INFORMATION SOCIETY TECHNOLOGIES (IST) PROGRAMME


*Diogene*

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# 1. Introduction

Diogene project began in April 2002 and ended in October 2004. The main project objective was to:

> *design, implement and evaluate with real users an innovative training Web brokering environment for ICT individual training (but based upon a domain-independent platform) able to support learners during the whole cycle of the training, from the definition of objectives to the assessment of results through the construction of custom self-adaptive courses.*

The realised system uses several **state-of-the-art technologies** such as: metadata and ontologies for knowledge representation, fuzzy learner modelling, intelligent course tailoring, co-operative and online training support. Besides, it includes a set of **innovative features** such as: individual learning style support, Semantic Web openness, Curriculum Vitae generation and searching facilities, free-lance tutors support, assisted Learning Objectives definition.

In the present section we give, first of all (1.1), a brief summary of the features offered by the training environment obtained as the main output of the Diogene project. Then we summarise work performed during the project (1.2) and actors involved (1.3). In next sections we give more details about this and further Diogene outputs: defined models and methodologies (chap. 2), the VO-based architecture (chap. 3), the training portal (chap. 4), the training content (chap. 5), results of the evaluation process (chap. 6), results of exploitation and dissemination activities (chap. 7).

## 1.1 The Training Environment

The Diogene Training Environment, completely Web-accessible, realises an architecture based on the **Virtual Organisation** (VO) paradigm and on the Web Service technology. Once inside a Diogene virtual *Training Agency*, a learner can select a particular set of topics from an ontology and let the system arrange a personalised self-adaptive course about chosen topics (personalisation is based on learner profiling). Apart this, the system is able to provide the following features.

- Give **free-lance tutors** the possibility to subscribe to a virtual *Tutor Agency* and to formally describe their professional competencies. Tutors, in this way, are considered as "learning resources" able to be exploited (if requested) by students during their learning process in order to obtain guidance.

- Individuate learners with similar needs and profiles and provide them a **co-operative virtual environment** named *Café* in order to support social interactions, mentoring and information exchange. The same environment is used to interface synchronously and asynchronously free-lance tutors with their students.

- Define and apply a **learner model** able to represent learner assessed achievements and obtain, for each learner, an electronic (and automatically updated) Curriculum Vitae (CV). Third parties interested to find qualified professional can connect to a virtual *Skill Agency* that, given a specified profile, is able to search in the Diogene VO compatible CVs.

- Apply a **pedagogical strategy** based on the Felder's theory[1] able to determine individual

[1] Felder R. M., Learning and Teaching Styles in Engineering Education, Engr. Education 78 (7), 674-681, 1988.

learning styles and adapt courses accordingly. The ability to dynamically improve the system representation of an inferred style is also provided and exploits information gathered during knowledge assessments.

– Allow content providers to semantically annotate Learning Objects (LO) according to an underlying ontology-based **knowledge representation model**. A tool named KMS was also realised to annotate content and to register it inside virtual *Publishing Houses* where they can be accessed from anywhere on the Diogene VO. The same tool also provides ontology editing features and registration capabilities inside Diogene *Knowledge Agencies*.

– Draw and use free content directly from the Web and from the Semantic Web exploiting Diogene *Web Catcher Agencies* that are based on a **knowledge extraction** methodology able to extract semi-automatically metadata from text and on a **knowledge harmonisation** methodology able to find correspondences between different ontologies.

## 1.2 Summary of the Work Performed

In this section we describe the evolution of the work during the project referring to the next sections for the description of outputs obtained. Figure 1 shows the Gantt diagram of the project where month 1 of year 1 is April 2002.

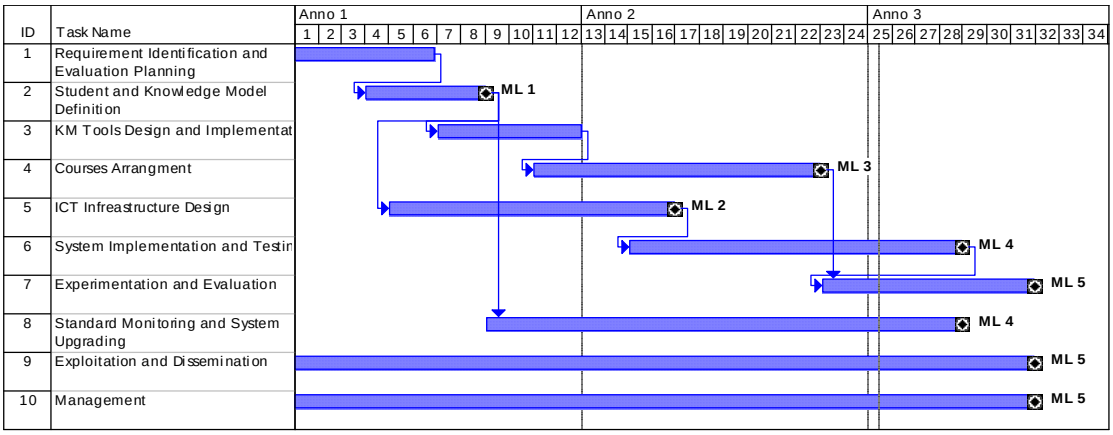



***Figure 1.*** *Diogene Gantt chart*

In **WP1** we have formalised the pedagogical requirements of the training environment together with the evaluation criteria successively adopted in WP7.

In **WP2** we realised two surveys on student and knowledge representation methodologies in order to have an overview of the state of the art in this matters. Then we defined a knowledge model, a student/tutor model and a didactic model that will be described in chapter 2.

In **WP3** we have focused on the design and implementation of the Knowledge Management System (KMS) for metadata and ontology editing, based on the knowledge model defined in WP2. The KMS will be described in chapter 5.

In **WP4** a main ontology covering the ICT domain was created and eight courses were implemented by project partners and indexed exploiting Diogene KMS. Developed ontology

and courses will be described in chapter 5.

In **WP5** methodologies for user grouping, CV searching, knowledge extraction and knowledge harmonisation were defined and tested with stand-alone prototypes. Moreover, the whole system's distributed architecture has been designed. Defined methodologies will be described in chapter 2 while the distributed architecture is object of chapter 3. In this Work Package we also have done a survey on existing E-Commerce tool. From the results of this survey we started a discussion about payment services to be included, after the end of the project, in the Diogene's architecture (see chapter 8).

In **WP6** all organisations of the Diogene network have been implemented. Chapter 4 presents an overview of the obtained prototype from the user point of view. The first version of the prototype have been refined once first experimentation results (see WP7) where available and a new version was delivered.

In **WP7** we have tested the first prototype of the system and given feedback to WP6 developers for the construction of the final version. This last version has been finally experimented and evaluated during the last months of the project. A summary of results of such evaluation process will be presented in chapter 6.

In **WP8** we have monitored the e-learning and Semantic Web standards (producing 2 reports) in order to allow the system to be compatible with the last trends of the field. The results of the first report has suggested us to focalise on the possibility to represent the Ontology also in OWL-Lite (target completely achieved). Results of the second report will be taken into account in future development around Diogene (see chapter 8).

In **WP9** we have outlined plans for the future exploitation of the project's. The same workpackage takes in charge the dissemination of project results. Results of dissemination activities are summarised in chapter 7.

In **WP10** a management activity, spanning the whole project, has ensured progress control, partners co-ordination and quality control. We have organized 6 internal meetings among the Project's Management Board which have been essential for both technical and management discussion about the project evolution.

### 1.3 The Partnership

The Diogene consortium is composed of 8 partners (university departments, research centres, educational organizations and SMEs) belonging to 7 different European countries.

**CRMPA** (Centre for Research in Pure and Applied Mathematics) from Salerno, Italy, is a not-for-profit consortium working in the Information Technology field and dealing, mainly, with distance learning and training. It has co-ordinated the whole project. It contributed mainly to technological activities, from the analysis of requirements to the implementation of the training environment, from the definition of models and methodologies to the design and implementation of KM tools. It was also involved in exploitation, dissemination and management activities.

**B&P** Badegruber & Partner (Austria) is a big adult education centre specialised in distance learning and training. It has played the role of system evaluator to assess, in co-ordination with other partners, the real added value of Diogene in terms of cost effectiveness, learning efficiency, flexibility in time and space, user satisfaction, etc. It has dealt with dissemination and management topics too.

**SU** Centre for Information Society Technologies (Bulgaria) is an interdisciplinary research and training institution supporting the development, introduction and wide use of Information Society Technologies. It has played the role of content provider by arranging a set of courses about ICT topics exploiting Diogene methodology and building the system's ICT Ontology. It has contributed to the constitution of a test bed of individual ICT professionals and free-lance teachers involved in the experimentation phases. It has assisted CRMPA in the design and implementation of some software components. Finally, it has dealt with exploitation, dissemination and management topics.

**DIIMA** The Department of Engineering of Information and Applied Mathematics of the University of Salerno (Italy) is promoter and partner of the Centre of Excellence in "Methods and System for Learning and Knowledge". It has participated in the analysis and experimentation phases by supporting the constitution of a test bed of free-lance teachers to be involved. Moreover, it has dealt with standard monitoring, exploitation, dissemination and management topics.

**ESI** European Software Institute (Spain) is an R&D services, consultancy an training provider dealing, mainly, with Software Engineering topics. It has played the role of content provider by arranging a set of courses about selected ICT topics. Moreover, it has contributed to the constitution of a test bed of autonomous and SME individual ICT professionals who have been involved in the experimentation phases. Finally, it has dealt with exploitation and management topics.

**GRETA** Greta du Vealy (France) is a public training organisation gathering many educational institutions dealing with adult and continuing vocational training. It has studied the educational requirements of the platform. It has played the role of content provider by arranging a set of courses about selected ICT topics. Moreover, it has contributed to the constitution of a test bed of individual ICT professionals who have been involved in the experimentation phases. Finally, it has dealt with exploitation and management topics.

