KNOWLEDGE MANAGEMENT PLATFORM (KMP)

A Semantic Web Service for the Cartography of Competences in the Telecom Valley of Sophia Antipolis

Abstract. The aim of the KMP project is to increase the portfolio of competences of the Telecom Valley of Sophia Antipolis by helping actors in expressing their interests and needs in a common space. The solution relies on the specification, design, building and evaluation of an online customizable semantic web application.

Key words. competency cartography, online service of competency management, semantic web service, Ontologies, knowledge management, usages, co-design

Fabien Gandon[(1)], Alain Giboin[(1)], Olivier Corby[(1)], Nicolas Gronnier[(1)], Cecile Guigard[(2)], Catherine Thomas[(3)], Claire Behar[(3)], Jean-Luc Faraill[(2)]

[(1)] INRIA Sophia Antipolis, France
[(2)] Telecom Valley Association, Sophia Antipolis, France
[(3)] RODIGE / IDEFI, Sophia Antipolis, France

1. Provide a Map of Competences to Foster Partnerships

The Knowledge Management Platform (KMP) project was launched in 2002 by, the Telecom Valley Development Commission, the University of Nice Sophia Antipolis (UNSA), the CNRS, the INRIA Sophia Antipolis, the GET, as part of the Emerging Uses Research Labs of the National Technological Research Center (CNRT) located in Sophia Antipolis and dedicated to Telecommunications, Internet, and Uses. KMP is a project of the French National Network of Research in Telecoms (RNRT) with a budget of 518 939 Euros

The primary objective of this project is to create and implement an innovative knowledge management solution based on: (1) a repository shared by the members of the Telecom Valley, including a map of competencies, actors and projects; (2) a common language to describe and differentiate the needs and the resources of all the participants.

The elaboration of the repository is articulated around three application scenarios: (1) promoting the Scientific Park of Sophia Antipolis and its international development by providing the local institutions with the pertinent and up-to-date information. (2) facilitating partnerships between different industrial firms of Sophia Antipolis. (3) facilitating collaboration on projects between industrial partners and the different research institutes.

Thus, the goal of KMP is to build an innovative solution of knowledge management shared within a community, in order to foster synergies and partnerships by providing a dynamic map of the competences of the different stakeholders. The solution relies on the specification, design, building and evaluation of an online customizable service.

This service will become the main component of a portal for the community of the industries, the academic institutes and the institutional organizations involved in the Telecom Valley of Sophia Antipolis. The implementation of this knowledge management solution should on the one hand reinforce the dynamics of competence creation and accumulation within the Telecom Valley and, on the other hand, allow discovering the processes and the applications relative to the cooperation in a network.

The main scenarios should be supported by the platform by answering the range of queries they give rise to:

(1) *Acquire and give a broader visibility of the Telecom Valley community*, answering queries such as: "What are the new technical competencies that appeared during the last 6 months? Identify the firms and/or institutes that have developed this competence", "Which firms are working on BlueTooth? What are the applications created? How many teams are involved?"

(2) *Search and exchange information in the case of Inter-firm cooperation*, answering queries such as: "I am looking for a partner specialized in encryption algorithms, who has already been involved in joint-projects and has an ISO 9001 certification", "Our company has a possible Y Project 6 months from now and plan to call its partners for the Z, W competencies.", "Which are the ISO 9001 version 2000 certified companies?"

(3) *Search and exchange information in the case of Public research – Private research cooperation*, answering queries such as "Which are the firms and research institutes interested in cooperation in R&D projects?", "I am looking for an industrial partner owning a fuzzy logic competence for the RNRT A Project"

This platform relies on a semantic web application available online for all the actors of the value chain of the telecom valley.

We can already identify three of the main concepts of the ontologies underlying KMP and that the platform helps locate:

- *competency*: the platform provides dynamic up-to-date cartography of the competencies available in the telecom valley and its complementary part *i.e.* the missing competencies;
- *actor*: the platform assists the identification and characterization of the actors of the value chain of the telecom valley;
- *interaction*: the platform supports the detection of existing or potential interactions between the actors of the value chain.

The project comes within the scope of the "Uses Lab" on Sophia Antipolis to observe the uses of the new technologies of information and communication. The project is user-driven and one of its goals is the analysis of collective uses of an online service to foster competency sharing through out the network of companies and institutes of the telecom valley.

The project is a real-world experiment: the steering committee is composed of about ten pilot users; it follows a prototype life-cycle with a strong emphasis on analyzing usages and practices; it is designed in collaboration with the Telecom Valley association, a true community of practices in the domain of telecoms and associated services. Pilot companies include: Amadeus, Philips Semiconductors, France Telecom R&D, Hewlett Packard, IBM, Atos Origin, Transiciel, Elan IT, Qwam System, Cross

Systems. Institutional organizations include: CCI Nice Côte d'Azur via IRT (Initiatives Riviera Technologies), Côte d'Azur Développement. Research institute include: UNSA, CNRS, INRIA and GET.

