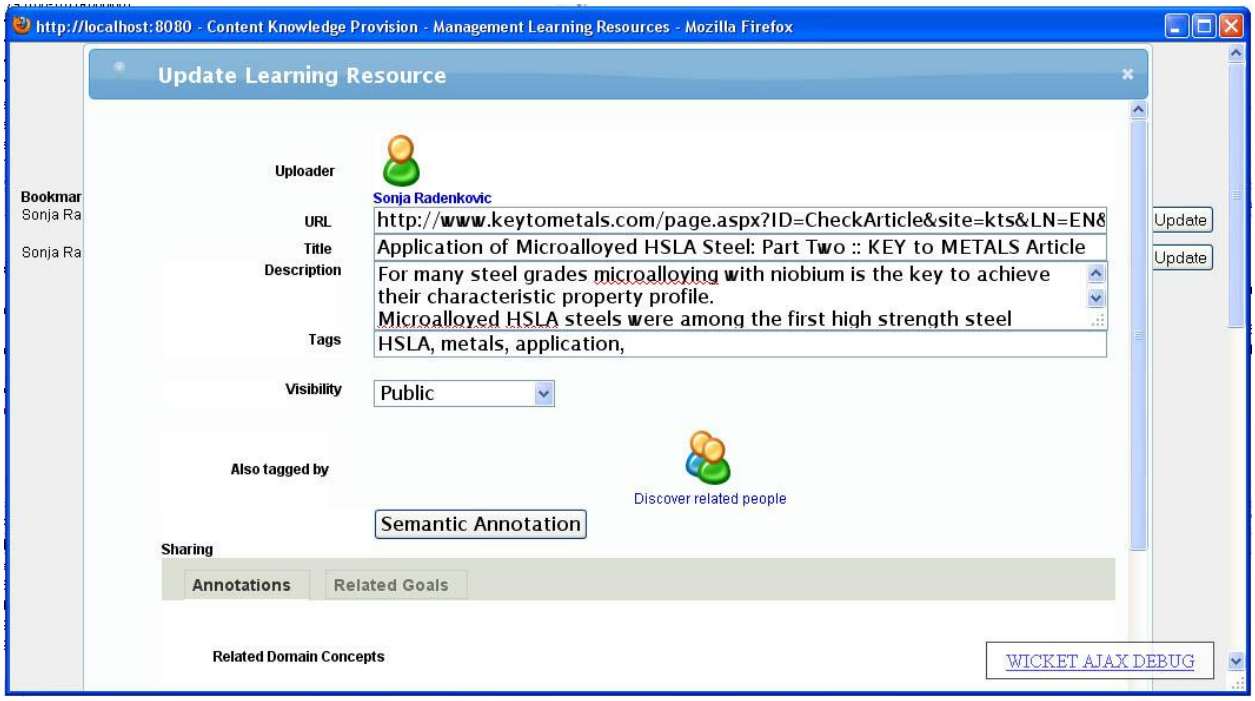


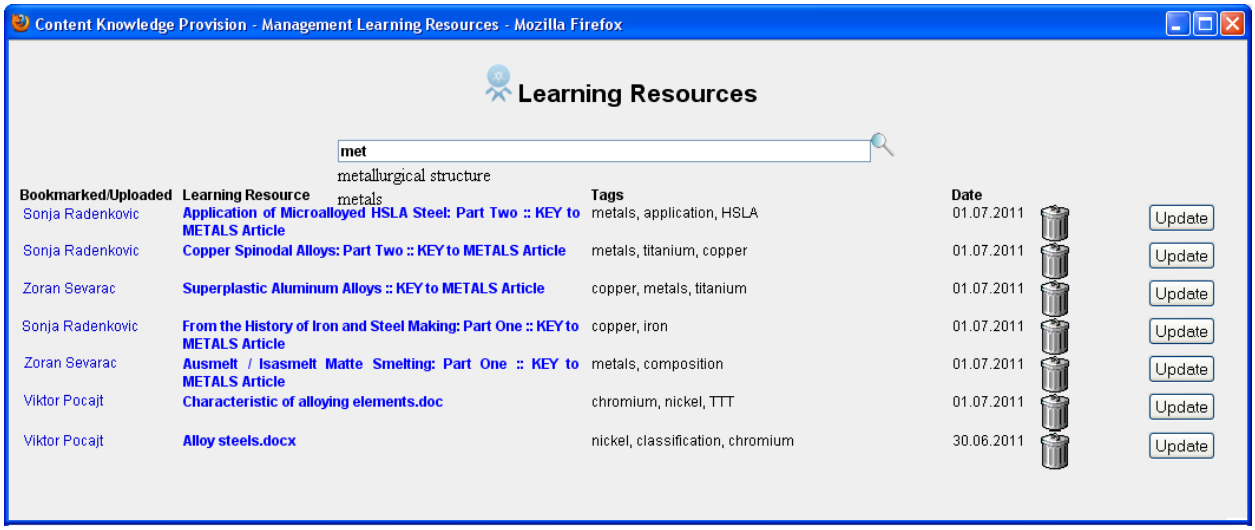
Figure 33 - Updating a bookmarked resource

5.1.5 Semantic search of knowledge objects

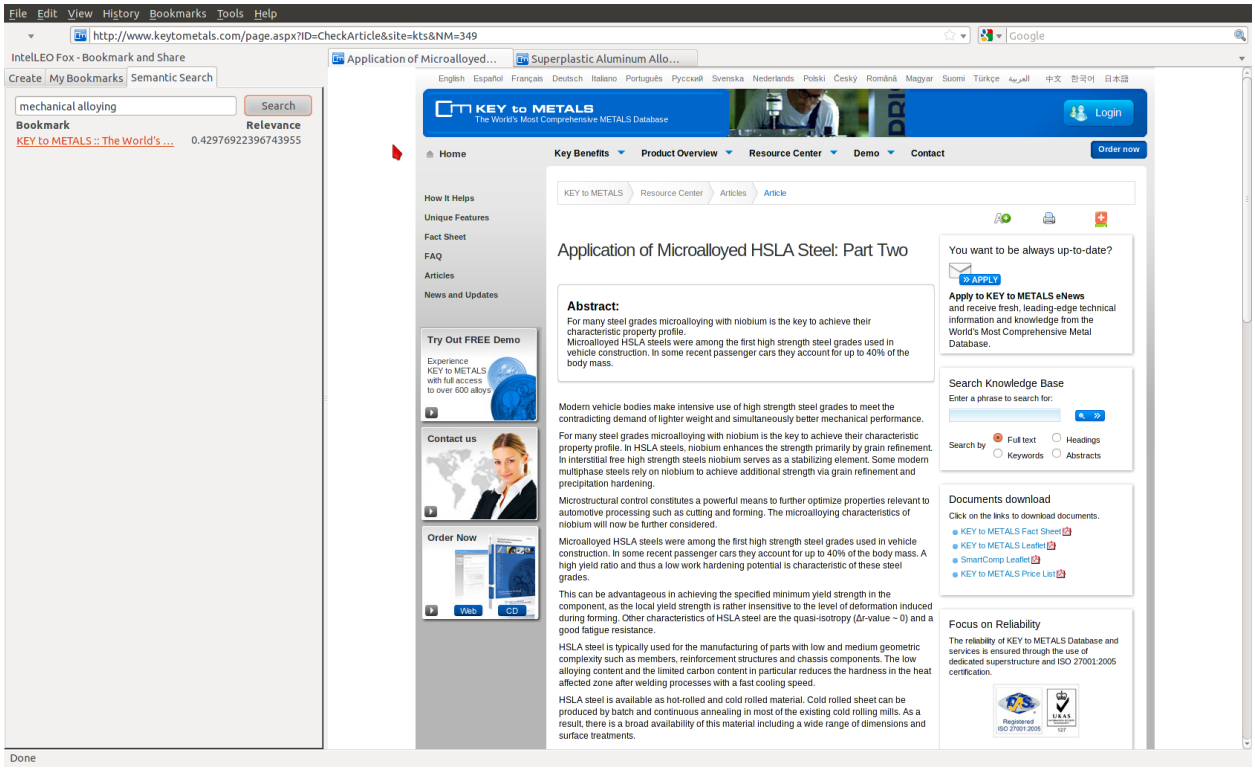
Semantic search of knowledge objects assumes searching a knowledge base based using domain ontologies and additional criteria, in order to find (an) appropriate knowledge object(s)/resource(s). Quick access to the relevant knowledge object(s)/resource(s) is essential here. The actors in this use case can be a human user (such as a researcher or an EO employee), as well as one or more service components (such as the Learning Planner (the LPC service)).