**LOGICDIS** LogicDis (Greece) is a large software company with 19 subsidiaries and more than 1000 employees interested to train and re-train its staff about ICT topics. It has played the role of end-user enterprise during the experimentation phases and partially involved in the design and implementation of a system's component (the Bank Organization). Finally, it has dealt with exploitation (focusing on the Technology Implementation Plan) and management topics.

**USG** Department of Computer and Information Sciences, University of Strathclyde (UK) is experienced in models and tools for intelligent information access with automatically constructed similarity thesauri and Ontologies. It has mainly been involved in the design and realization of the Semantic Web search capabilities of the system and the implementation of other minor components. Finally, USG has dealt with dissemination and management topics.

# 2. Diogene Models and Methodologies

As mentioned in chapter 1, the main objective of Diogene has been the construction of an innovative platform able to play the role of broker among different educational entities and the students. This implied the definition of several original models and methodologies that have been applied in the realisation of the prototype. The purpose of this chapter is to summarise Diogene achievements in models and methodologies definition.

Following paragraphs will summarise main models and methodologies defined and obtained as outputs of WP2 and WP5 (see 1.2). Models and methodologies here defined have been exploited in the realisation of the prototype as described in chapters 3 and 4. As described in chapter 7, moreover, the work behind the definition of such models and methodologies conducted to the publication of several scientific papers.

## 2.1 Diogene Knowledge Model

First of all, the system needs to describe pedagogical information about the didactic domain it is specialized on (e.g., Computer Science, Math, History, and so on). We have developed an original knowledge representation methodology for the didactic knowledge description. It is based on an **Ontology** composed of a restricted set of relations among didactic concepts (which are the Ontology's elements, or *Domain Concepts*). These relations allow the system to achieve a very good trade-off between knowledge representation expressiveness and reasoning computational efficiency. The Ontology relations together with their semantics are described below.

- *HP* (*Has Part*): *HP* $(x, y_1, y_2, ...., y_n)$ means that the concept $x$ is composed of the concepts $y_1, y_2, ...., y_n$ , that is to say: to learn $x$ it is necessary to learn $y_1$ and $y_2$, and, ...., and $y_n$.

- *R* (*Requires*): *R* $(x, y)$ means that to learn $x$ it is necessary to have already learnt $y$. This relation poses a constraint on the Domain Concepts (DCs) order in a given *Learning Path* (the Learning Path being the final sequence of concepts delivered to the student).

- *SO* (*Suggested Order*): *SO* $(x, y)$ means that it is preferable to learn $x$ and $y$ in this order. Note that also this relation poses a constraint on the DCs' order but in this case it is not necessary to learn $y$ if we are interested only in $x$.

It is worth noting that the proposed knowledge representation paradigm is not intended to provide a general-purpose knowledge representation framework. For instance, there is no possibility to express subset relations, because each DC is an individual element (possibly decomposable in other elements) and there is no representation of set of elements or classes like in common semantic networks. The reason is that such simple knowledge representation rules are tailored to the Diogene's planning needs, while a universal treatment of Ontology representation (valid also for non-didactic purposes) was out of the scope of the project.

Another important knowledge representation structure used by the system is the Learning Objects (LOs from now on) indexing realized by means of **Metadata**, a more and more common technique in e-learning. We use LOs' Metadata to enable the machine to "understand" and manipulate the available learning material. Each LO's Metadata is filled-in by Content Providers. We use the IMS Metadata 1.2.2 standard which has been extended by including in the Pedagogical category 4 more attributes. These attributes are used in order to describe the teaching styles of each LO, following a pedagogical strategy suggested by Felder in '80s (see next paragraph).

As we will see later in chapter 5, we have applied this knowledge representation strategy to a specific ICT subject, building an Ontology for the Computer Science. The resulting Ontology has been exported in SHOE, DAML+OIL and OWL-Lite. Moreover, by using metadata, we have indexed a total of 716 LO belonging to 8 courses (as we will deepen in chapter 5) that have been used during the experimentation phase.

## 2.2 Diogene Student and Tutor Models

The Diogene Student Model is composed by a Cognitive State used to describe the knowledge degree achieved by each student about every DC and by a set of Learning Preferences to group information about the student perceptive capabilities, and preferred learning styles.

Formally, the *Cognitive State* is composed of a set of student beliefs representing "the system knowledge about each student knowledge". If the Ontology is composed by $n$ DCs ($d_1,\ldots,d_n$), then the Cognitive State of a given student is represented by the set: $Beliefs = \{B_1, B_2,\ldots, B_n\}$, each $Bi$ being a belief so defined: $B_i = <d_i, Evaluation_i>$, where $d_i$ is the i-th Ontology DC, while $Evaluation_i$ is a fuzzy evaluation of the knowledge reached by the student for the concept $d_i$.

Concerning *Learning Preferences*, instead, we focalise our attention on some LO attributes contained into a few fields of the Educational Metadata category of the IMS learning standard. They refer to generic features of a LO, such as its language, context (the student educational level), age range, typical learning time, interactivity level, learning resource type, difficulty and so on. Learning Preferences contains, moreover, information on preferred learning style according to the four couples of learning categories proposed by Felder as explained below.

- *Sensing versus Intuitive Learner*. It represents the abstraction level of the documents the user prefers. A *Sensing* student tends to like learning facts, he likes to use the same methods. The student will need more practical case studies. An *Intuitive* student often prefers discovering possibilities and relationships. He likes innovation and dislikes repetition and too much memorisation.

- *Visual versus Verbal Learner*. It indicates whether the student prefers textual or visual documents. A *Visual* student remembers best what he sees: pictures, diagrams, flow charts, films, and demonstrations. A *Verbal* student gets more out of words, written and spoken explanations. He has to write summaries or outlines of course material in his own words.

Each feature of the Learning Preferences is described by an atomic fact associated with an *Evaluation* fuzzy value. Thus, if we take into account $m$ features ($f_1, \ldots, f_m$), the student Learning Preferences are represented by the following set: $LP = \{P_1, P_2,\ldots, P_m\}$, each $P_i$ being a preference so defined: $P_i = <eq_i, Evaluation_i>$, where $eq_i$ is an atomic fact with the following syntax: $f_i = v_i$. $f_i$ is an attribute name while $v_i$ is an admissible value for $f_i$.

The values of each *Evaluation* (both for Cognitive State and for Learning Preferences) are continuously and automatically updated by the system during the learning process by exploiting results of assessment activities. We use the IMS LIP 1.0 standard (suitably extended) to represent the Student Model. Tutor Models are represented in a similar manner and using the same standard but taking into account only the *Cognitive State*. In 2.4 we will deepen this argument.

## 2.3 Diogene Didactic Model

We have developed some inference mechanisms in order to allow the system to reason about the knowledge representation structures abovementioned (the Students/Teachers Models, the Ontology and the LOs' Metadata). The "brokering" service offered by Diogene works as follows. The student inputs the system with a training query which specifies a set of Concepts (the *Target Concepts*) of the Ontology which the student is interested in. Using the Ontology and the student's Cognitive State the system can automatically generate a course by composing a Learning Path containing all those Concepts needed to learn the Target Concepts (the system includes sub-concepts and pre-requisite concepts to the training query). The Learning Path is also *totally ordered* by following the Ontology ordering constraints (the *R* and *SO* relations).

Finally, for each Concept of the Learning Path we choose a LO taking into account also the student's Learning Preferences (represented in the Student Model) which are matched with the LOs' Metadata. The collection of LOs so obtained is called Presentation. The system suggests to the student different Presentations, each composed of a set of LOs taken from a different Content Provider and with a different price. The students can choose the most suitable Presentation and finally the system is responsible to deliver to the student the chosen Presentation taken from the specific Content Provider and to arrange payments.

Diogene adopts the pedagogic theory proposed by Felder and other authors. The students' preferred learning styles are compared with the LOs' teaching styles in order to select the best material. This strategy is dynamic because we use the student's successes and failures of each on-line test in order to update his/her Student Model (both the Cognitive State and the Learning Preferences). We also have studied the possibility to automatically modify the didactic rules contained in the Ontology (the *HP*, *R* and *SO* relations). Anyway this approach seems to be more difficult to realize because the Ontology describes didactic knowledge common to all learners, and the induction of a user-independent pedagogical strategy from the students' successes and failures is harder than the customization of a learning strategy for a specific learner.

## 2.4 User Grouping and CV Searching Methodologies

Furthermore, the system is able to match the Student Model with the Teachers' Models in order to suggest a set of free-lance tutors taking into account the training query and the teacher's skills. The information about the students' skills represented in the Student Models' data base of the system can be queried (respecting the privacy requirements) by third parties interested to hire certified staff.

The system provides some collaborative tools based on an automatic clusterization of the students depending on their Cognitive States. Students are clustered in groups (*virtual classes*), each one addressing a specific topic (a Domain Concept) and composed of students with more or less the same knowledge level on that topic.

All the users of a virtual class can access to a set of common material and exercises and can collaborate through threaded discussions and chats. Students who reach high levels of abilities about specific matters can (if they consent) become mentors of students that are approaching such matters for the first time. The same collaborative environment is used to interface synchronously (by means of a Chat tool) and asynchronously (with a Forum) free-lance teachers with their students.

Finally, the system is also able to suggest to a learner some learners who have similar interests and similar profiles. This functionality works as follows: given a learner *L* submitting to

Diogene a training query *TargetC*, and with a *Cognitive State CS(L)*, the system first of all computes the *Learning Path* of *TargetC* in order to take all the necessary concepts for *TargetC*. Then, for each DC *d* of the computed *Learning Path*, Diogene computes the distance between *CS(L).d* and $CS(L_i).d$, *CS(L).d* being the *Evaluation* of *d* in *CS(L)* and $CS(L_i).d$ the *Evaluation* for *d* in *Cognitive State* of the i-th student.