A progression through co-design is applied to every aspect of the project:

- mock-ups of interfaces are built with end-users;
- specification and identification of needs involve pilot users to foster the emergence of new usages. It was the case, for instance, for the cluster identification functionality as described in section 3.
- multidisciplinary teams worked on the different models formalized in RDF/S and used by CORESE (economists, managers, industrials, researchers, librarians, etc.)

Ontologies were built from models provided by domain experts and end-users: models of competencies, models of the telecom domains (networks, computer science, etc.), task models, value chain of the telecom valley, etc.

Eleven pilot firms and nine pilot research institutes were interviewed by researchers in management to validate management and economic models, initialize their profiles and train them to use the system in order to update their profiles and submit queries to find new partnerships and business opportunities.

The second version of the prototype is finished and online, it is being tested by end-users. It was decided to multiply and to accelerate the prototype cycles in the next 9 months.

A survey is being prepared to evaluate the value added by the tool and its role in the creation of new knowledge in the Telecom Valley.

2. A Semantic Web Service for the Cartography of Competences

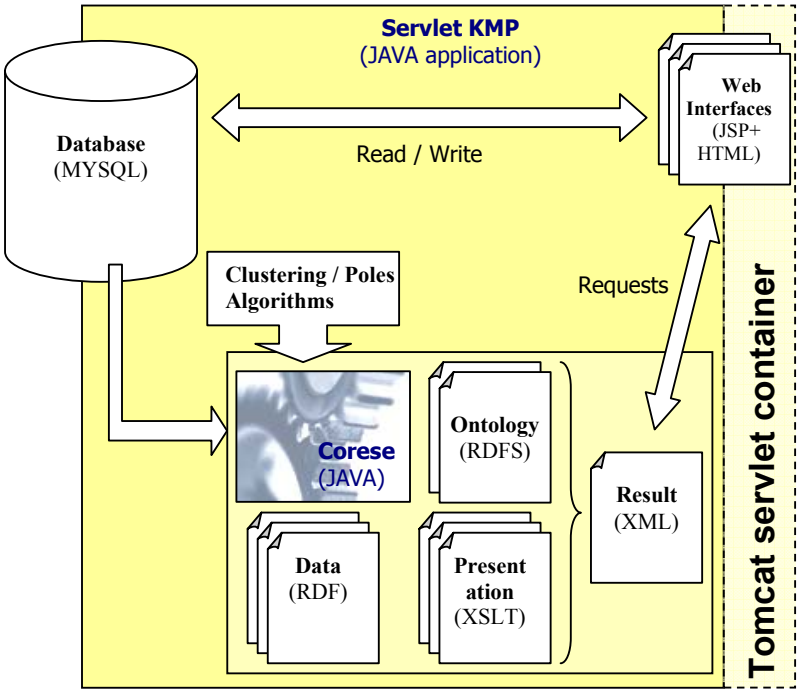
KMP is a real world experiment on the design and usages of a customizable semantic web service to generate web documents that depict and assist the management of competencies available in the telecom valley of Sophia Antipolis, at the level of the organizations (companies, research institute and labs, clubs, associations, government agencies, schools and universities, etc.)

This Web application relies on ontology-based models and inferences and merges the frameworks of the semantic web (RDF, RDFS) and the classic web (HTML, CSS, SVG) and the structured web (XML, XSLT) to integrate data coming from very different sources, allow queries from different viewpoints, adapt content to users, analyze, group, infer and render indicators of the Telecom Valley situation.

KMP relies on the integration of multiple components: databases for back-end persistence, web servers with JSP and servlets to provide front ends, and the CORESE semantic web server [1] to provide semantic web processing capabilities.

Databases are used to store the different ontologies (e.g. ontology of technologies, of actions, of deliverables, of markets, of cooperation, *etc.*), the models (e.g. value chain of a telecom valley), and the users' data (e.g. descriptions of firms, research centers, competences, projects, *etc.*). Direct accesses and modifications of ontologies and other data are managed directly at the database level. Wrappers extract the

relevant/authorized data from the databases and export them in RDF/S to feed CORESE as needed.



CORESE is used to load RDF and RDFS data as soon as inferences are needed.

For CORESE, a query is either a triple or a boolean combination of triples. For instance the following query retrieves all the persons (line 1) with their names (line 2) who are authors (line 3) of a thesis (line 4) and returns its title (line 5):

```
(1) ?p rdf:type kmp:Person
(2) ?p kmp:name ?n
(3) ?p kmp:author ?doc
(4) ?doc rdf:type kmp:Thesis
(5) ?doc kmp:Title ?t
```

The first element of a CORESE triple is a variable or a resource qualified name (XML qname); the second is either a property qname, a variable or a comparison operator; the third is a variable, a value or a resource qname. CORESE offers a broad range of operators to extend, control and approximate queries [1]: comparison operators and their negation (equality, ordering, inclusion); type comparators and their negation (strict specialization, specialization, same type, generalization, strict generalization); negation as failure; queries on ontologies; select operator to list the values desired in the answer; group operator to group the retrieved answers according to one or more concepts; count operator to counting the (different) answers retrieved; ontological and structural approximation in query solving; etc.