The user interface of *Semantic search of knowledge objects* is presented in Figure 34. Entering the search term (possibly using the implemented auto-complete option) and clicking the search

symbol (the magnifying glass symbol) initiates the search and presents a list of ranked search results. The list contains all resources from the repository that match the search term, not only those bookmarked/uploaded by the user who performs the search.



(a)



(b)

Figure 34 - Semantic search of knowledge objects a) using the IntelLEO-toolbar version of CKP b) using the CKP sidebar

When the user enters the search term in the *Search* box, the service queries the repository looking for the learning resources that have the same annotations like the user's learning goals and returns a list of the ranked search results. The process of ranking the search results is based on calculating semantic similarity between the learning resources and the user's learning goal (or the similarity of those resources with some other kind of learning asset (e.g., competence, activity)

as requested by a specific service on whose behalf the search is performed). The inputs for measuring the semantic similarity are the tags and the semantic annotations (concepts from the domain ontology) for the learning resources, and the tags related to the target competences for the user's learning goal. The output of similarity measuring is the number between 0 and 1 that is relevant for ranking the learning resources. Clicking a user's name in the *Bookmarked/Uploaded* column filters the list to only the resources bookmarked/uploaded by that specific user, Figure 35.

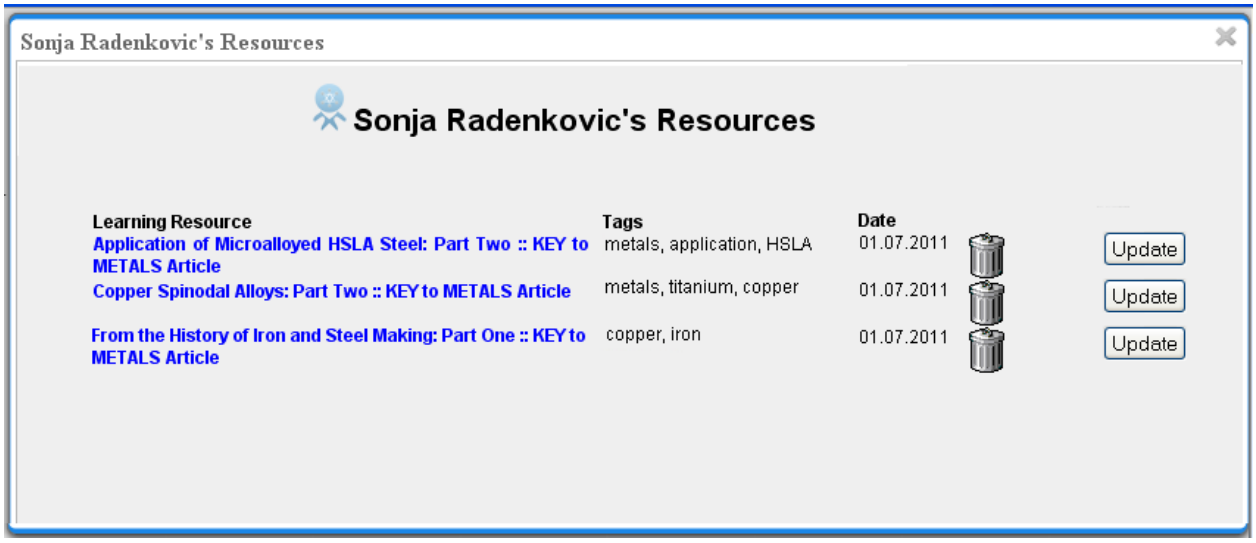


Figure 35 - Filtering the search results “by user”

5.1.6 Synergy with other services

Table 4 – Synergy of the CKP service with the other IntelLEO services

No	Service Functionality	Main innovation	Synergy among other services
1	Bookmarking Knowledge Objects	Allowing users to bookmark new knowledge object into a knowledge base	LPC, WGC, UMCT
2	Uploading Knowledge Objects	Allowing users to upload local resources into the knowledge base	LPC, WGC, UMCT
3	Managing Knowledge Objects	Allowing users to view/update/delete knowledge objects from the knowledge base	-
4	Semantic Annotation and Indexing	Supporting both manual and automatic annotation of learning resources, with respect to available domain concepts.	-
5	Semantic Search	Enabling searching for domain concepts Allowing users to find learning resources and (re)use them based on the domain concepts these resources are annotated with.	LPC, WGC

6 Individual and Organisational Learning Framework

6.1 Learning Path Creator CS

The Learning Path Creator core service allows users to have ubiquitous access to their personal learning spaces. Through this service, users can manage and attain their learning goals, composed of a set of competences, by receiving support from the social context of their IntelLEO, and also contributing back to it through sharing their learning experiences. All members of an IntelLEO, coming from various collaborative organizations, can use this service. To realize this socially-aware perspective on Personal Learning Environment (PLE) within an IntelLEO, in the following we describe the main functionalities of this core service:

Managing Learning Goals functionality supports users in planning and managing their personal learning goals, specifying the competences to be acquired within the learning goal and creating a learning path to follow in order to acquire each specific competence (Figure 36A). In addition, it helps users to harmonize their learning goals with organizational objectives and norms by giving them an overview of what competences are valued within the organization with regard to the existing duties, projects and tasks. Contrary to other competence-based approaches pursued in other projects in this area, here users are not limited to choose their learning goals from only a set of predefined goals provided by their organization; they can create new competences which they want to achieve or browse the list of available competences within their IntelLEO (note that organizational objective are represented as competences) and choose the ones that they find relevant to their learning goals. This functionality also provides users with personalized visual hints for each available competence, which indicate the importance of that competence or its required level of expertise for a certain user with regard to the duties the user is responsible for (Figure 36B).

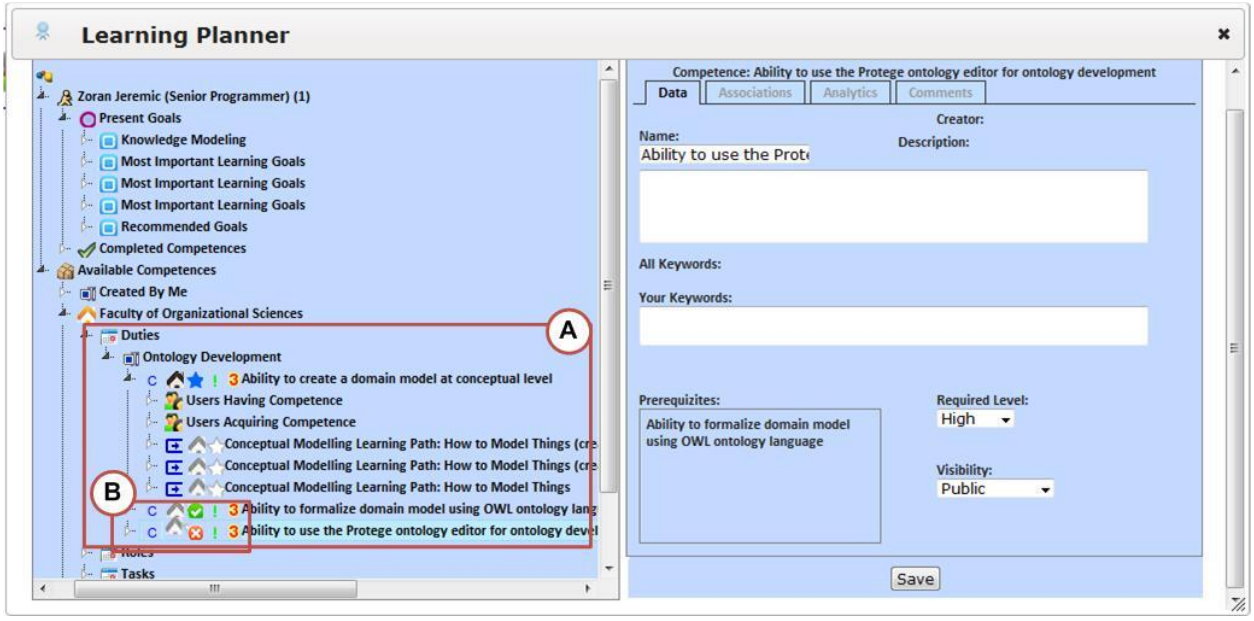


Figure 36 - A) Representing organizational objectives in terms of required Competences (and their accompanying LPs) – from a Duties perspective. B) Visual hints providing personalized information to users.