Each learner $L_i$ is ranked with respect to the sum of the distances computed for all the DC of the *Learning Path*. Finally, the system returns the ranked list to the student who is then able to contact the learners following this ordering suggestion.

## 2.5 Knowledge Extraction and Harmonisation Methodologies

We have also developed a different way to collect LOs, no more based on (human) detailed indexing of high quality learning material but on an automatic classification of Web-retrieved documents. The reason of this additional tool offered by Diogene is the wish to attract students to the system with some free (although not quality guaranteed) facilities. The system performs an automatic classification of textual documents found on the Web. These documents are then treated as LOs and linked to the Ontology Concepts. The difference between our textual categorization mechanisms and the common textual categorization methodologies used in scientific literature and commercial tools is the possibility to deal with Semantic Web information possibly attached to the documents.

Diogene is able to perform different kinds of Semantic-Web based document categorization. In the first case, given a concept of the Ontology, the system takes its name and the associated textual description and extracts from these some keywords which are used to formulate a query for a commercial Information Retrieval engine (we use Google).

In the second case, Diogene is able to map an Ontology found on the Web with its own Ontology. The key idea of this mapping is the comparison of the elements of the two Ontologies (the Diogene's DCs with the concepts of the other Ontology). We do not map relations, so avoiding the treatment of isomorphism searching among the Ontologies. In fact we do not need to map relations but only the concepts, because our objective is to use this mapping in order to efficiently categorize LOs of the found Ontology with Diogene's DCs.

Finally, the mapping is based on statistical similarity which is in its turn based on the textual descriptions associated with each concept. The mapping works as follows. The system compares an Ontology (*F*) found on the Web with its own Ontology (*O*). Each element of *O* (each Diogene's DC) is compared with the elements of *F* in order to establish a map among the two Ontologies.

The mapping mechanism is based on the comparison of the (textual) descriptions attached to the concepts contained in the ontologies *O* and *F*. Once the mapping (*M*) has been created, it is used as follows: all the documents ($d_i$) linked to an element *e* of *F* are linked to a Concept *c* of *O* if *M(e,c)* holds. In this way we can save computational time since we do not need to classify each document $d_i$ but only its conceptual description *e*. $d_i$ can finally be used by the system as all the other LOs (except for the price).

# 3. The Diogene Architecture

Diogene is modelled as a Virtual Organisation (VO) strongly based on the use of Web Services. The Diogene VO is populated by entities offering and consuming services. Such entities are grouped in four categories: users (humans that provide and consume services), organizations (physical entities that as software components provide and consume services), utility components (software components embedding the technology assuring the architecture integrity) and accessor components (software components providing the access from outside to the Diogene VO and from the Diogene VO to outside).

## 3.1 Diogene Users

Diogene Users can be grouped in the following main categories (it is important to note that the same physical user can play different roles in Diogene so it can belong to more of these categories).

- **Learner**: is a student registered in the Diogene VO. He/she acquires knowledge through learning experiences provided by Diogene specific learning services. A learner skilled about some topics can offer mentoring support to other learners about such topics usually for free.

- **Freelance Tutor**: is a professional tutor offering his/her specialized mentoring support to learners about specific topics usually under the payment of some price.

- **Skill Searcher**: is an enterprise manager interested in hiring certified staff. He/she performs queries on skill repositories.

## 3.2 Diogene Organisations

Organizations of different type offer services with respect to the specifications of the Diogene VO and collaborate for the realisation of their own services. The kind of organisations supported by Diogene are summarised in the following list.

- **Publishing Houses** (PH). They store training content and provide remote access to it. They provide search and retrieval functions on the local repository via metadata-based queries.

- **Web Catcher Agencies** (WA). They are able to extract training content directly from Web and Semantic Web. Through a keyword-based text categorisation algorithm they are able, where absent, to semi-automatically extract metadata from textual learning objects ad to link them to structures maintained by the KA.

- **Tutor Agencies** (TG). They work as entry point for freelance tutors, they manage the freelance tutor archive (containing tutor models) and provide searching facilities on such archive.

- **Brokerage Offices** (BO). They research, prepare and provide training offers for learners on demand, based on customisation information (learner model, learning strategies, price, learning goals). They collaborates with PH and WA in order to retrieve didactical material that best fit the customisation requests. They collaborate with TG to retrieve and provide freelance tutors that best fit learner needs.

- **Training Agencies** (TA). They provide the basic environment for learning experiences

and tutoring activities. They are responsible for the delivery of courses and for the provision of course management and execution functions. They maintain learner models and are able to provide (on demand) course offers by exploiting services offered by BO.

- **Knowledge Agencies** (KA). They maintain and manage knowledge structures (concept dictionaries and ontologies) for the whole Diogene Network.

- **Café** (CA). They support social interactions, mentoring and information exchange by providing users a set of collaborative synchronous and asynchronous facilities. They are able to automatically arrange groups among users of registered TA by individuating and grouping learners with similar needs and/or profiles.

- **Skill Agencies** (SA). They provide search engine capabilities on Learner Models Databases of registered TA in order to let third parties interested to hire certified staff to find qualified professional (with respect to privacy requirements). They maintain, moreover, statistics of requests in order to rank required competencies.

- **Bank** (BA). It's a singleton organisation that logs transactions information occurred inside the Diogene VO. In future versions it will regulate also transactions through integration of an e-Commerce system.

More instances of the same Organisations live inside the VO. The various instances stand on different hosts and are managed (administered) by different users. Figure 2 depicts some interactions between Diogene organisations.

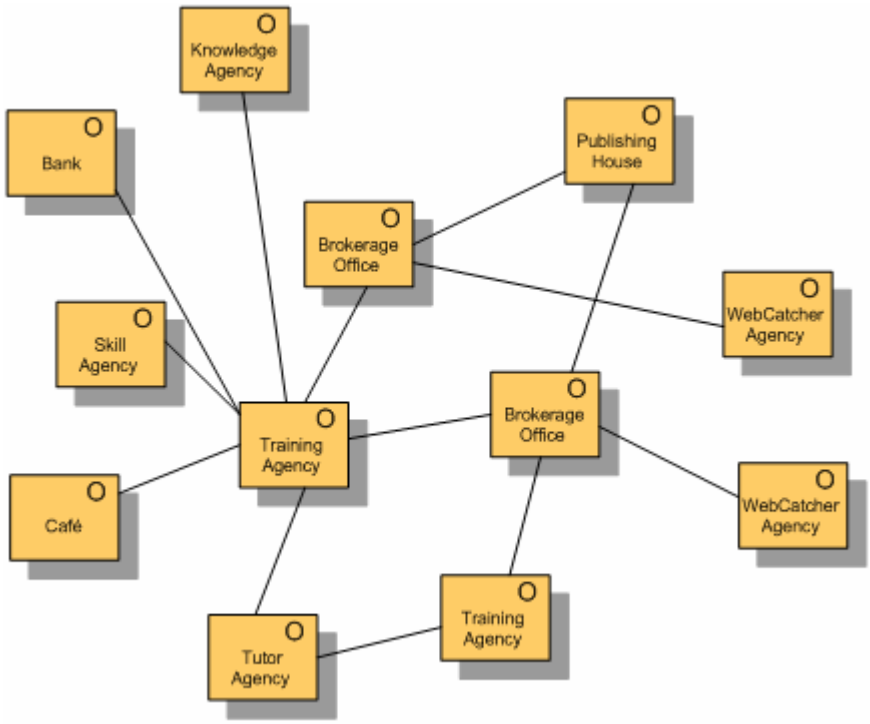



***Figure 2.*** *Interactions among Diogene Organisations.*

Following the principles of the Convergent Architecture[2], Diogene Organizations can manage Processes, Resources and other Organizations. Resources live encapsulated within the Organizations and collaborate with them to accomplish their own tasks. Resources can also be used as containers for the information exchanged between organisations. Resources can manage its own data and other Resources.

Processes express and are realised by the collaboration between Organisations or by the collaboration between Organisations and internal Resources. Processes can create and consume/use Resources and can use other Processes.

### 3.3 Utility and Accessor Components

Utility Components have no business-domain relevance but embed the technologies that explicitly assure the Architecture integrity. The Diogene VO includes the following two singleton components.

- **Authentication Agency**: it provides all services for the registration and authentication of users of the whole Diogene VO. After authentication, it releases a token that must be used as a ticket to access and be authenticated in all VO services.

- **Diogene Services Registry**: it includes Diogene White Pages (containing information about services offered by organisations), Yellow Pages (organizing services in categories) and Green Pages (including information about how to execute services).

Accessor Components provide the access to the Diogene VO services and also the access through the Diogene VO components to external services. The only Accessor Component of the Diogene VO is the following.

- **Diogene Network Reception**: the Internet entry point for all Diogene users. It provided features of user and organisation registration, it publishes characteristics and services offered by the Diogene VO, it provides administration features for the Services Registry.

### 3.4 Some Orchestrated Scenarios

In a first scenario, a **Learner** asks for a personalized training offer to his/her **Training Agency** (1) through its entry point (Training Agency web portal), starting from a concepts list that he/she wants to learn (Target Concepts).

Training Agency calls the **Knowledge Agency** (2) passing to it the target concepts in order to build the learning path, it will be composed by all concepts necessaries to the learner to reach the target concepts. Knowledge Agency builds the learning path using the owned knowledge structure, ontology and concepts dictionary, and the learner acquired knowledge.