CORESE implements its matching algorithm against the type hierarchies of the ontology using an extension of the projection operator as defined in the Conceptual Graphs formalism.

In addition CORESE enables us to represent domain axioms: we proposed a rule extension [2] to RDF and CORESE integrates an inference engine based on forward chaining production rules. The rules are applied once the RDF is loaded and before the query processing occurs.

For instance the following production rule encodes a domain knowledge saying that if there ever was a registration of a firm to the KMP project then this firm is of type "KMP firm" and thus is a pilot firm of the project.

```
<cos:rule>
      <cos:if>
            ?f rdf:type kmp:Firm
            ?f kmp:happenTo ?event
            ?event rdf:type kmp:BecameMember
            ?event kmp:group kmpi:KmpGroup
      </cos:if>

      <cos:then>
            ?f rdf:type kmp:FirmKmP
      </cos:then>
</cos:rule>
```

The second example of rule (below on the left) formalizes the definition of "identical competence" as defined by researchers in management and economics. It allows users to answer queries such as "what are the most frequent competences in the Telecom Valley?" by generalizing and grouping competencies (answer shown below on the right).

```
<cos:rule>
      <cos:if>
            ?cmp1 rdf:type kmp:Competence
            ?cmp2 rdf:type kmp:Competence
            ?cmp2 not::kmp:identical ?cmp1
            ?cmp1 not::kmp:identical ?cmp2
            ?cmp2 != ?cmp1

            ?cmp1 kmp:action ?action
            ?cmp1 kmp:deliverable ?deliverable
            ?cmp1 kmp:environment ?environment

            ?cmp2 kmp:action ?action
            ?cmp2 kmp:deliverable ?deliverable
            ?cmp2 kmp:environment ?environment
      </cos:if>

      <cos:then>
            ?cmp1 kmp:identical ?cmp2
      </cos:then>
</cos:rule>
```

Quelles sont les 5/10/15 **compétences les plus représentées** dans Telecom Valley ?

Retour

10 Compétences réparties en 5 groupes :

Un groupe de 2 compétences identiques :

(18 ressources)
- Réaliser / Développer, Logiciel, Système d'Information (*Coframi, Bb*)
- Générique, Logiciel, Système d'Information (*Coframi, Bb*)

Un groupe de 2 compétences identiques :

(12 ressources)
- Réaliser / Développer, Logiciel, Informatique industrielle (*Coframi, Bb*)
- Générique, Logiciel, Informatique industrielle (*Coframi, Bb*)

Un groupe de 2 compétences identiques :

(3 ressources)
- Recruter, Collaborateur, Environnement Télécom (*Elan IT ReSource, Bb*)
- Recruter, Collaborateur, Technologies de l'information (*Elan IT ReSource, Bb*)

Un groupe de 2 compétences identiques :

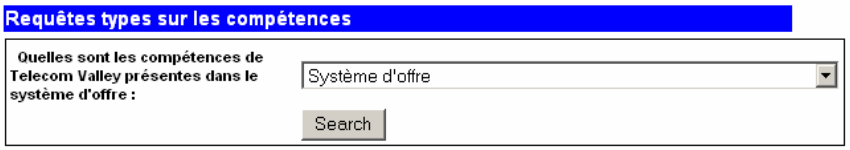
(2 ressources)

Finally, CORESE also provides a language to rapidly define forms by aggregating and formatting results of queries on the ontology (e.g. a drop-down box may be populated by asking for the sub-types of Markets).

For instance the following code describes a form to submit a query to get the competences available in the Telecom Valley in a market chosen by the user.

```
<group name='envCmp' select='false'>
      <!-- select='false' means no Properties checkbox -->
      <input type='hidden' name='title' value="comp_env" />
      <select submit='true' name='env' title="Quelles comp&eacute;tences de Telecom Valley sont pr&eacute;sentes dans le syst&egrave;me d'offre : ">
            <class>kmp:Environment</class>
            <selected>kmp:Environment</selected>
      </select>
      <query>
            select merge ?p ?c ?labelEnv where
            ?f rdf:type kmp:FirmKmP
            ?f kmp:position::?p ?pos
            ?pos kmp:competence::?c ?cmp
            count::?cmp rdf:type kmp:Competence
            ?cmp kmp:environment ?env
            ?env rdf:type get:envCmp_env
            <!--recupere le label de la classe choisie-->
            ?class = get:envCmp_env
            ?class rdfs:label ?labelEnv@fr
      </query>
</group>
```

The resulting form is shown in the following screenshot:

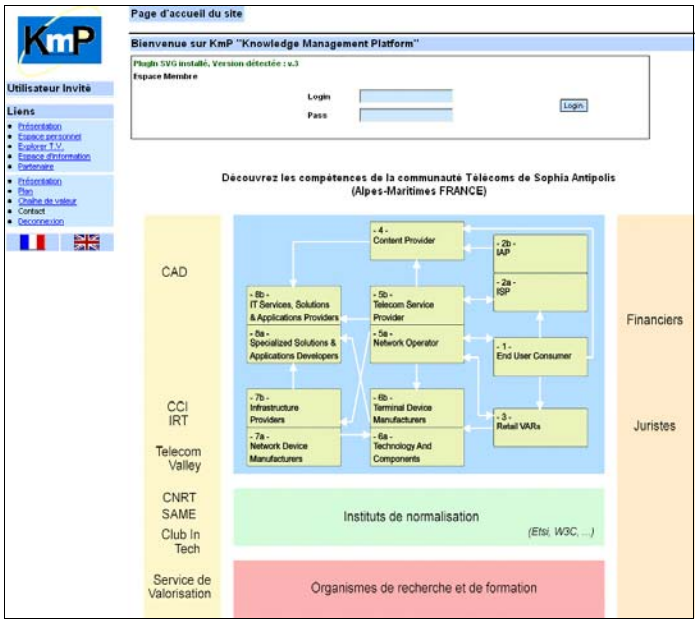


The result obtained for this query on the "E-Business" market is the following one:

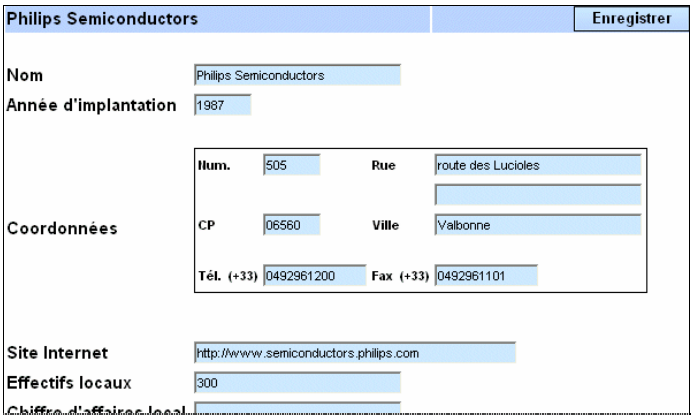
3. Guided Tour of the KMP Portal

Login and private spaces

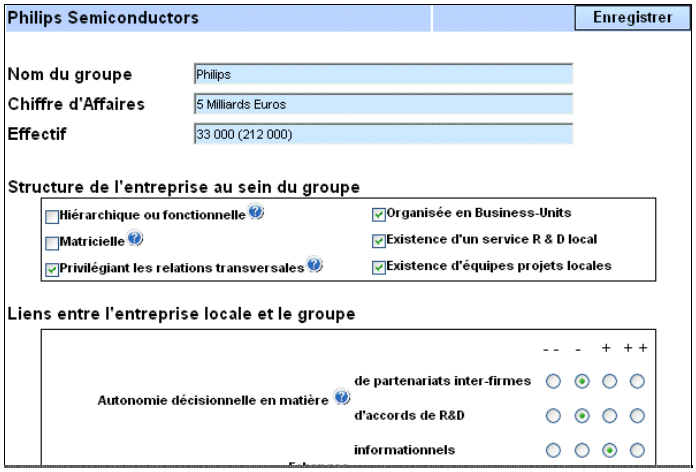
The screenshot on the right is the login window of the portal. Every page of the portal has (1) a top bar that gives the current position of the user in the map of the web site (2) a navigation bar on the left that changes with the context (user, position in the site, etc.) and (3) a main frame with the current content. In the following screenshots we only show the main frame. Here the main frame shows a login window and the SVG view of the value chain as modeled in the underlying RDF/S files.



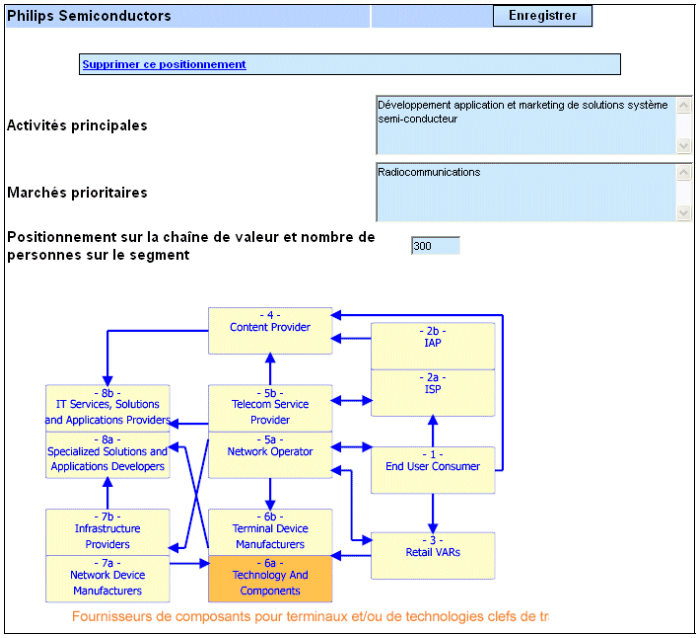
Once connected, the users can access the private spaces of their organization. For a company, the first part of this space is dedicated to information about the local implantation of the firm. In this screenshot a local branch of Philips is described