Semantic Annotation and Indexing is used for semantic annotation and indexing of learning resources (e.g. online resources, documents, etc). It provides two types of annotations: manual and automatic. While adding learning resources to their learning goals, users are asked to describe it using commonly used or customized tags and to connect it with appropriate domain

concepts. In addition, users can use the Content and Knowledge Provision Service (CKP) to annotate online resources while browsing on the Internet. They can use tags or their learning goals which they considers relevant to annotate the online resource. Automatic processing and annotation of the resource is performed in order to annotate it semantically using the concepts from the domain ontology. The resulting (RDF) data is stored in the RDF repository for later use by other services.

Semantic Search aims at enabling effective and easy retrieval and reuse of stored learning resources, i.e. learning goals of other users, competences, learning paths, learning activities or knowledge assets. The Semantic Search allows users to search for resources based on a given domain concept or a tag input. As can be seen in (Figure 36), as the user starts typing the term "ontology", (s)he can see the list of available domain concepts/tags, from which the user selects "ontology". Then he/she can see all the learning resources annotated with this concept, 4 learning goals and one learning activity in this example, plus two videos. Clicking on each of these learning resources will take the user to the position of this resource on the left-hand side tree. This service makes use of the services of the repository layer to search for the data and learning resources repositories. If none of the available resources directly matches the user's request, it will check for semantically related domain concepts or tags, find resources annotated with them and suggest those as potentially useful resources for the given user. In order to find similar domain concepts we are using existing ontology relations (e.g. skos:broader, skos:narrower), as well as, domain concepts and tags used often in the same context.

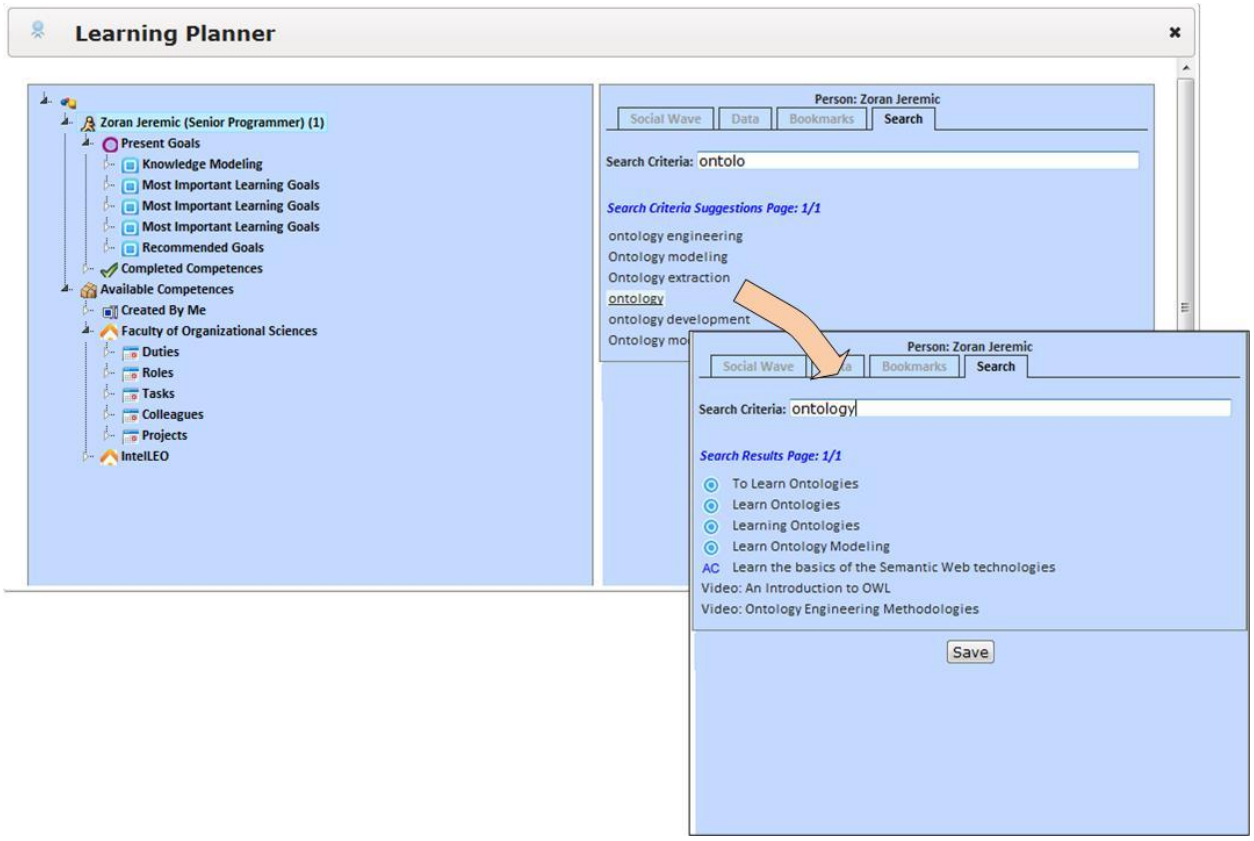


Figure 37 - Semantic Search in LPC.

Analytics functionality is responsible for processing and analyzing the data about users' learning activities and their interaction with diverse kinds of learning resources (e.g., learning goals, target competences, activities and knowledge assets). It makes use of the interaction data stored in the RDF repository to provide users with feedback, primarily through different kinds of visualizations, to support them in planning and monitoring their learning process. For instance, each

available competence provided in *Knowledge Building Service* is accompanied by information such as the number of users who have acquired it, the positions of those users in the organization, and the comments and discussions about it (Figure 37). Moreover, *Analytics* supports organizational learning and knowledge sharing incentives/inhibitors. Browsing the *Analytics* of a certain available competence, updates the managers of an organization on how frequently this competence has been used within the organization, in the context of which learning goals, by users of what organizational positions, and what the main issues regarding this competence are. This allows managers to apply any necessary modifications in the definition of the competence itself or learning paths associated with it, to better harmonize organizational and individual learning needs. Also discovery of emerging competences or other learning resources can be learned via this functionality. If some user-created competences are frequently being (re)used by members of an organization, the managers might consider them as 'emerging' organizational goals. As can be seen, organizational goals are also dynamic and can evolve via the contributions of the community members. Moreover, this targets individuals' intrinsic motivation for knowledge sharing by giving them the feeling of being competent in contributing to the organization's goals and objectives.

Figure 38 - Analytics in LPC – showing the number of users who have achieved a certain competence, or have it overdue in their learning goals, and their organizational positions.

Learning Path Recommender: Based on the contextual data about a user's tasks, learning goals, competences and other relevant information, this functionality recommends learning paths for achieving a certain target competence to the user (Figure 38). A learning path is comprised of a sequence of learning activities along with descriptions (metadata) of knowledge assets required for performing those activities. To recommend the most appropriate LPs to the users, the LP Recommender first exploits cosine similarity measure between the vector of concepts and tags representing user's personal preferences and, the vector of concepts and tags related to an LP to find how similar each LP to the user's preferences is. In order to provide a more accurate recommendation of LPs, this service further considers users who had previously used the candidate LPs, and checks their similarity with the current user. The rationale for this comparison is that we believe those LPs followed by users with similar interests and background are likely to be better adopted than those used by users with whom the given user has no similarity or the similarity is very low.