Once the learning path is ready and fixed the best learning strategies for the learner the Training Agency calls the **Brokerage Office** (3) of the Diogene Virtual Organization in order to obtains the training offers to propose to the learner. Each Brokerage Office starting from the data received by Training Agency (learning path, learning strategies, learner model, etc..) will prepare a own training offer.

[2] Richard Hubert. Convergent Architecture, Building Model-Driven J2EE Systems with UML. John Wiley & Sons

To do this the Brokerage Office calls the **Publishing House** (4) and the **WebCatcher Agency** (4) asking them to provide the list (list entry are the metadata that describe the single Learning Object, included the price) of available material, that best fit the Training Agency requirement.

Figure 3 summarises interaction among Diogene Organisations to provide results for the first scenario.

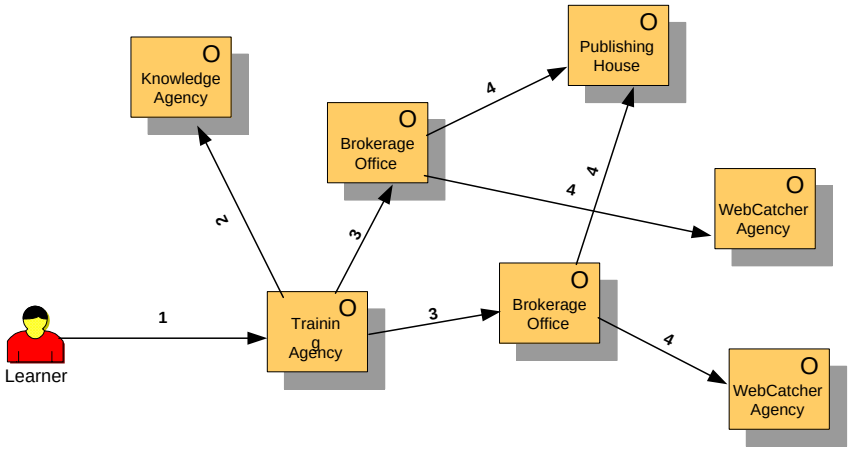



***Figure 3.*** *Summary of interactions among Organisations for the first scenario.*

In a second scenario, a Freelance Tutor accesses through **Tutor Agency** (1) to his/her jobs list and clicking on a specific job she/he can be redirected to a specific **Training Agency** (2).

The Training Agency offers a tutoring environment where the tutor can control learner activities, status, profile, results and progresses. Training Agency offers also an entry point for the **Café** (3) where tutor can meet his learners and collaborate and communicate with them.

Figure 4 summarises interaction among Diogene Organisations to provide results for the second scenario.

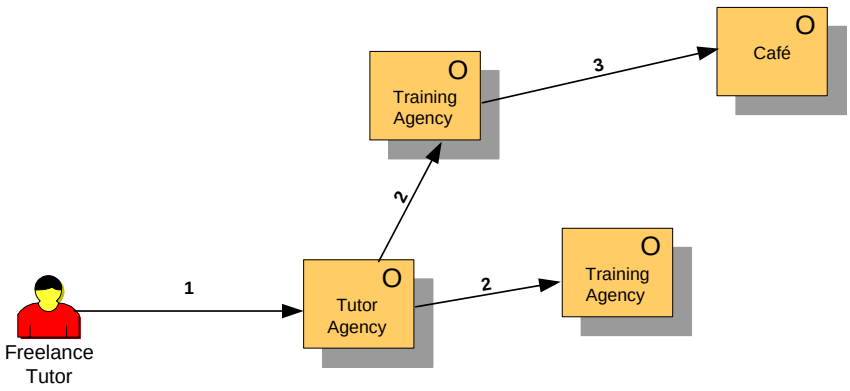



***Figure 4.*** *Summary of interactions among Organisations for the second scenario.*

### 3.5 Some Technological Details

The Diogene Virtual Organization lives into Internet environment. Organizations expose their services as Web Services described using the WSDL standard. Actually, we think that Web Services choice is the best one for a distributed environment because they are based on standards like SOAP, HTTP (protocol) and XML (meta-language for message describing) that encourage interoperability.

The authentication services have been developed ex novo and have been released as a Utility Component called **Authentication Agency**. Services provided by Authentication Agency are: User registration, User authentication and Validity check of Security Token. Security Token is a representation of security-related information (e.g. X.509 certificate, Kerberos tickets and authenticators, mobile device security tokens from SIM cards, username, etc.). Security Token travels across the Diogene Network (from a service to another one) embedded in a SOAP message. In order to achieve a consistent Token passing across the Diogene Network we use WS-Security.

For the implementation of **Diogene Services Registry** we used the known UDDI (Universal Description, Discovery and Integration protocol) technology that is one of the major building blocks required for successful Web services. UDDI creates a standard interoperable platform that enables companies and applications to quickly, easily, and dynamically find and use Web services over the Internet. UDDI also allows operational registries to be maintained for different purposes in different contexts. The UDDI project takes advantage of World Wide Web Consortium (W3C) and Internet Engineering Task Force (IETF) standards such as Extensible Markup Language (XML), and HTTP and Domain Name System (DNS) protocols.

Additionally, cross platform programming features are addressed by the Simple Object Access Protocol (SOAP) known as XML Protocol messaging specifications found.

# 4. Diogene at work

The purpose of this chapter is to give an overview of Diogene from the user point of view. Anyone interested to use the prototype can reach it through the www.diogene.org site. The Diogene Network Reception (see Figure 5) is the entry point of the whole the Diogene VO, its aim is to offer a single access point where all useful information of the network can be found.

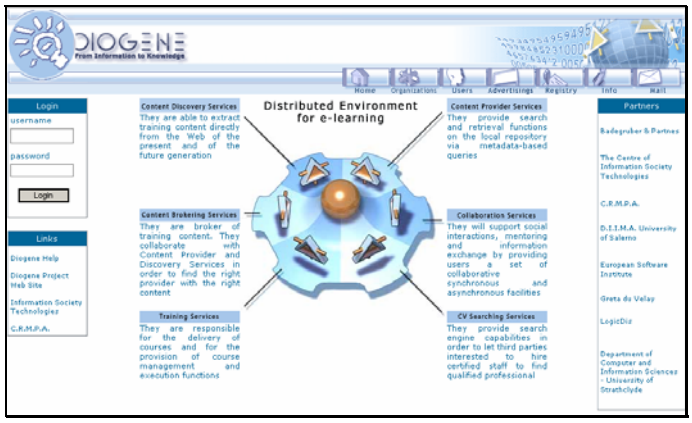



***Figure 5.*** *A snapshot of the Diogene Network Reception.*

In the Diogene Network Reception it is possible to find information related to the project and to contact project staff for further information. Through the reception it is possible to know all information concerning the organizations available inside the network and services provided (see Figure 6).

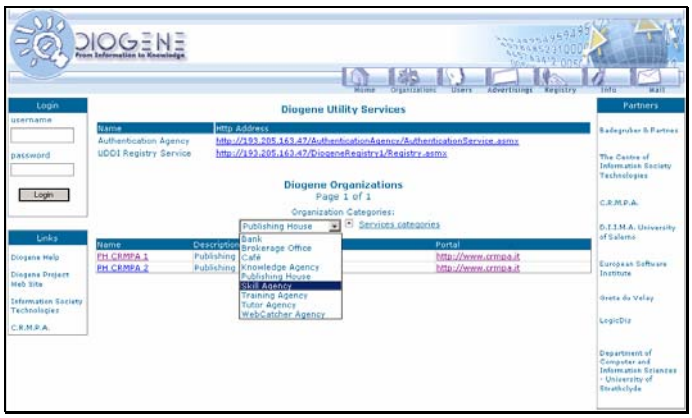



***Figure 6.*** *A snapshot of the Organisations section.*

Moreover the reception acts as a single registration point, where a new user can register and join itself to an available network organization. Once registered and logged, the user can go directly to any organisation he joined. Contacting the staff it will be possible for the user add a

new organization and to be registered as a local administrator in order to manage the organization data and services (see Figure 7).

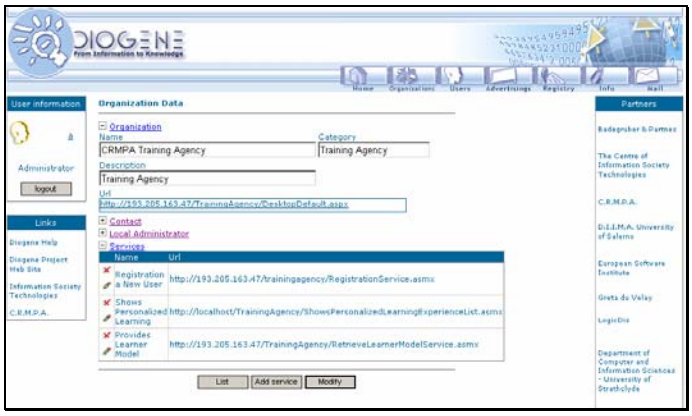



***Figure 7**. A snapshot of the Organisations data section.*

## 4.1 Learner View

An user registered as learner can access to a **Training Agency** and perform the following tasks:

- Manage its own profile, including change of learning preferences and learning attitudes;
- Define Learning Objectives (Target Concepts – see Figure 8a);
- Ask a Personalized Training Offers (Courses);
- View Courses Cart;

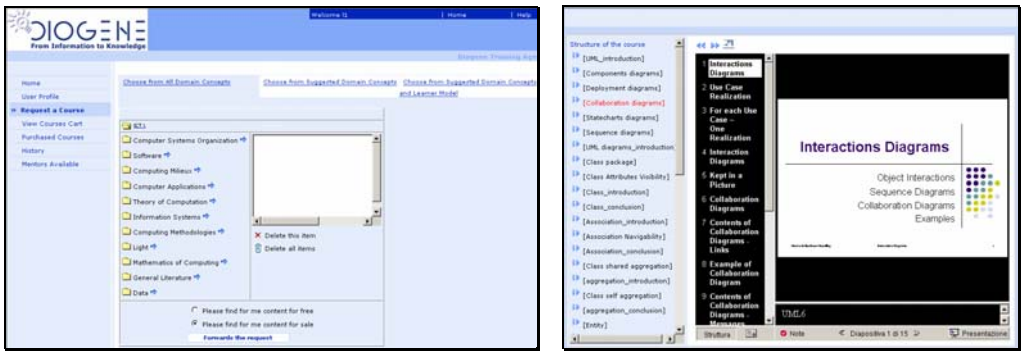



***Figure 8**. A snapshot of the Definition of Learning Objectives section (left) and of the Course running section (right).*

– Buy Personalized Training Offers;

– Run a Personalized Training Experiences (see Figure 8b);

– Require Mentor Support;

– Ask for Remedial Work;

– Select a mentor (Expert Learner or Freelance Tutor);

– View Course History.