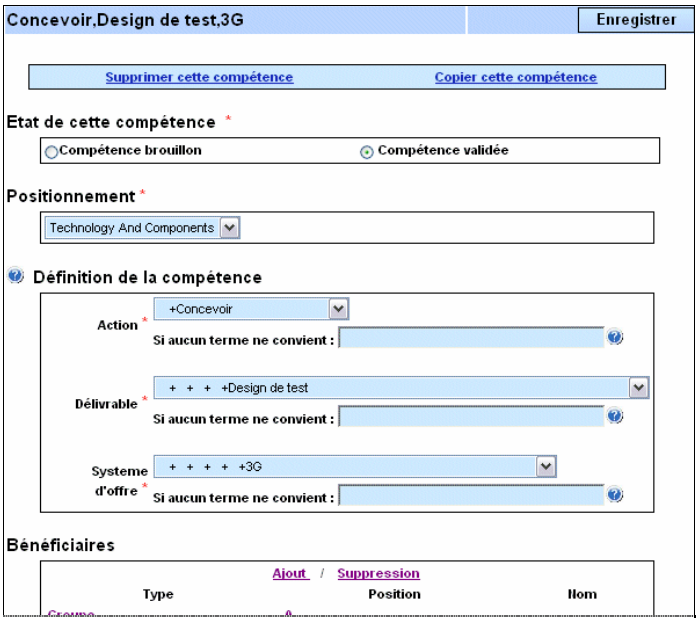
A second part is dedicated to the non local description of the firm if the firm has a national of world-wide identity. Here, for instance the Philips Group is described.



The company positions itself on the value chain and describes its usual partnerships and favorite partners. All these descriptions and forms use the underlying ontologies.

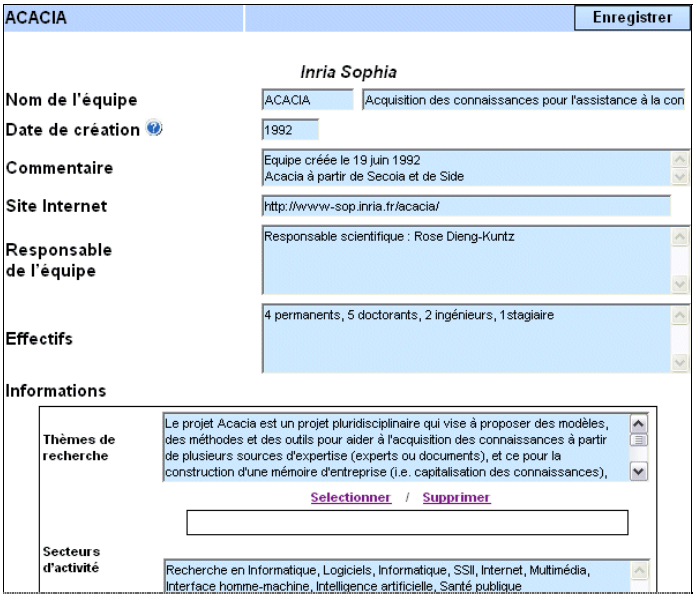


The company also lists its competences and describes each one of them using the model proposed by researchers in management and economics using three dimensions: the action involved in the competence (e.g. design) the deliverable of the competence (e.g. microchips) the domain (e.g. 3G mobile technology) and the resources involved. Each one of these dimensions has its ontology discussed and maintained by specific stakeholders.

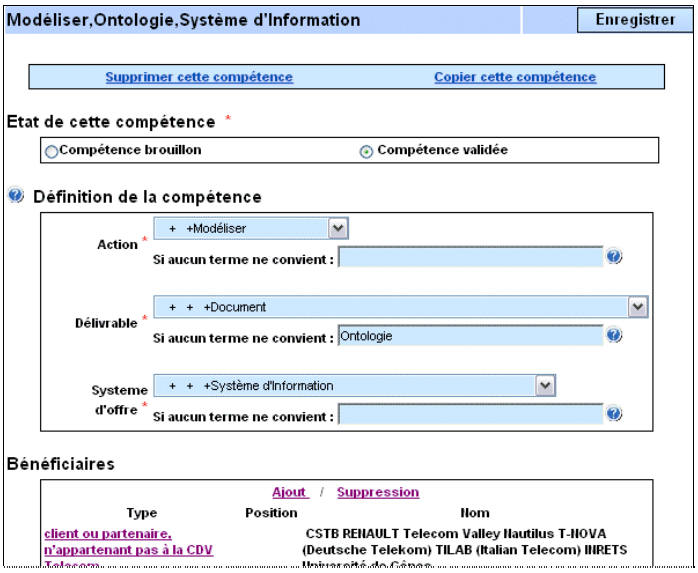


Additional information include: level of strategic importance, cooperation and R&D for this competence, industrial cooperation for this competence, informal cooperation with other communities of practice. They also list their past and current projects with the competences involved.