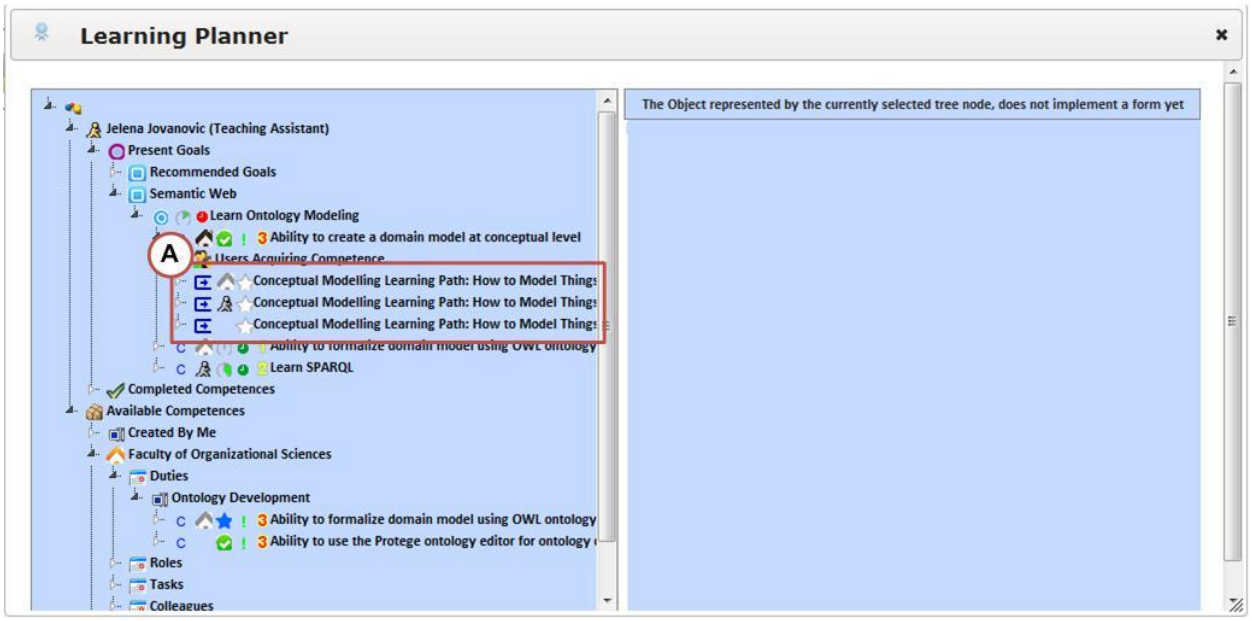


Figure 39 - Recommended LPs for a specific Competence.

Social Wave receives information about the events occurring in the LPC and other connected tools, e.g. MediaWiki and Elgg, and updates the social (activity) stream of users who might be interested in those events (Figure 39). In order to receive updates related to any particular user and his/her learning activities, one has to follow that user. Once a user decides to follow somebody, he/she will be informed about all the events related to that person. Moreover, a user might decide to follow certain competences and in that case, he/she will receive updates about all the events related to those competences. For specific learning resources, e.g. learning goals and target competence, Social Wave performs filtering of events, so only those events that are related to the given learning resource are shown within Social Wave inbox of that specific resource.

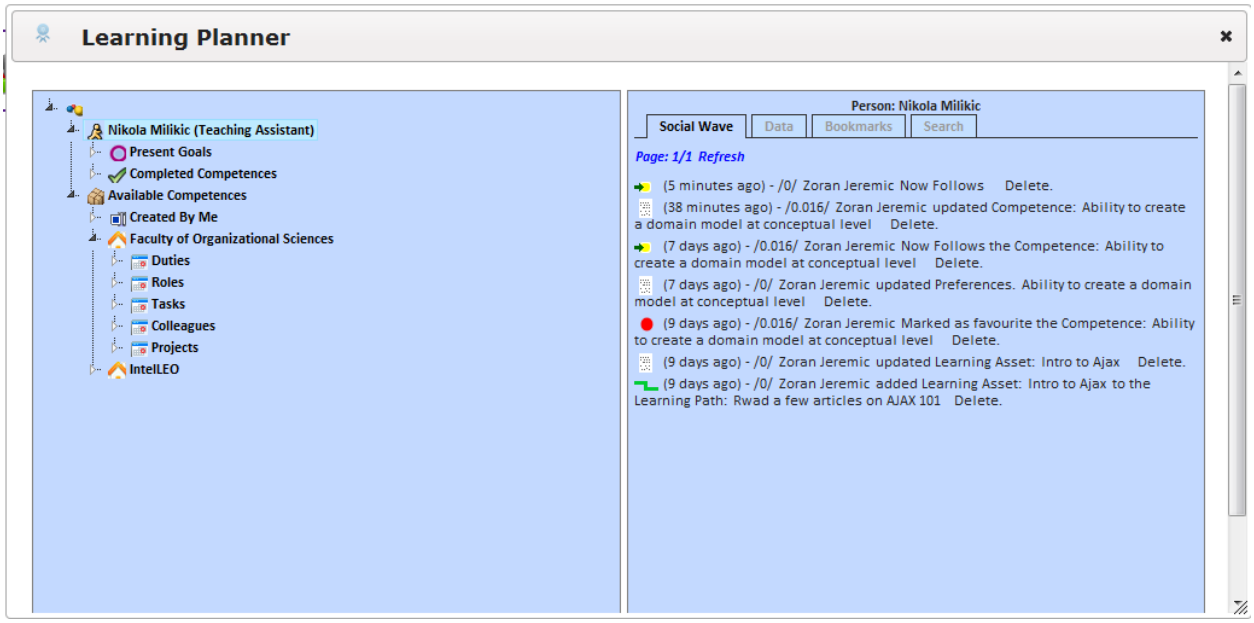


Figure 40 - Social Wave

6.1.1 Synergies with other services

Table 5 – Synergy of the LPC service with the other IntelLEO services

No	Service Functionality	Main innovation	Synergy among other services
1	Managing Learning Goals	- Allowing users to harmonize their individual learning goals with those of the organization - Allowing users to create their own defined learning goals, in terms of competences and accompanying LPs.	LPC, CKP, WGC, UMCT
2	Semantic Annotation and Indexing	- Supporting both manual and automatic annotation of learning resources, with respect to available domain concepts.	CKP
3	Semantic Search	- Enabling searching for domain concepts - Allowing users to find learning resources and (re)use them based on the domain concepts these resources are annotated with.	-
4	Analytics	- Providing various kinds of feedback to users, based on their and other users' learning activities - Providing personalized visual hints to users on available competences and helping them in planning their learning process.	UMTC
5	Learning Path Recommender	- Recommending learning paths to users, based on the contextual info about the user, his/her learning profile and also their similarity to other users who have used the same LP.	UMTC
6	Social Wave	- Providing awareness to users based on the events happening in LPC and other connected tools - Allowing users to follow their colleagues, or learning resources, to be able to know what events are being performed by those colleagues, or on those learning resources.	UMTC, WGC, CKP,

6.2 Organisation Policy CS

The Organizational Policy Core Service is used to specify the context and priorities at the organizational level. Organisational Policy CS is consisting of five functional modules:

1. Competence Management Module (CMM);
2. Organizational Management Module (OMM);
3. Learning Management Module (LMM);
4. Inter-organizational Management Module (IMM);
5. Motivation Management Module (MMM)

One of the aims of IntelLEO is harmonization of individual learning goals of employees with the goals of organization. Organisational Policy CS is a tool that is meant to be used only by managers of organization, in order to define and promote contextual settings, policies and priorities of the organization. These settings, policies and priorities will then be utilized by other Core Services, especially by Learning Planner. OP CS is used initially for describing competence definitions (with CMM), organizational structure, positions, duties and roles within an organisation (with OMM). When these tasks are completed, managers can bind a set of competency requirements with each duty, position or role (with OMM). OP CS allows also to prepare templates for recommended learning paths related to certain prioritised competencies (with LMM) and to harmonise descriptions of competences with partner organisation involved in Extended Organisation (with IMM). Finally, managers can define motivational policies for competence development within the organisation (with MMM) by promoting vacancies, incentives and development priorities.

6.2.1 Competence management with CMM

CMM contains the list of competence definitions for an organisation. Competence definitions can be added, associated with each other (as sub-competences or pre-requisites), edited and deleted by managers or HR specialists of this organisation. First, top-level competences should be defined ('Add new competence' button), then sub-competences can be added ('Add sub-competence to selected competence'). After specifying the title and description of a new competence, a manager should also select suitable pre-defined domain topics and user-defined tags for each competence (Figure 41).