Moreover the learner can access to a **Café** in order to do the following tasks:

– Create a new discussion table;

– Find a new user to invite to his table;

– Access to the reserved table with the selected mentor;

– Accept invitations received by other learners;

– Create a forum post;

– Use the forum (see Figure 9);

– Manage his own table as moderator.

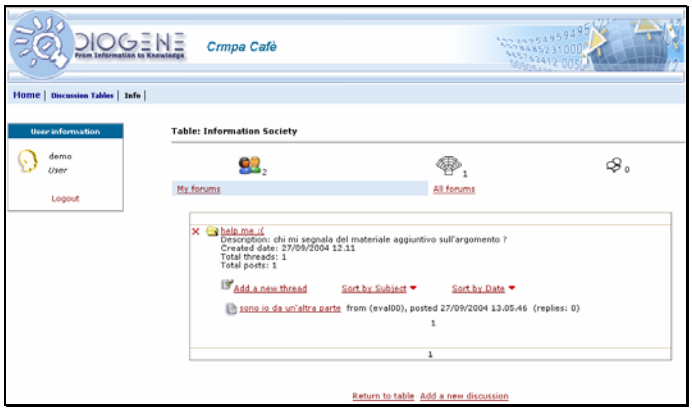



***Figure 9****. Snapshot of the use of the forum in the Café.*

## 4.2 Freelance Tutor View

An user registered as Freelance Tutor can access to a **Tutor Agency**. Every Freelance Tutor has his informative card that is made of:

– **Tutor Info** containing general information about him, such as first name, second name,

contact information, etc;

– **Tutor Model** containing professional skills such as language, competencies on ontology concepts, etc.

Each Freelance Tutor can view and update his Tutor Model (see Figure 10).

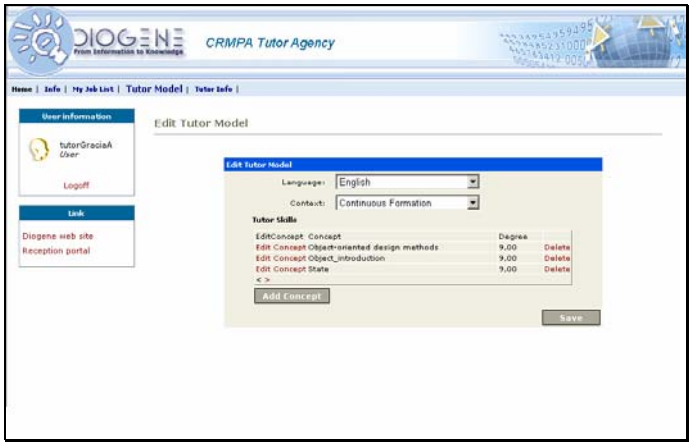



***Figure 10****. Snapshot of the Tutor model management section of the tutor agency.*

Every Freelance Tutor can manage his list of current jobs: a structured summary of the activities related to a communication/collaboration task between the tutor and a learner. Each Freelance Tutor can add, view, update and delete private jobs (see Figure 11).

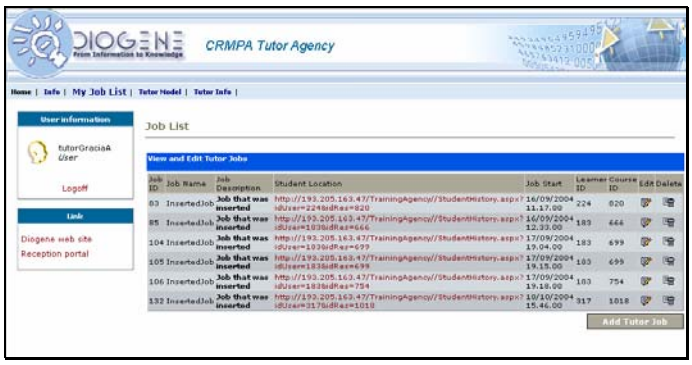



***Figure 11****. Snapshot of the Job management section of the tutor agency.*

Freelance Tutor accesses to his active jobs list and, clicking on a specific job, he redirect towards Training Agency. So tutors can view learner contact info, job info like the tutoring starting date etc. Moreover a Freelance Tutor can access to the Café in order to manage the reserved discussion table as moderator.

### 4.3 Skill Searcher View

The Skill Searcher can access a **Skill Agency** and do the following tasks:

– Manage skill searching profiles (each skill searcher can add, view, update and delete private skill searching profiles) in order to define a set of predefined threshold used for the search (see Figure 12).

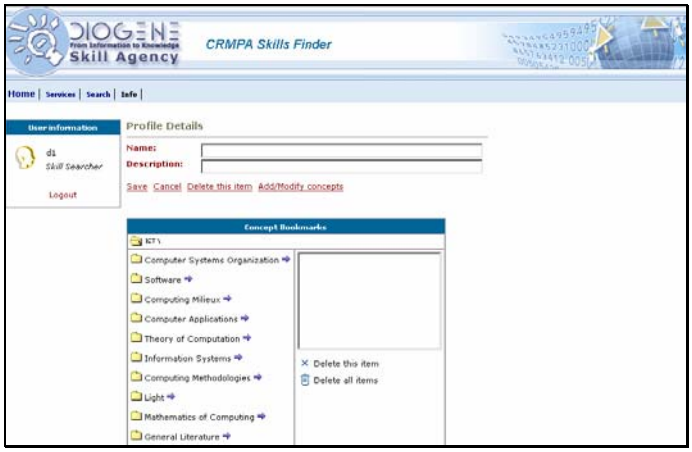



***Figure 12**. Snapshot of the Profile Management section of the Skill Agency.*

– Search learners with specific skills basing on mandatory requirements (e.g. language, educational level and competencies) and/or a predefined profile (see Figure 13).

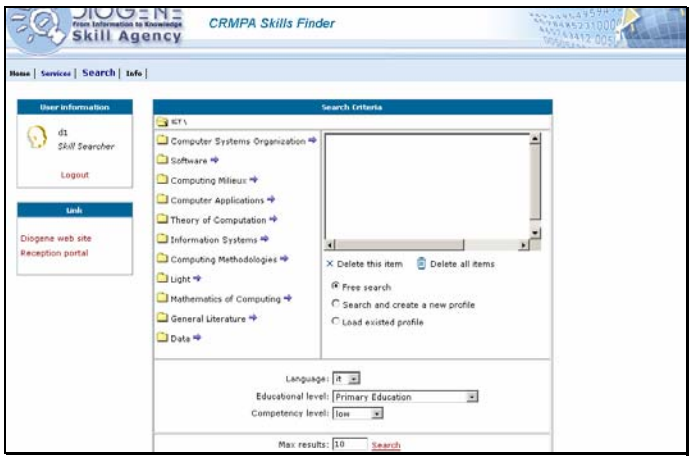



***Figure 13**. Snapshot of the Search section of the Skill Agency.*

# 5. The Training Content

In order to test Diogene capabilities, a Main Ontology covering the ICT domain was created basing on the ACM classification and eight courses were implemented by project partners and indexed exploiting Diogene KMS: *Object Oriented Analysis and Design based on UML, XML, Information Security for SMEs, Increasing Organisational Performance with the Balanced IT Scorecard, Digital images for multimedia, PHP and implementation of dynamic Web sites, Business Process Management* and *Building COTS Based Systems*.

This chapter will briefly summarise the outputs of Diogene in relation to these nine objects (main ontology + the eight courses). A paragraph is dedicated to each of these objects. A final paragraph is dedicated to the content indexing process and to the description of the related Knowledge Management System (KMS).

## 5.1 Diogene Main Ontology

The actual Diogene Ontology contains **1652** concepts and it is based on a Main Ontology derived from the ACM Computing Classification System (CCS)[3]. The heart of the CCS is a tree consisting of 11 first-level nodes and one or two levels under each of these. The main reasons for choosing ACM CCS as the main source for our ICT Ontology are the following:

- ACM CCS is the most wide spread taxonomy of ICT terms;
- It is directly linked with the ACM & IEEE Computing curricula guidelines, describing how courses in the field of computing have to be arranged in the suitable training programmes at various levels;
- It is more easily to be expressed using the Ontology relations we have chosen;
- It will allow easily to assign additional resources (books, papers, etc.) to the courses designed and offered through Diogene, because of the wide spread use of the ACM CCS as a main classification resource for computing literature.

We extended the CSS in such a way. First of all, we can slightly broaden the interpretation of the CSS as a tree, and think about it as a DAG (directed acyclic graph). The roots of the DAG are the 11 first-level nodes of CCS. For each new course offered through Diogene, the necessary adjustment (change, enlargement) of the ICT Ontology is necessary. In order to do so, the course authors prepared a list of all main concepts taught by their course, and linked these concepts with the CCS with the relations explained in chapter 2.