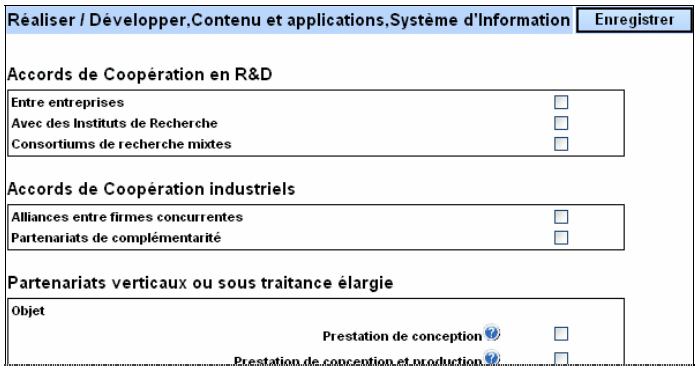
Public research labs have an equivalent private space for their description starting also with information on the local implantation.



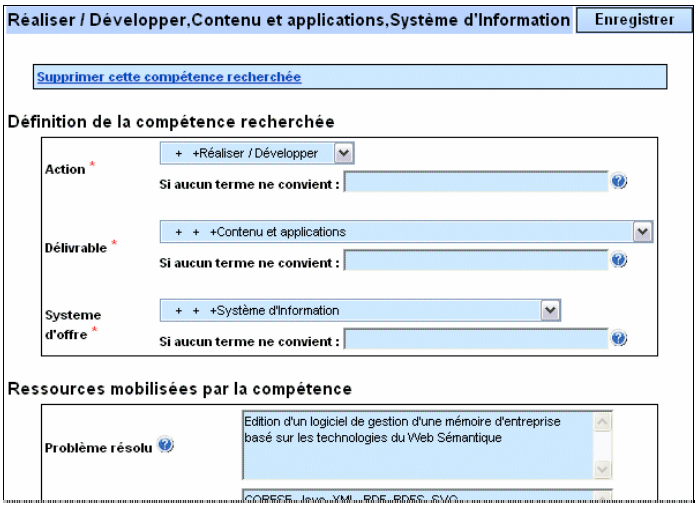
Likewise, they list their competences, describe them and list the cooperation and R&D for each one of them. They also list their past and current projects with the competences involved.



Actors describe the partnerships they are looking for and the projects they are currently starting.



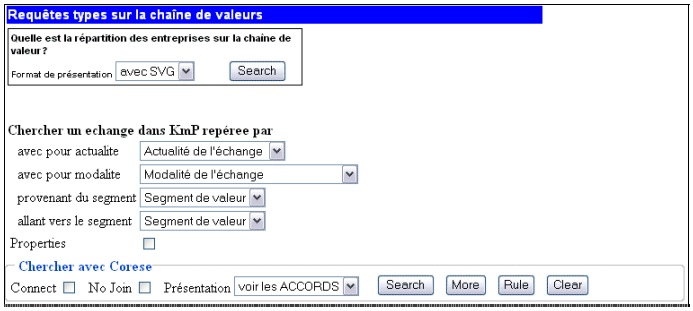
They also describe the competences they are looking for.



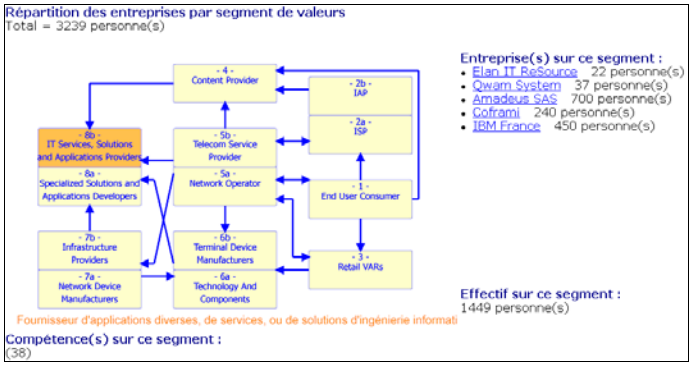
All these details rely on different ontologies and are saved in databases. From all this, the matching process can start.

Explore Telecom Valley

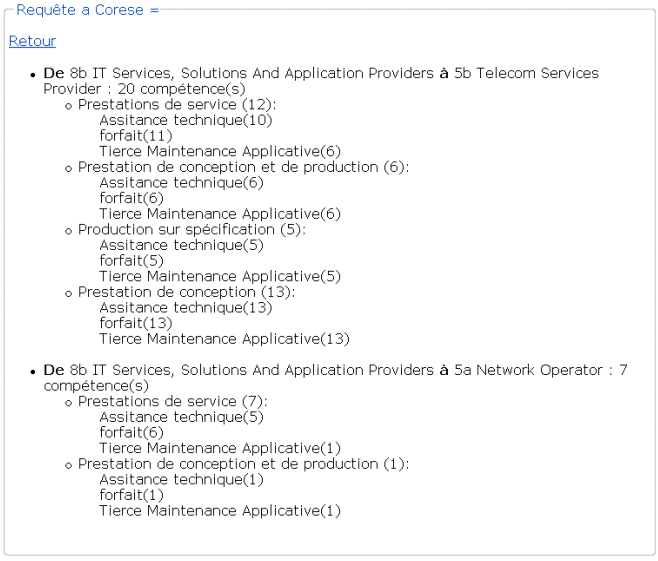
The first way of exploring the telecom valley is through predefined queries. The screenshots on the right show a window with a number of predefined on-the-fly queries of the RDF data and RDFS ontologies. The query first provides a SVG view of the value chain and other queries propose to analyze exchanges, flows and partnerships on the value chain.