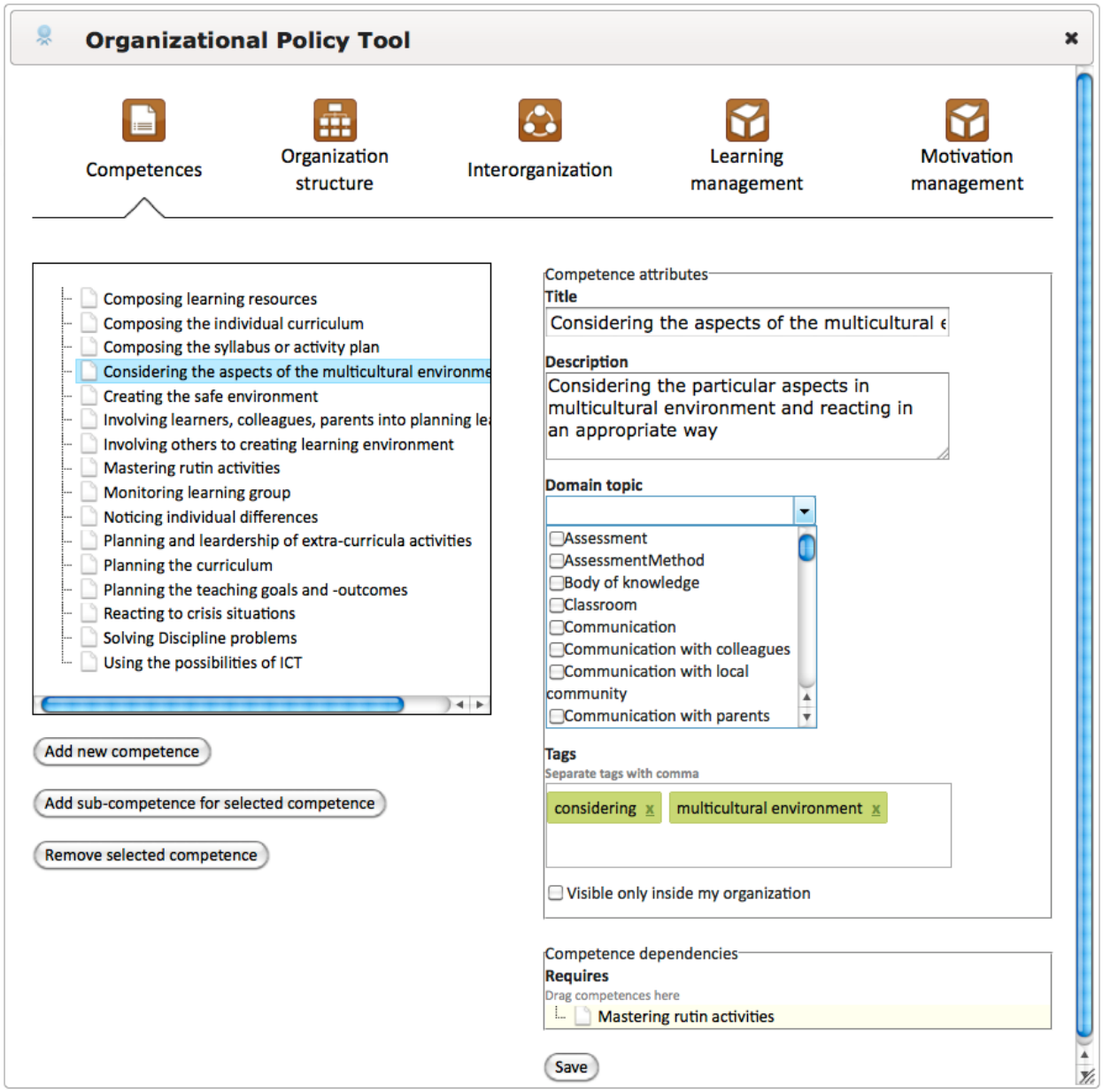


Figure 41 - CMM

6.2.2 Defining organisational structure with OMM

The list of all competences can become long and difficult to browse in a large organisation. In order to provide only relevant set of competences to a user, competences should be structured on the basis of roles, positions and duties of employees. This is done with the help of OMM. First, the manager defines the structure of her organisation: departments, units, sub-units. Positions are always associated to a unit, roles can be defined without this kind of association (Figure 42). For each position or role, a set of duties can be defined with OMM. Then, for each duty, a competence (or a set of competences) are specified. It is important to note that OMM does not deal with specific employees, only generic positions and roles that can be assigned to multiple employees.

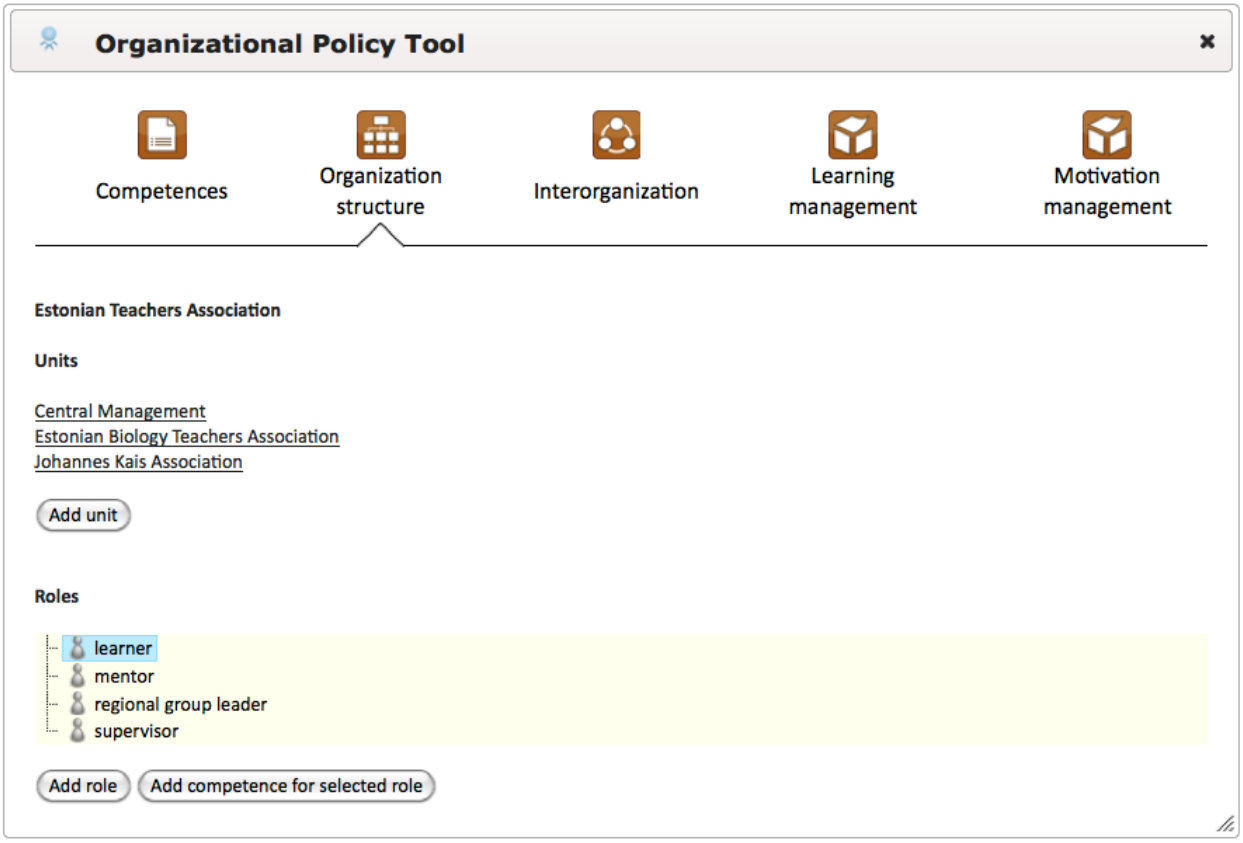


Figure 42 - OMM

6.2.3 Interorganisational competence management with IMM

One of the main goals of Intelleo is to support cross-organisational learning and knowledge-building. Managers can use IMM for harmonising competence definitions between two organisations forming an Extended Organisation.