The relation *Has Part* have been used for the definition of the hierarchy of the concepts, in order for them to fit to the CCS trees. The other two relations, *Requires* and *Suggested Order* have been used to define the order of the different sub-trees. For each new sub-tree of concepts, created for every specific course, it was decided at what place(s) in the Ontology it had to be included (for a single course more than one such sub-tree can be created).

We also permitted “joining” of the sub-trees by allowing some cross-linking, but only if this didn’t cause a loop. The concepts with the same name, existing in the different parts of the CSS, were analysed and, depending of their semantics, were renamed or cross-linked. The Figure 14 shows a little branch of the Diogene ICT ontology.

[3] The 1998 version of the ACM CCS scheme, valid also today, is the key resource in the ICT area. The original description of this classification can be seen at http://www.acm.org/class/1998/overview.html and at http://www.acm.org/class/.

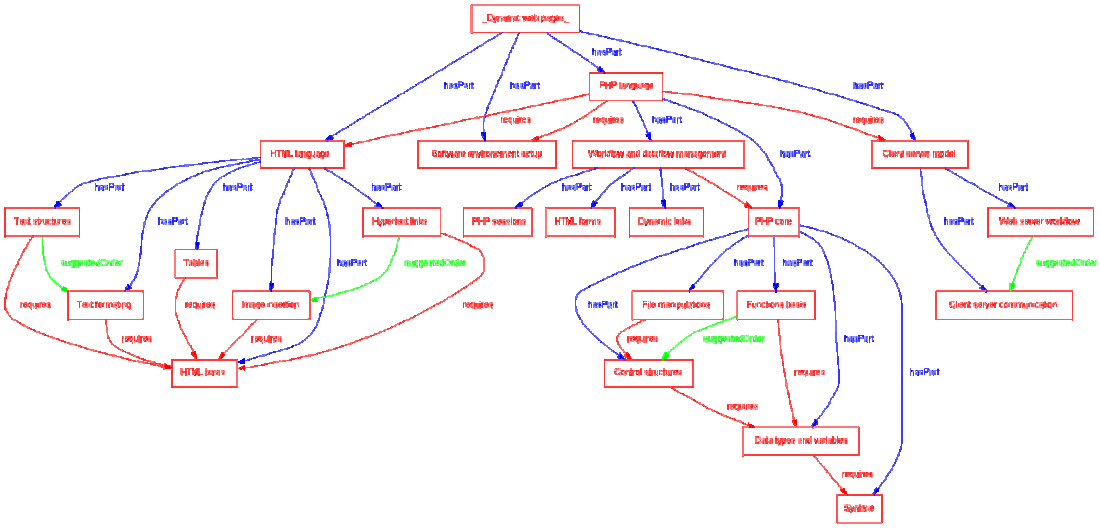
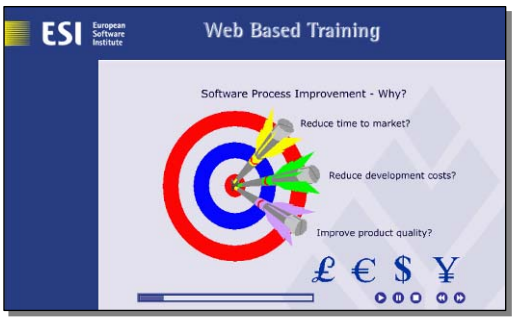



***Figure 14:*** *A Branch of the Diogene Ontology*

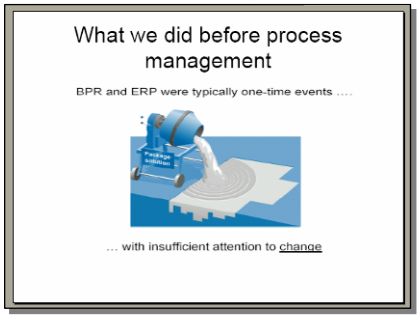
## 5.2 Course 1: Balanced IT Scorecard




The Balanced IT Scorecard (BITS) is an effective communication mechanism for formulating, transmitting and agreeing on the strategy of an organization, facilitating the alignment of improvement initiatives with the overall strategic business plan and the elaboration of a strategic measurement system.

The course introduces participants to software process improvement; the Balanced IT Scorecard and how it is used to facilitate the definition and communication of the organisations business goals and strategy, to translate the strategy into a coherent set of improvement objectives for the organisations key operational areas, to establish cause-and-effect relationships between the organisation's drivers of success and to align software process improvement initiatives with top-level business objectives. The course includes 88 learning objects. Course sub-ontology includes 29 concepts. The course is available in English and Spanish.

## 5.3 Course 2: Business Process Management

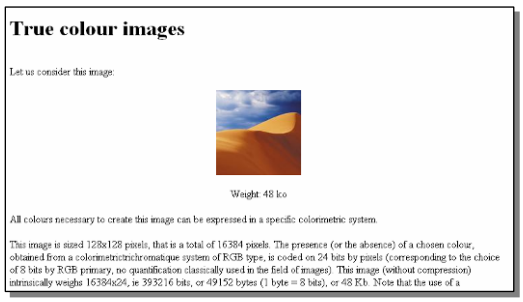



In today's dynamic business environment, customer needs, competition, globalization, and technology have combined to produce a powerful effect on the process of delivering goods and services to the marketplace. In order to succeed, manufacturing and service process analysts must be able to understand business as well as technology decisions. Increasingly, businesses are seeing themselves as collections of processes of various types.

The course will allow to students to acquire fundamental of business process definition, modelling, and analysis, integrate, monitoring and reporting

knowledge and skills. It will leverage management capabilities for process improvement. After completing they will be able to quickly and proactively deal with market changes, customer needs and competitive threats. The course includes 14 learning objects. Course sub-ontology includes 77 concepts. The course language is English.

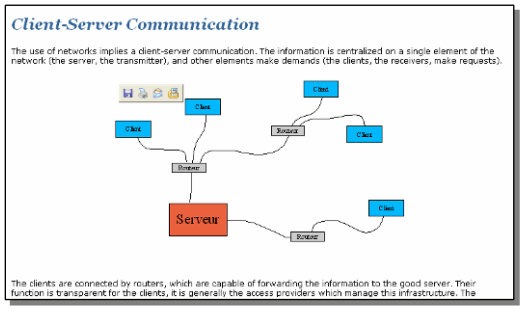
### 5.4 Course 3: Digital Images




This is an awareness course to use digital images in professional multimedia use. This training is not software specific but the basics will be usable for any software and any graphical chain. The objectives are to understand the relation between eyes, colours and images, how digital images work, how it can be used for and how to manipulate them.

Main topics include: light and colours, software environment setup, image types, graphical chain, file formats and legal aspects. The course includes 200 learning objects. Course sub-ontology includes 38 concepts. The course is available in English and French.

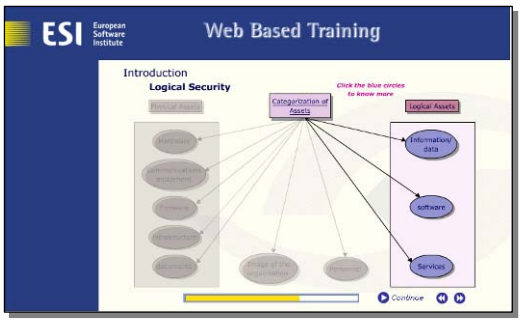
### 5.5 Course 4: Dynamic Web Pages with PHP




This course is focused on the elaboration of dynamic Web pages by using the PHP language. It includes client/server overview, Web server and workstation configuration, HTML basis, and PHP fundamentals. It gives the basic knowledge and working methods, and provides selected complementary resources.

Main course topics are: software environment setup (which specific development software to install and how to do it), client/server model for the Web (the way a client computer deals with a web server); HTML language, PHP language and concepts. The course includes 84 learning objects. Course sub-ontology includes 22 concepts. The course is available in English and French.

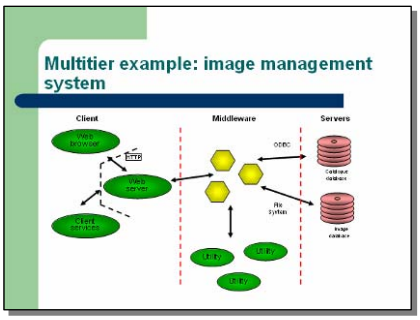
### 5.6 Course 5: Information Security for SMEs




Nowadays, information is a key factor in business' competitiveness. In order to preserve information from any change or corruption, it is necessary to provide secure data access and processing, to understand information transmission related risks, to know the means to reduce these risks and mitigate the impact whenever the risks occur.

The objective of the course is to define the main concepts related to Information Security, to describe a set of problems associated to data protection, and finally provide basic recommendations and advices for organisations who want to preserve confidentiality, authenticity, integrity, and non-repudiation of data flows. The course includes 152 learning objects. Course sub-ontology includes 39 concepts. The course is available in English and Spanish.

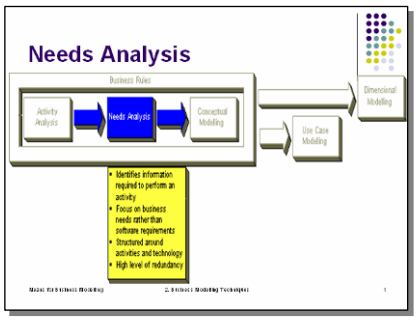
### 5.7 Course 6: Management Practices of COTS




The first goal of this course is to introduce the main issues related to the COTS based development. The use of pre-existing COTS components, when building large-scale software systems causes many different problems. These problems lead to diverse principles and techniques and methodologies for integrating large-scale complex systems, when compared to the traditional development approaches.