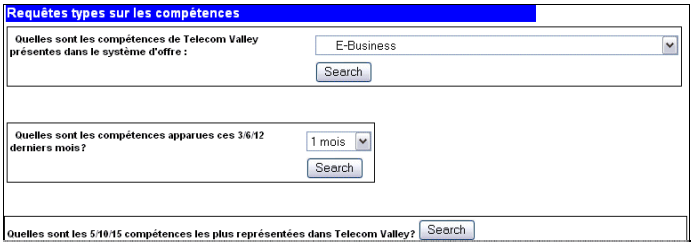
This screenshots shows the SVG interface to browse the value chain. Statistics obtained when clicking on the widgets of the SVG correspond to answers of CORESE on the RDF/S.



This screenshot shows an analysis of the flows between two segments of the value chain (box 8 and box 5 in the value chain diagram).

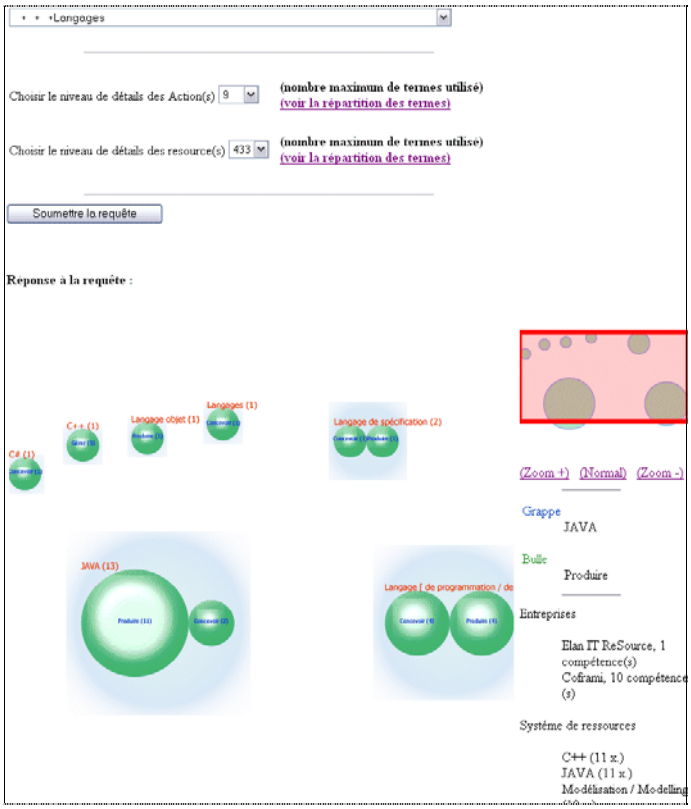


Predefined queries allow the users to know what competences are available in the telecom valley. Here the screenshot shows the form to submit a query asking for competences in "E-Business"



and the result of this query.

More complex algorithms provide clustering views to analyze the industrial park. This screenshot shows one of theses views called the "Poles". It presents a set of grapes (corresponding to resources - here programming languages), each grape contains bubbles representing actions (e.g. produce, design) associated to these resources in competences present in the Telecom Valley. Once again this SVG view is dynamically generated from the integrated RDF/S data collected. It provides very powerful tools to analyze the diversity of the valley in an up-to-date fashion.



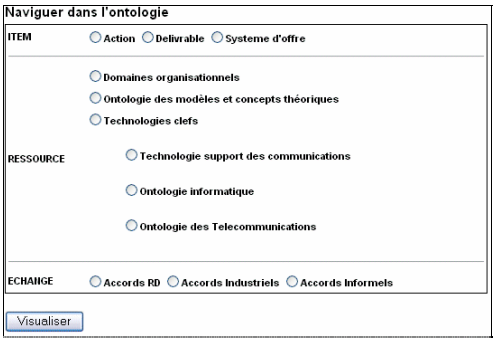
These views and analysis tools provide indicators for institutional organizations to understand the landscape of the Telecom Valley, and for actors to find opportunities, niches, partners, etc.

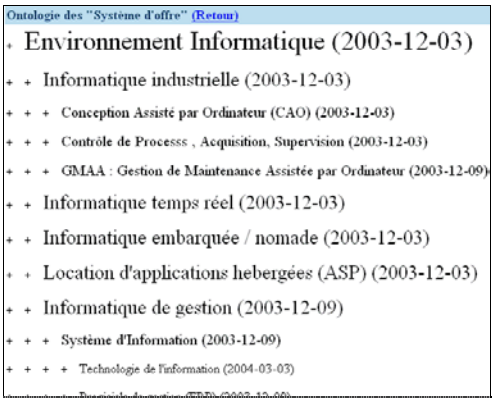
Collective maintenance of the ontological consensus

The ontologies here are vital at the scale of the telecom valley to solve the problem of matching partners: they play their full role in allowing interoperability.