Mapping of competencies is an assigning of mapping relationships between competencies of two organizations. The mapping is intended for implementation of IntelLEO recommendations. If two competences in different organizations are mapped, managers of these organizations can use this knowledge for a comparisons and recommendations. The knowledge about mapped competences can be used as the base for IntelLEO recommendations to users in case of looking personal in organization partner.

Mapping of competencies between two organizations can have full (exact) or partial match. A full match means that all properties of two competences are the same, including name, prerequisites and so on. In some cases, it can be hard to achieve an exact match mapping between competencies of different organizations. In the process of mapping one competency to another, the manager can define relations between properties of competence. In such cases, a partial match mapping between the two competencies can be made to provide a better orientation in scope of competences of the peer organization. The partial match means that only some properties of two competencies are the same, but others are not.

The manager of organization A can decide to map a competency of the own organization to a competency of organization B. Manager initiates the mapping process and his initial proposal for full mapping is sent to organization B. The manager of organization B receives this proposal,

reviews it and in case she agrees with it, accepts the mapping without any changes. In such case the full match mapping becomes bidirectional and will be fixed in IntelLEO. From this time, the information about mapping becomes available to all IntelLEO services.

During the negotiation process the both participants can modify the mapping over and over again, accompanying these changes by textual comments. The mutual mapping will be in place only if the proposal is approved by both sides. And in case if all properties not meet a condition of 'exact match' the match can be considered only as partial.

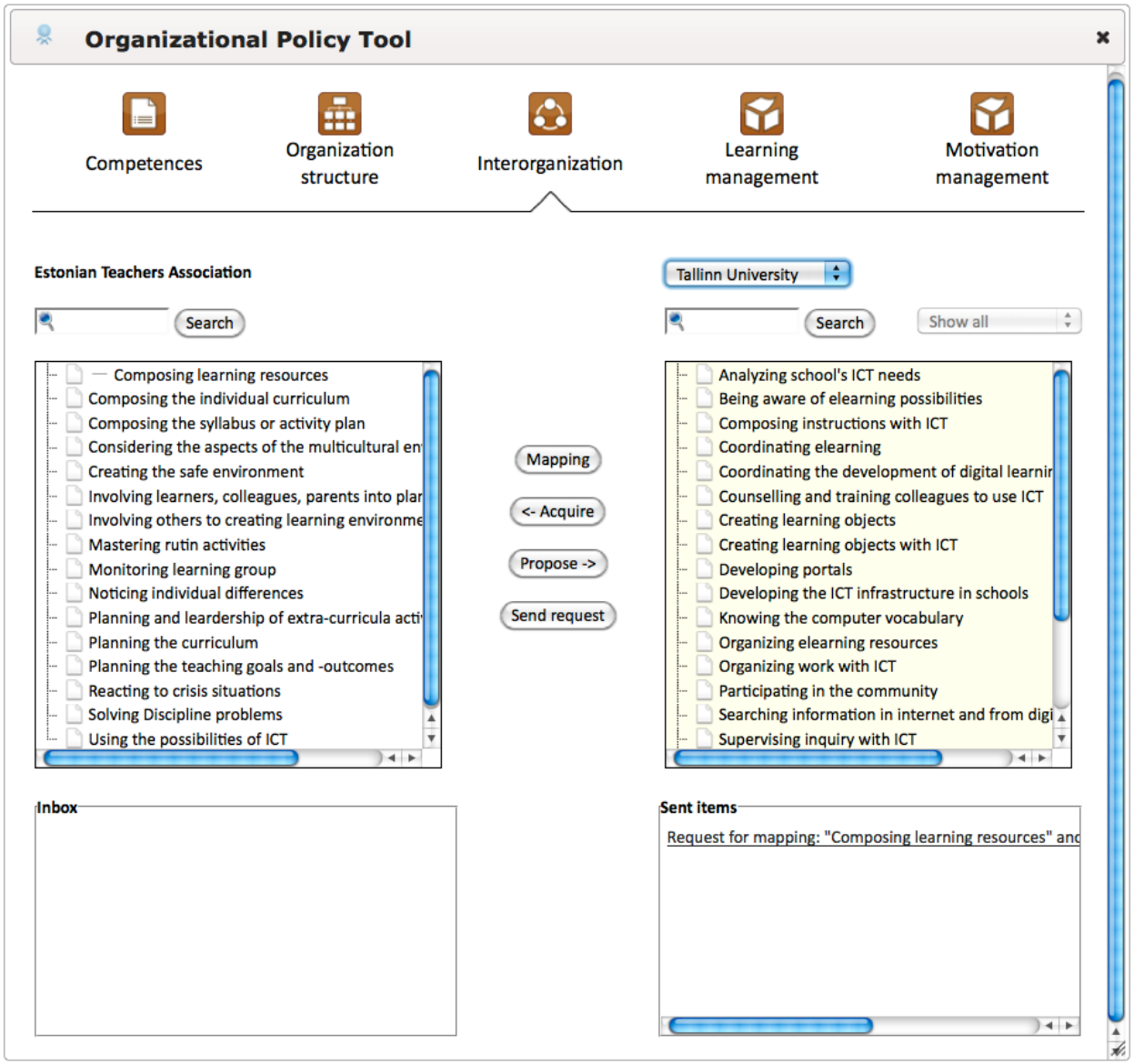


Figure 43 - IMM

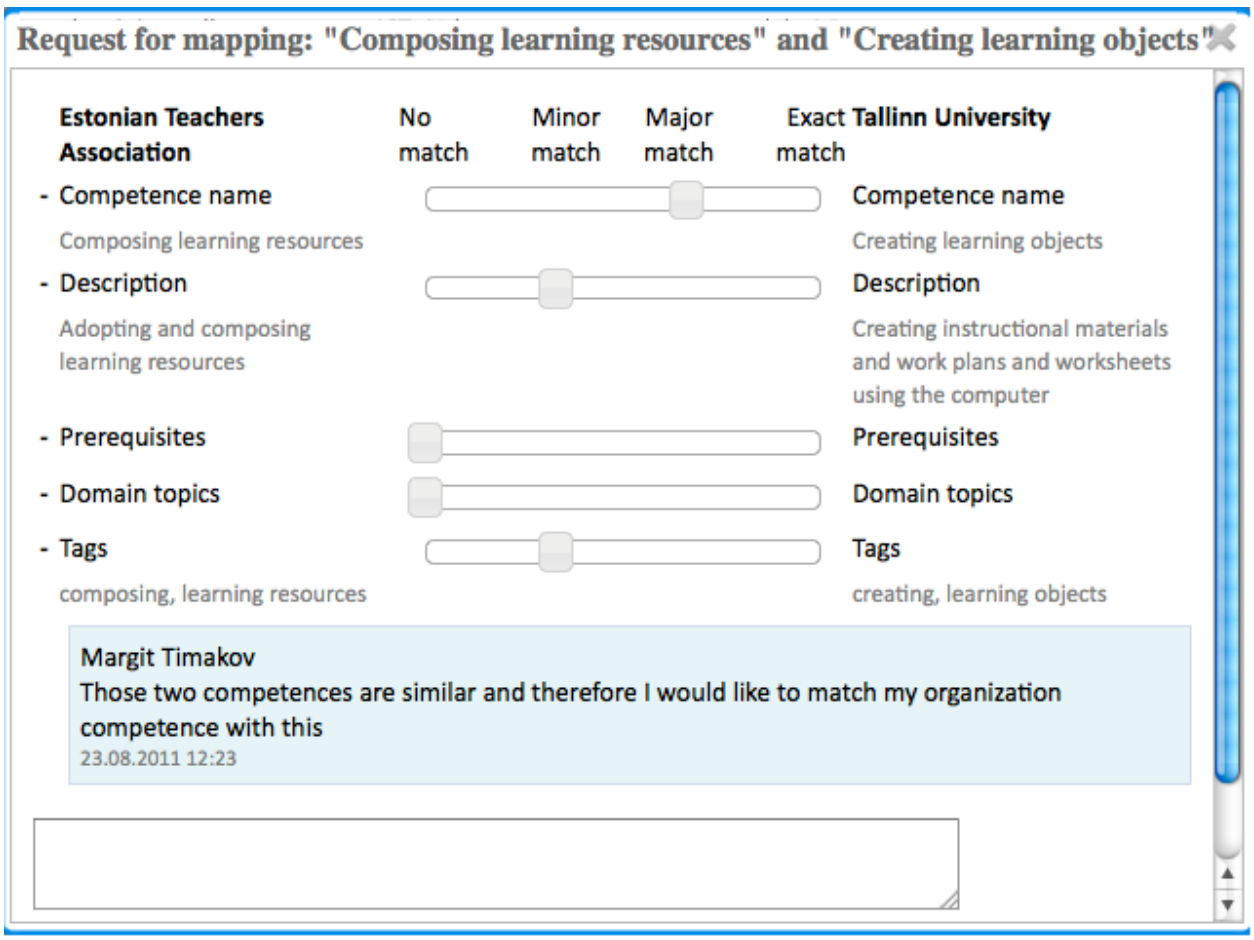


Figure 44 - IMM 2

6.2.4 Learning management with LMM

A work with LMM begins from defining the recommended Learning Path Templates for competence development that are based on the requirements of selected position or role specified within OMM. These recommended Learning Path Templates are associated with the competences of selected position/role, which in turn can include sets of related learning activities required for achieving such competencies. Each learning activity can be associated with several knowledge assets.