Another main goal is to describe, in detail the change in the traditional development. The next key topic of the course is related to the maintenance and evolution of the system which also appears to be a challenging task for software engineers. The course includes 34 learning objects. Course sub-ontology includes 38 concepts. The course language is English.

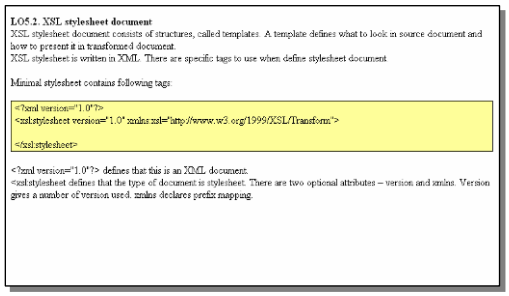
### 5.8 Course 7: Object Oriented Analysis and Design Based on UML




The Unified Modeling Language (UML) has been created as a response to that need and represents one of the most significant developments in object technology. The use of UML for both the business model and the application design can promote synergy between the business and development views of the system.

The course presents the whole UML notations – from use cases' description and class diagrams with various types of association, aggregation, multiple inheritance, etc., up to advanced UML concepts such as constraints, properties, and stereotypes. The course illustrates how UML can be applied to describe both conceptual business models and the business processes that act on those models. The course includes 97 learning objects. Course sub-ontology includes 126 concepts. The course language is English.

### 5.9 Course 8: XML




Extensible Markup Language (XML) is a simple, very flexible text format. Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere.

The course presents the foundations of the XML language, and gives a solid base for developing further software applications in various domains. The course includes the following key topics: Introduction to XML, DTD definitions, Namespaces, Transformation with CSS, XSL Transformation, XPath, Document Object Model, XML Schema, XML and Database, XML programming modes. The course includes 47 learning objects. Course sub-ontology includes 56 concepts. The course language is English.

### 5.10 Indexing Content: the Knowledge Management System

In order to edit learning object descriptions (metadata) and to create tests, a separate tool named KMS was realised. The KMS deals with the IMS Metadata standard but with minor changes can deal also with the Learning Object Metadata (LOM) standard. KMS is also linked with the well-known Protégé Ontology editor[4] which is used to link the metadata descriptions with an Ontology on a specific domain.

The KMS can be used in different phases of the learning material creation/indexing, as shown by the following list.

- **Interactive Test Editing**. The teacher makes a multiple choice test, by providing the system with: a question, information possibly related to the question, a set of answers and a possible feedback to the student related to each answer. The test is then formatted by the system and can be used on-line by the student(s).

- **Metadata Editing** (see Figure 15a). KMS provides the teacher with a graphic interface for the input of the metadata values for each Learning Object (i.e. any kind of previously made learning material, included the interactive tests made with the KMS itself).

- **Link with Protégé for Ontology creation**. From KMS it is possible to execute Protégé, to create an Ontology, then to come back to KMS in order to perform some semantic consistency checking.

- **Metadata-Ontology Linking** (see Figure 15b). Given an Ontology and a Metadata describing some Learning Object, it is possible to use KMS in order to graphically link the Learning Object with one or more elements of the Ontology. The link is then represented by the system using the "taxonpath" attribute of the IMS standard.

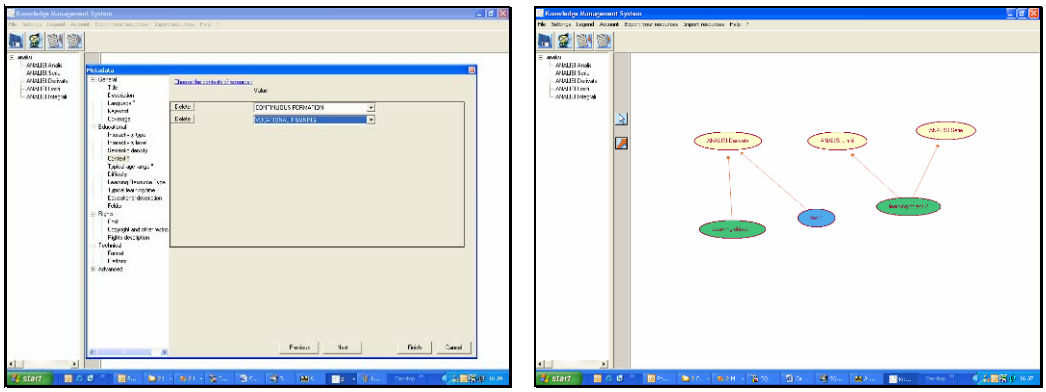


***Figure 15:*** *Metadata editing (left) and metadata-ontology linking (right) in the KMS.*

[4] More details on Protégé can be found at http://protege.stanford.edu.

# 6. Experimentation and Evaluation Results

The *Experimentation* phase of Diogene was carried out between March and July 2004 and was purposed to inform the project consortium of any operational issues with the system and therefore enable system improvement best suited to project objectives and stakeholders' requirements.

The subsequent *Evaluation* phase was carried out between August and October 2004 and was aimed to both provide feedback on the final Diogene system for future improvement and to reflect on the work that the Diogene project team has produced for the community. This includes consideration of the processes undertaken by the project, lessons learnt and suggestions for improvement.

The next two paragraphs describe the two phases and present main findings of both. More details on results obtained can be find on further documents[5] available on www.Diogene.org.

## 6.1 The Experimentation Process

Experimentation was a continuous process that built up on different versions of the Diogene prototype and involved 59 learners and 7 tutors. The experimentation work was split into two phases: Phase I and Phase II.

- **Phase I** involved a limited number of users and evaluated Diogene on a first simplified scenario including only the following organisations: Authentication Agency, Diogene Services Registry, Diogene Network Reception, Publishing Houses, Brokerage Offices, Training Agencies and Knowledge Agencies.

- **Phase II** involved more test users (also tutors) and evaluated Diogene on a second and third, more complete, scenarios including also remaining organisations: Tutor Agencies, Café, Skill Agencies and the Bank.

In total, the experimentation team identified:

- 124 technical and functional related problems (system runtime errors, unreliability of the Diogene messaging service, problems with data retrieval, system performance problems, login and access control problems, listing and access control problems);

- 68 information and context related problems (missing explanation about fields, concepts structure, user feedback, organizations, Diogene architecture and usability problems);

- 282 recommendations for further system development and improvement.

The final prototype of Diogene resolved 75 technical and functional related problems, 3 information and context related problems and applied 10 recommendations for further system development and improvement. All other found issues could potentially be addressed in future versions of Diogene (see chapter 8) as well as recommendations that could help upgrade the Diogene system with additional functionality to make it more related to stakeholders requirements.

[5] Relevant documents are: "Experimentation Comments and Suggestions" for the Experimentation phase and "Evaluation Results" for the Evaluation phase.

## 6.2 The Evaluation Process

The evaluation has taken two phases and involved different stakeholder groups. Evaluators group included 137 learners, 21 tutors, 11 skill searchers. All work was split into two phases: Phase I and Phase II.

– **Phase I** involved a limited number of experienced users and new users and evaluated the Diogene final prototype, including learners and tutors.

– **Phase II** involved more experienced users and also new users and evaluated the Diogene final prototype, including learners, tutors, skills searchers, and domain experts.

Evaluation proved that Diogene has had a significant impact on the brokerage of ICT courses. This can mainly be seen in the comments drawn from evaluators and the reliability of the Diogene system in bringing together learning content and learners in an automatic and needs oriented way.

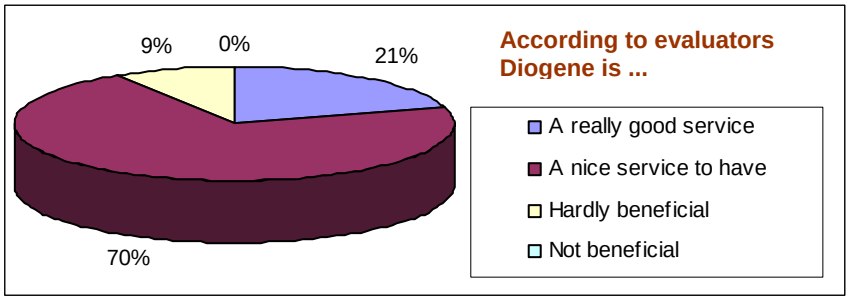



***Figure 16:*** *Estimation of satisfaction of Diogene stakeholders*

Evaluators have demonstrated a willingness to interact with the system and claimed correspondence with the requirements identified by stakeholders in the initial phase of the Diogene project in most cases.

In the evaluation feedback the importance of further system development, and subsequently the improvement of Diogene services, was highlighted by many test evaluators. The major impact of the work of the Diogene project will be on the current partners of the consortium as they look at taking forward the results and lessons learnt by the project. This will involve a reflection and decision-making process, using results produced by the evaluators, and recommendations made.

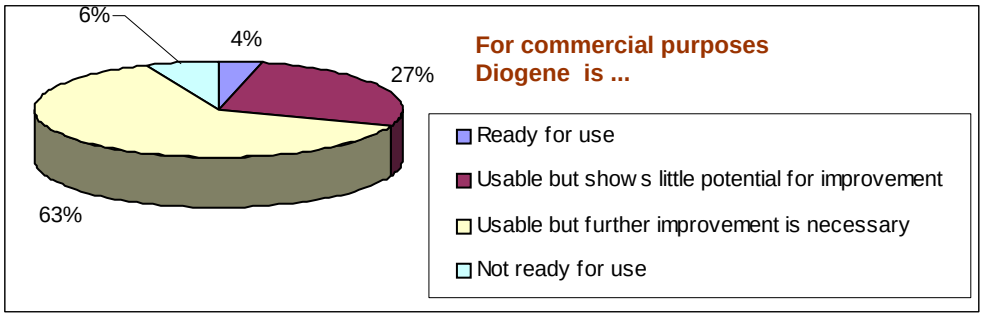



***Figure 17:*** *Estimation of Diogene commercial readiness*

The current state of the evaluation results however suggests that work provided by Diogene

shall be driven forward by further activities as there is a high chance that Diogene will be accepted as a service among the wider community.