From the initial proposal of the project, it was decided that ontologies would be built and populated through usage and not by some knowledge engineers. Thus several actors are active in this modeling task: experts in economics and management who proposed and laid out the theoretical models of competencies and value chain; pilot users and members of the Telecom Valley association who described scenarios helping the framing of the ontologies; end-users who provided examples of information they would like to exchange; ontologists who helped model and integrate the different contribution.

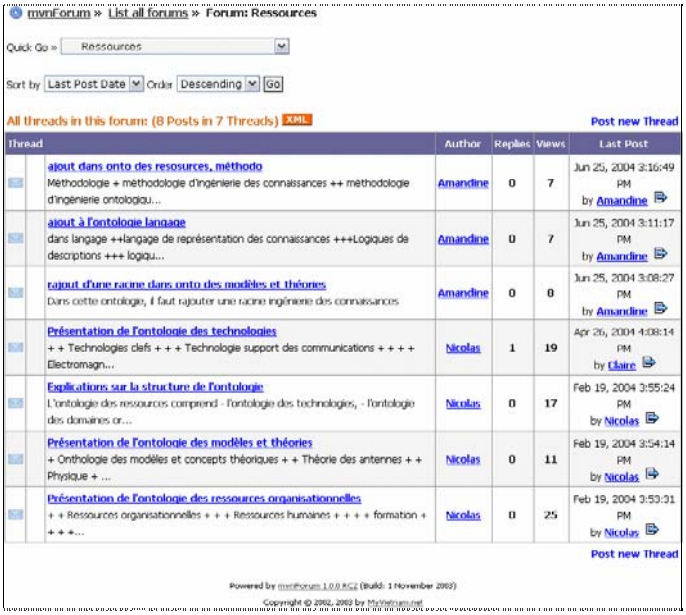
A very simple interface provides browsing capabilities for the ontologies. Using these views users can navigate and learn the parts of the ontologies they are interested in.

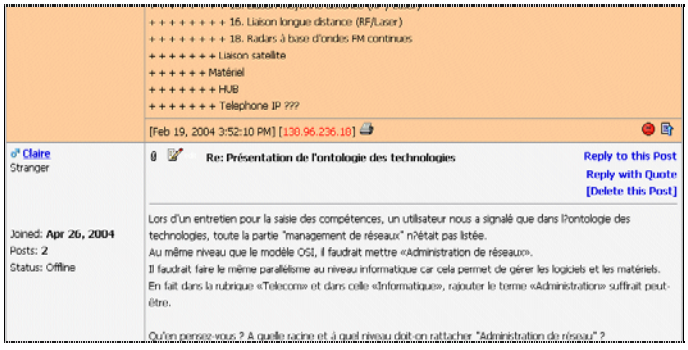




Associated to these views is a forum (we use mvnForum RC2) with a number of threads to discuss different aspects of KMP.

This forum is also used to discuss the ontologies. The screenshots here show the part of the forum dedicated to the modeling of the resources and an extract of a message discussing a part of the ontology of technologies. When a consensus is reached, a moderator validates the changes in the corresponding database and regenerates the ontology.





4. Conclusion

KMP is large user-driven project to deliver a public portal of the Telecom Valley of Sophia Antipolis mainly based on the Semantic Web technologies.

The platform integrates contributions coming from whole the Telecom Valley:

- several ontologies are discussed and validated by multiple actors using forums, brainstorming sessions, existing taxonomies, etc.
- several sources of data are integrated: models provided by practitioners and researchers in management, descriptions of firms using industrial and economic markets vocabulary, description of research institutes using academic terms, etc.

Production rules and inferences are used to fill the gaps, enrich the different contributions and bridge the different viewpoints allowing a broad variety of queries and analysis to be run.

At the time of writing this article, 11 companies and 18 Labs already have an account and entered some descriptive information. The site requires identification to control the access of the different users and restrain them to what their ownership allows. Although their profile might be incomplete they can already use the entered information to explore the Telecom Valley and look for partnerships.

The whole system relies on RDF, RDFS, and Rules to describe the models and actors of the Telecom Valley. Exploiting this semantics the platform is able to:

- apply rules to maintain knowledge in different view points e.g. generalize and group identical competences detailed in the profiles of the actors to provide statistics to researchers in management;
- exploit underlying models to propose graphic views of the Telecom Valley using XSLT to produce SVG rendering and combining on-the-fly models defined by the economists with data entered by the different actors;
- apply clustering algorithms and produce graphic representations in SVG to allow institutional and industrial actors to get abstract views of the cartography of competences in the Telecom Valley;
- apply complex query constructors to find partners, build consortiums, extract indicators, build statistics, sort and group results, etc.

So far, KMP is the largest real-world public application using most of the functionalities offered by the CORESE semantic web server.

References

[1] Corby, Dieng-Kuntz, Faron-Zucker. Querying the Semantic Web with the Corese Search Engine, PAIS2004 at ECAI2004, 2004

[2] Corby, Faron-Zucker. Corese: A Corporate Semantic Web Engine, Workshop on Real World RDF and Semantic Web Applications, WWW, 2002