LMM user interface is divided into two columns. On the left column the tree with LPTs, competences, activities and knowledge assets is arranged. By selecting each tree branch on the left manager can view the properties of this branch on the right side. Also for each selected branch (except knowledge assets) the corresponding sub-branches can be created.

Learning Path Templates can be either designed from scratch by a manager or imported from an employee's Learning Planner. Imported Learning Paths can be edited by a manager before publishing as officially recommended Learning Path Template.

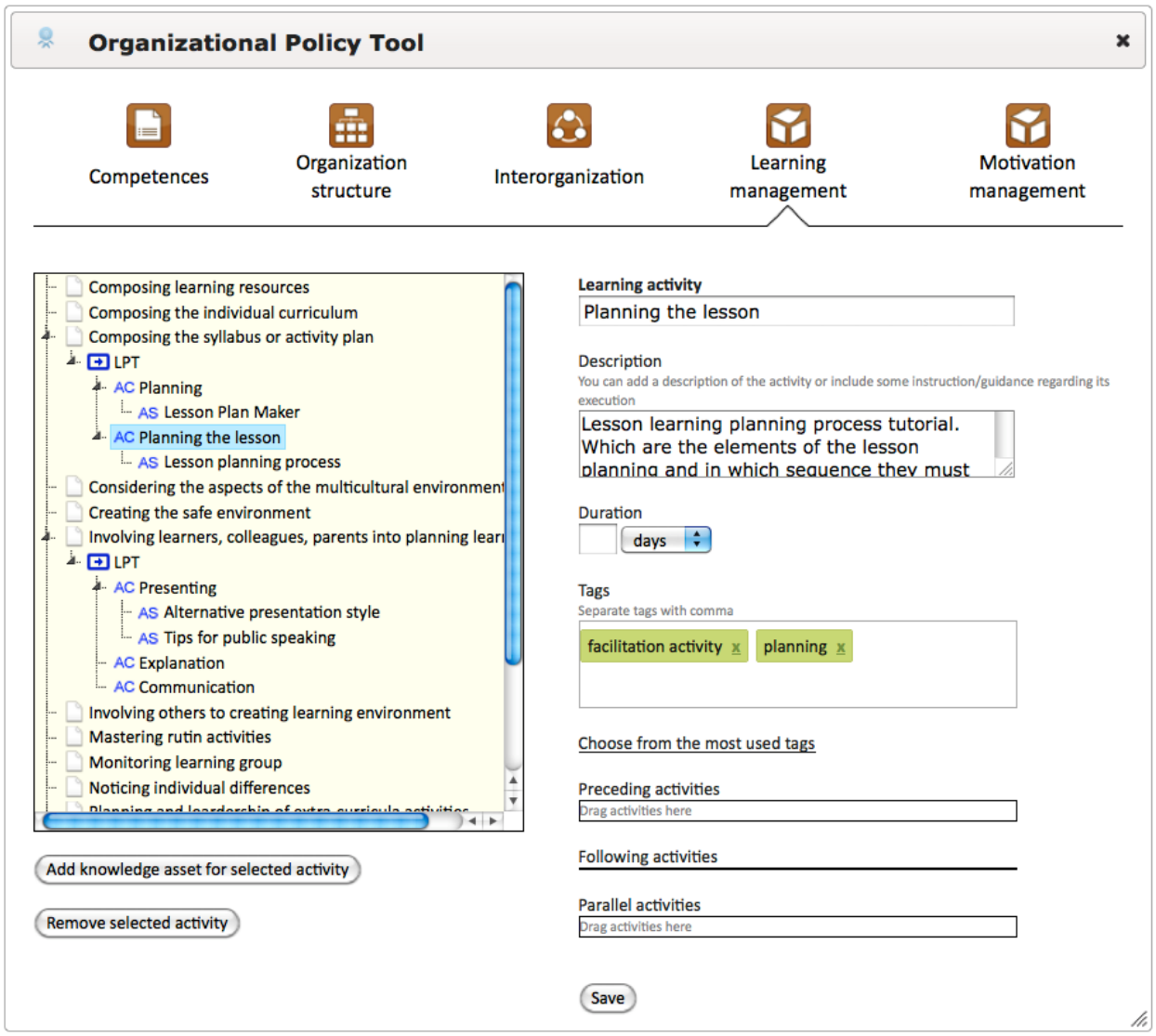


Figure 45 - LMM

6.2.5 Managing motivational incentives with MMM

MMM is divided into four sections: Vacancies (for promoting vacant positions and roles), Incentives (for defining certain bonuses and their conditions), Priorities (prioritised competences) and Indicators (measurable indicators that are used for selecting the nominees for various incentives).