It shall also be addressed that many of the evaluators thanked the Diogene project team for keeping them involved in this evaluation process and informed about the development of Diogene as a service that may be available in the near future. Increased motivation of users during their evaluation work as well as their acknowledgement of the innovative character of Diogene have been approved in that sense.

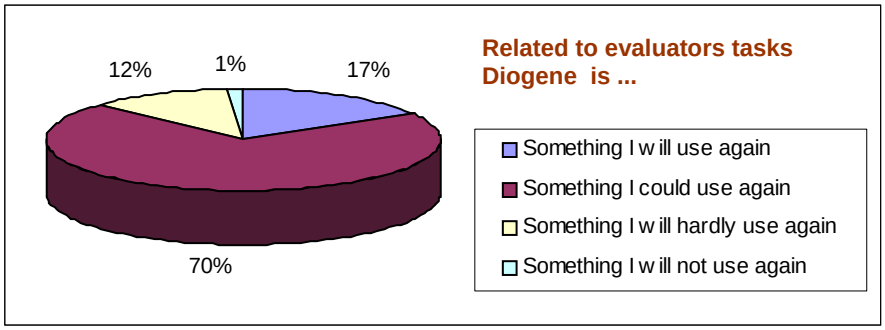



***Figure 18:*** *Estimation of the willingness to re-use Diogene*

This shall encourage the whole project team to work for the availability of Diogene services after the project.

# 7. Dissemination Activities

In order to disseminate the know-how resulting from Diogene through the European Community, several dissemination activities were undertaken. Dissemination activities included the **participation to conferences, workshops, events and fairs** related to learning and training topics in order to present Diogene ideas. The following list includes events where a Diogene representative was involved and a Diogene presentation was made.

1. ESI presented Diogene at the "Self Learning for Work Projects Sharing Day" (K2 knowledge sharing event), 15-16 July 2002, Madrid.

2. SU participated in the joint e-Learning workshop held on 13.02.2003 in Reading, UK, together with representatives of other E-Learning Research Projects (GENIUS, Career Space initiative, ADL SCORM, etc.) in the area of E-Learning, where it has represented the idea of Diogene and discussed some forms of future possible co-operation.

3. B&P presented the project at a local Congress 'Wissen verbindet' in Linz, Austria (Knowledge Congress), 11 Sep 2003 November, Linz.

4. B&P has presented the project at the European Project Platform of the LearnTec 2004 in Karsruhe, Germany (European E-Learning Congress and Trade Fair), 10-11 Feb 2004, Madrid.

5. CRMPA presented Diogene at the Kick-Off meeting of the E-LeGI (European Learning Grid Infrastructure) project held in Barcelona form 1 to 3 March 2004.

6. USG presented a poster on "An experiment with ontology mapping using concept similarity" at Recherche d'Information Assistee par Ordinateur (RIAO 2004), Avignon, France, 26-28 April 2004.

7. CRMPA presented the Diogene's scientific methodologies regarding course generation/personalization at the First Kaleidoscope Semantic-Web and E-Learning Workshop, Paris, May 3-4, 2004.

8. CRMPA presented Diogene on the 1st Kaleidoscope Learning GRID SIG Newsletter issued in June 2004 and distributed among the 72 members of the Kaleidoscope Network of Excellence.

9. USG presented a paper on "Automatically attaching web pages to an ontology" at Information Processing and Management of Uncertainty in Knowledge-Based Systems (IPMU 2004), Perugia, Italy, 4-9 July 2004.

The list of **scientific papers** about Diogene and underlying models and methodologies is reported below.

1. M. Gaeta, N. Capuano, A. Gaeta, F. Orciuoli, L. Pappacena, P. Ritrovato, "DIOGENE: A service Oriented Virtual Organisation for e-Learning". Proceedings of the 4th International LeGE-WG Workshop "Progressing with a European Learning Grid". Stuttgart, Germany, 2004.

2. M. Vergara, N. Capuano, E. Sangineto. Diogene: a Training Web Broker for ICT Professionals. Proceedings of the 2nd International Conference on Multimedia and ICT in Education. m-ICTE 2003, Badajoz, Spain, 2003.

3. Minchev A., Stefanov K., "Advanced Electronic Payment Systems and their Applications – Diogene Case study", Fourth International Conference "Investments in the future", Varna, Bulgaria, 25-26 September 2003.

4. Minchev A., Vladinova L., Stefanov K., "Distance Education Standards and Legal Issues – European perspective", International Conference CompSysTech'2003, Sofia, Bulgaria, 19-20 June 2003.

5. N. Capuano, M. Gaeta, A. Micarelli, "IWT: Una piattaforma innovativa per la didattica intelligente su Web", AI*IA Notizie, Anno XVI, N. 1, March 2003.

6. N. Capuano, M. Gaeta, A. Micarelli, E. Sangineto. An Intelligent Web Tutoring System for Learning Personalization and Semantic Web Compatibility. Proceedings of the 11th International Conference on Powerful ICT Tools for Teaching and Learning. PEG 2003, St. Petersburg, Russia, 2003.

7. N. Capuano, M. Gaeta, L. Pappacena. An e-Learning Platform for SME Manager Upgrade and its Evolution Toward a Distributed Training Environment. Proceedings of the 2nd International LeGE-WG Workshop "e-Learning and Grid Technologies: a fundamental challenge for Europe". Paris, France, 2003.

8. Nikolov R., Stefanov K., Vladinova L. "Professional E-Learning – Technological Standards, Methodological challenges and Advanced applications", International Conference "New Technologies in Learning", Sofia, Bulgaria, 16-17 May 2003.

9. R. Villa, R. Wilson and F. Crestani, "Ontology Mapping by Concept Similarity", Submitted to the International Conference on Digital Libraries (ICDL 2004), New Delhi, 24-27 February 2004.

10. Stefanov K., Todorova K., "Computing Ontology Creation", International Congress MAASEE'2003, Borovets, Bulgaria, September 15-21, 2003.

11. Villa, R., Wilson, R. and Crestani, C. "An experiment with ontology mapping using concept similarity". Recherche d'Information Assistee par Ordinateur (RIAO 2004), Avignon, France, 26-28 April 2004.

12. Villa, R., Wilson, R. and Crestani. F. Automatically attaching web pages to an ontology. Information Processing and Management of Uncertainty in Knowledge-Based Systems (IPMU 2004), Perugia, Italy, 4-9 July 2004.

13. Vladimir Lilov, Sylvia Ilieva, "Competitive Development of Solutions based on COTS Technology", Second International Conference on COTS-Based Software Systems ICCBSS 2003, Ottawa, Canada, February 2003.

In order to provide information related to Diogene progresses and intermediate results, a project **Web Site** was realised and made available under the www.diogene.org domain. A summary of Diogene is also presented in the "e-Learning made in Europe" Web site[6] and in the K2 virtual exhibition centre (stand 37)[7].

[6] See http://www.know-2.org/index.cfm?PID=46&ProjID=33358&action1=display&action2=public.

[7] See http://www.know-2.org/index.cfm?PID=173&userid=37&action1=9.

# 8. Conclusions and Future Work

Diogene project designed and implemented an innovative Web brokering environment for ICT individual training (but based upon a domain-independent platform) able to support learners during the whole cycle of the training, from the definition of objectives to the assessment of results through the construction of custom self-adaptive courses.

An ontology covering 1652 concepts and eight ICT courses including a total of 716 Learning Objects in three languages were realised to experiment the system. The experimentation phase spanned eight months and involved 235 users coming from seven countries. Experimentation results are encouraging and the 91% of evaluators identified Diogene as a nice or really good service to have and the 87% expressed his willingness to use it again.

On the other side, the 63% of evaluators envisaged the necessity of further improvement of the system before its commercial use. In particular, a total of 474 problems and suggestions for future improvements were collected. A selection of 88 of them have been solved and applied in final version of the prototype. Anyway further work is still needed to move Diogene from the state of prototype to the state of product. First activities in this direction will be related to the integration of e-Commerce features as described in the survey produced during project activities[8] and the conformance to last e-Learning and knowledge representation standards according to the recommendations produced during the project[9].

Apart the whole Diogene distributed system for ICT professional training, many other exploitable results are available as project outputs. They can be summarised as follows:

- Diogene models and methodologies as summarised in chapter 2 (knowledge model, student and tutor models, didactic model, user grouping and CV searching methodologies, knowledge extraction and harmonisation methodologies);

- The Diogene Ontology and training courses as described in chapter 5 (balanced it score-card, business process management, digital images, dynamic Web pages with PHP, information security for SMEs, management practices of COTS, object oriented analysis and design based on UML, XML);

- The Diogene software framework implementing the distributed infrastructure described in chapter 3 that can be used as basis for other VO-based architectures;

- The Knowledge Management System (KMS) that can be used as stand-alone tool for metadata, test and ontology editing (this latter feature is based on Protégé, an external open source Ontology editor).

In order to disseminate the know-how resulting from Diogene, several dissemination activities were undertaken. In particular Diogene was presented at 9 European events. Diogene underlying models and methodologies, moreover, inspired the realisation of 13 scientific papers. Further papers have been produced and submitted but still are in the review phase.

[8] See document “Survey on E-Commerce tools” available at www.diogene.org.

[9] See document “Standard Monitoring 2nd Report” available at www.diogene.org.

## 9. Contact Details

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www.Diogene.org.

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