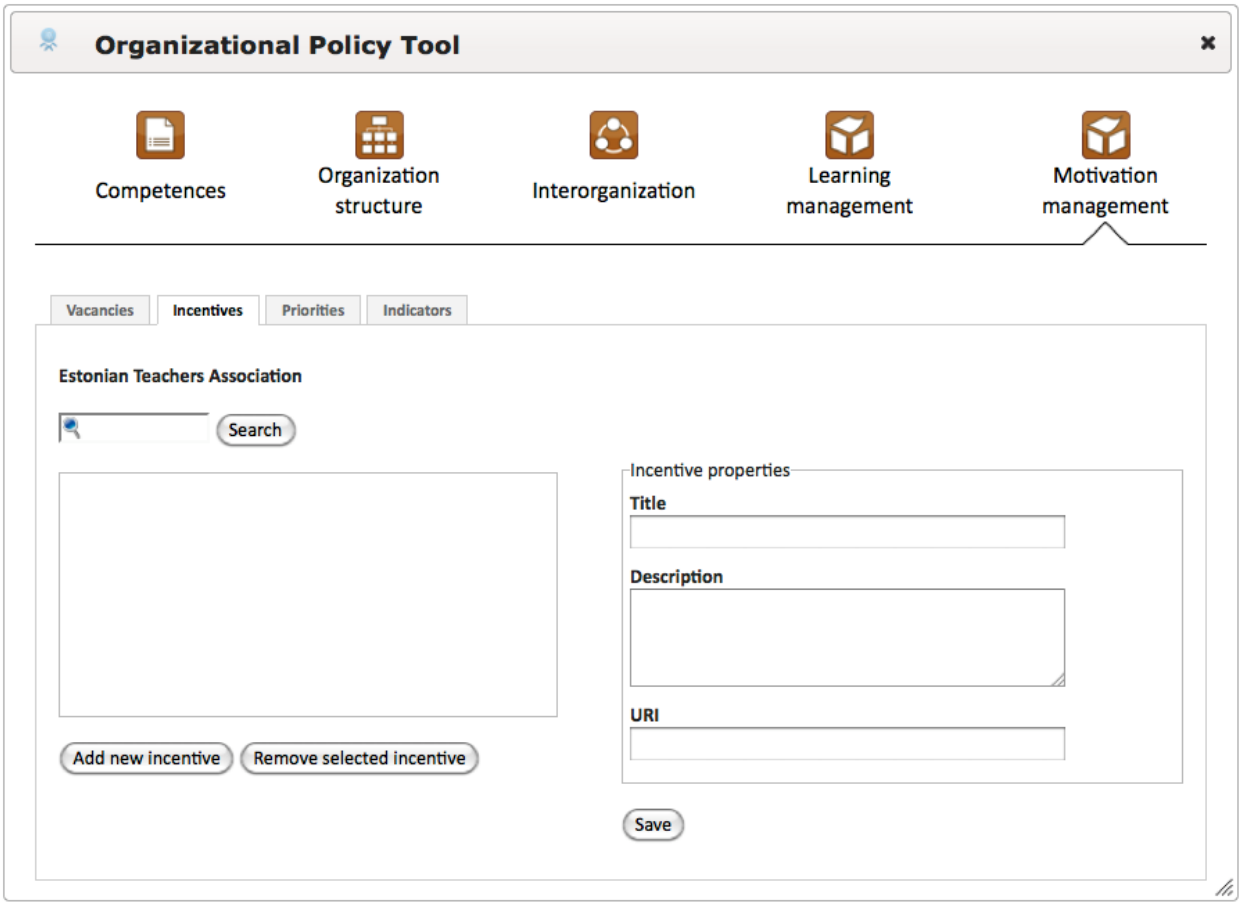


Figure 46 – MMM

7 Integration of Core Services

7.1 Implementation Framework for Integration of Core Services

Based on the set of services that were considered as being part of the IntelLEO platform, the components supporting such a services platform have been developed (see sections 3 through 6). The software architecture in Figure 47 illustrates the different IntelLEO components, which exist in the final platform, and the different architectural layers into which the components are divided (see also deliverables D1.3 – IntelLEO Concept and D2.1 – IntelLEO Early Prototype Specification).

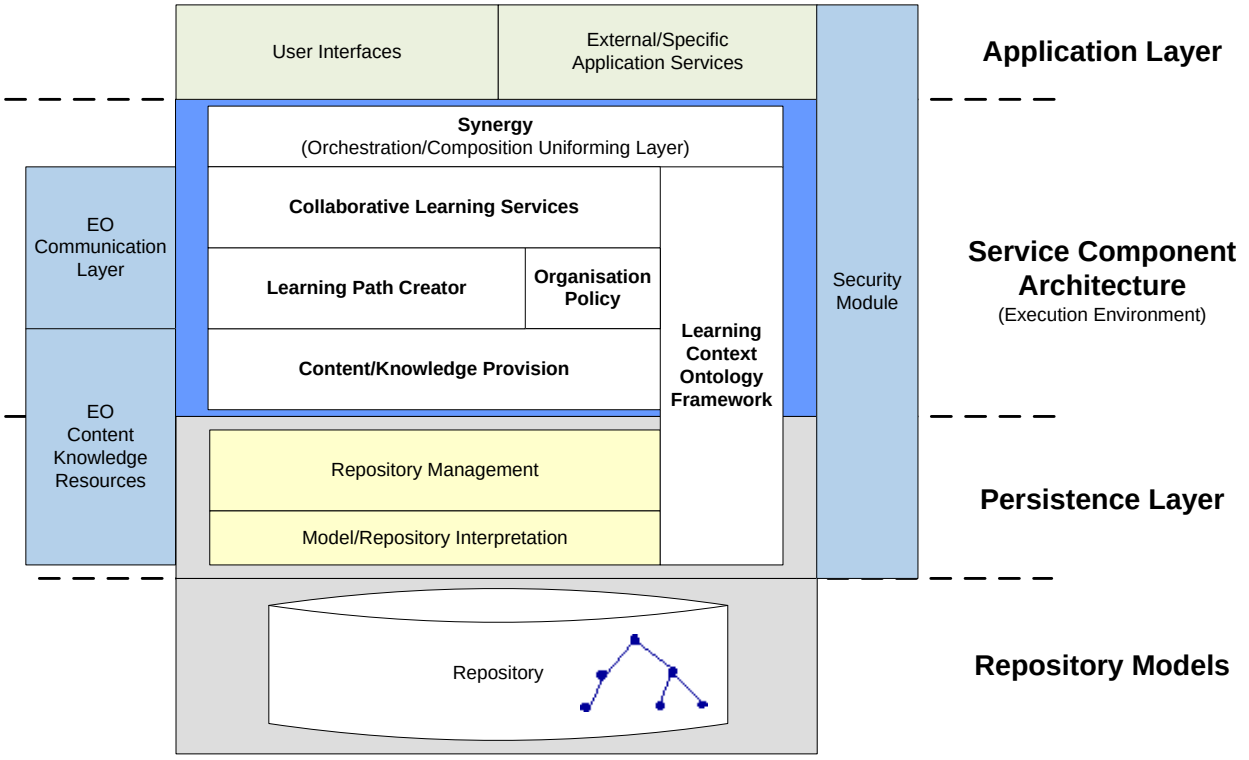


Figure 47 - IntelLEO architecture

As can be seen in Figure 47 above the IntelLEO platform's central layer is based on the Service Component Architecture (SCA), in which the different IntelLEO services are located. This central layer serves two main purposes:

a) It provides a common execution environment for all services

b) It provides the possibility to combine and orchestrate different services into composite services, leveraging the SCA orchestration and (Web-)Service capabilities

Thus, the central SCA-based layer allowed for easy re-use and combination of developed service components in order to serve different application-specific functionality.

While the SCA-based Service layer is responsible for integrating the IntelLEO platform's internal components/services, the Persistence Layer and Application Layer are focused on necessary integration with underlying storage systems (databases and RDF repositories) and existing software systems (LSMs, legacy systems) respectively.

The Persistence Layer is realised as an object-oriented enterprise persistence system to be as independent from the underlying storage implementation as possible. All IntelLEO services' interaction with the storage systems is routed through the persistence layer, which abstracts the actual storage implementation into a uniform object-oriented foundation, on which all services are working.

The Application Layer consists on the one hand of a set of web-based user interfaces, which provide capability for a human user to directly interact with the IntelLEO service platform, and on the other hand of a set of application-specific adapters and connectors, which integrate the IntelLEO services with existing software systems. These adapters and connectors are specific for each of the three business case implementations to reflect the BCs' unique requirements.

In addition to this and to facilitate a highly distributed development – both in terms of location and time – the IntelLEO consortium agreed on a set of software tools, libraries and frameworks to be used during development and relied on a number of collaborative software development tools and services.

The software tools used, together with their version, link and name of the task they are being used for, are listed in the following Table 6. These tools, which have been used to develop and run the IntelLEO system, are state-of-the-art tools and software to provide a modular, extendable and expandable service-oriented approach.

Table 6 – Overview of used software tools

Function	Software	Version >=	Link
Programming Language	Java	1.6.0_xx	http://www.oracle.com/technetwork/java/index.html
IDE	Eclipse	3.6	http://www.eclipse.org
POJO-based Persistence	Hibernate	3.5.1	http://hibernate.org/
Databases	H2 Database	1.1.131	http://www.h2database.com/
RDF API	Jena	Jena 2.6.4	http://jena.sourceforge.net/,
RDF to Java Mapper	JenaBean	JenaBean 1.0.7	http://code.google.com/p/jenabean/
RDF storage	SDB	SDB 1.3.5	http://openjena.org/SDB/
RDF publishing server	Joseki	Joseki 3.4.4	http://www.joseki.org/
Service Execution Environment	Tuscany SCA Java	1.6.1	http://tuscany.apache.org/sca-java.html
Runtime Environment / Servlet/JSP Server	Jetty	7.0.1	http://www.eclipse.org/jetty/
Web Application Framework	Wicket	1.4.17	http://wicket.apache.org/
Version Control	Subversion	1.6.17	http://subversion.apache.org/
Feature and Bug Tracking	Mantis	1.1.1	http://www.mantisbt.org/

8 Conclusion

This document summarises the results of the work realised in tasks T420 Ontology framework, T430 Collaborative Learning Services, T440 Content/Knowledge Provision, T450 Learning Path Creator and Organisational Policy and T460 Full Prototype Integration within the IntelLEO Full Prototype. The present deliverable provides a brief overview of the functionality implemented for the full prototype.

The presented functionality will be integrated within different BC and tested by all project partners. The feedback from industrial partners will be used to update/improve the functionality and complete it with other models. Certain improvements in respect to usability (e.g. user interface etc.) will be performed in parallel to testing according to the user feedback.