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1 Current research of interest to the LeGE-WG

1.1 LeGE-WG events

The LeGE-WG has organized 4 international workshops in Lausanne, Paris, Berlin and Stuttgart. These resulted in 71 papers covering a wide spread of topics and provides a useful snapshot of the current state-of-the-art in the application of Grid technology to eLearning within Europe. This snapshot is presented in the workshop summaries below.

In addition, the WG has helped add a European "Learning Grid" dimension to a number of other national and international events, thereby raising the profile of both the group and the domain.

While an important objective of the workshops was to disseminate knowledge of what Learning Grid work was being done across Europe, the main benefits came from the development of a community which, though sharing and discussions has advanced the then current perceptions of the issues underlying Learning Grids and their application. This progression, arising not only from discussions at the workshops, but also from participation as Working Group members in a wide range of other events at national and European level, is clear in the gradual emergence and evolution of a "Working Group" vision for this field. This vision is captured in section 2 of this report.

1.1.1 Workshop 1

The 1st workshop, with the theme **"Formulating the requirements of a European GRID for e-Learning"**, took place on September 16, 2002 in Lausanne, Switzerland, at the same location as the 6th IEEE International Enterprise Distributed Object Computing Conference (EDOC 2002) (http://www.edocconference.org). The focus of this workshop was on identifying and formulating the requirements of a European GRID Infrastructure for e-Learning. Thus, the workshop was targeted at, but not limited to:

- analysing the economic, technological and pedagogical challenges underpinning the use of GRID technologies for e-Learning,
- identifying learning solutions that can take advantage of GRID technologies,
- identifying the challenges to existing educational and didactical models,
- identifying and formulating the requirements of a European GRID Infrastructure for e-Learning.

The workshop was organized by the Greek node participating in the thematic network **Learning GRID of Excellence Working Group (LeGE-WG)**, sponsored by the Information Society Technologies Program (IST) of the European Commission. The Greek node consists of ZEUS Consulting S.A., serving as a Principal Contractor, the University of Patras and the Western Greece Development Center, participating as Members.

Prof. Athanasios N. Skodras, representative of the University of Patras, Greece, chaired the workshop. Dr. Theo Dimitrakos, representative of the Central Laboratory

of the Research Councils, United Kingdom, and Dr. Pierluigi Ritrovato, representative of the Center of Research in Pure and Applied Mathematics, Italy, chaired the Program Committee, which was comprised by scientists and professionals with high levels of expertise and experience in the research fields addressed by the workshop.

The workshop's Call for Papers had been issued right after the official commencement of the thematic network. Given the restriction of time, Publicity Chairs had to actively work and cooperate with the rest of the thematic network's participants towards the broadcasting of the 1st International Workshop towards a European Learning Grid.

Specific notice should be given to the fact that the Workshop took place in a country other that of the participants organizing it. Though the purpose of such a decision was to collocate the Workshop with an International Conference in order that it is given as much publicity as possible, this caused some difficulties , in particular in establishing communication with potential participants, accommodating the Workshop and addressing all organizational issues within the restricted budget available. Nevertheless, the experiences gathered during the organisational procedures of the 1st Workshop held within the frames of the thematic network were of value and lead to the development of an "organisational checklist" for the Workshops to follow.

A brief summary of the workshop follows.

Chairman Prof. Athanassios Skodras who handed a welcome speech to the attendees made the official opening of the 1st International Workshop towards a European Learning Grid. Then, chairman of the Program Committee Dr. Theo Dimitrakos made an introductory presentation of the objectives of the thematic network "Learning Grid of Excellence-Working Group". Dr. Dimitrakos presented the network's organisational structure and described in detail its objectives, namely the clarification of fundamental issues underpinning the application of GRID computing for e-Learning, the cultivation of the necessary common background for the establishment of a European Learning Grid Infrastructure and the establishment of a solid baseline for full exploitation of the EU-US co-operation initiative on Science and Technology for e-Learning.

Based on its thematic priorities, the Workshop was organised into three major sessions:

1. Identifying and formulating the requirements of a European GRID Infrastructure for e-Learning
2. Identifying learning solutions that can take advantage of GRID technologies
3. Analysing the economic, technological and pedagogical challenges underpinning the use of GRID technologies for e-Learning

Within the frames of Session 1 there were four scientific/position papers presented, covering in an adequate extent the thematic content of the Session. The Session lasted 60 minutes, successfully triggering discussions on the scientific approaches presented by the authors. Indicatively, some of the approaches discussed were based on the technological requirements necessary for the deployment of dynamic virtual communities for Learning Grids, the potentiality of collaborative learning based on Grid infrastructure etc.

Within the frames of Session 2 five scientific/position papers were presented addressing one of the thematic network's main objectives, which is the identification of learning solutions that can benefit from the use of Grid technologies. Though the session's duration has been estimated to 60 minutes, it has been prolonged due to the extensive discussions held between the authors presenting their approaches and the audience.

The third Session of the workshop included the presentation of five scientific/position papers addressing the economic, technological and pedagogical challenges to underpin the use of Grid technologies in e-Learning applications. Though the papers presented in the session were of broad thematic backgrounds, an extensive discussion on some of the approaches presented has been made possible, mainly on topics related to distributed learning environments and their sources of delays and firewall architectures related to access control.
Worth mentioning is the fact that the 1st International Workshop towards a European Learning Grid was honoured by the presence of Dr. Domenico Laforenza, member of the National University Computing Centre of Italy and well known expert in Grid Technologies. Dr. Laforenza's presentation was based on addressing the challenges of the broad use of Grid technologies as the computing infrastructure of the future.

The Workshop was officially closed only after a panel session had taken place mainly addressing the challenges and implications of the deployment of a European Learning Grid Infrastructure and summarising the outcomes of the working day.

Concluding the working day, the major issue addressed was the possibility and the timeframes expected for the application of Grid technologies to the advantage of e-Learning applications.

Information about this workshop can be found on the LeGE-WG website.
The paper proceedings are available in an electronic format on the web site of the BCS (British Computer Society): http://ewic.bcs.org/conferences/2002/1stlege/index.htm.

1.1.2 Workshop 2

The 2nd workshop, with the theme **"e-Learning and Grid technologies: a fundamental challenge for Europe",** took place on March 3 & 4, 2003 in Paris, Ecole Centrale de Paris, France. The focus of this workshop was to assess the state of national and international initiatives regarding e-Learning, and to show how the deployment of GRID infrastructures may contribute to the development of vocational education in Europe. Specific targets include:

- Cross-connection between Grid technologies and e-Learning: the Grid supporting e-Learning applications as well as e-Learning concepts and methods supporting Grid developments;
- National, European and International policies : evolving the legislative and regulatory context, in particular teacher's rights concerning e-Learning initiatives;
- Evolving from Grid Services Provision to Training Services Provision : best practices and e-Learning examples.

The workshop has been organized by the LeGE-WG's French National node. The French Node is comprised of Communication & Systèmes - Systèmes d'Information (Principal Contractor), together with the Ecole Central de Paris (CRSA) and LIRMM: Université Montpellier II et CNRS (Members).

LeGE-WG Workshop had two main goals:

1. getting inputs concerning research priorities and available opportunities;
2. disseminating concerns about the synergies between Human Learning and advanced technologies such as the GRID.

The workshop was introduced by presentations from Theo Dimitrakos, CCLRC, introducing the LeGE-WG, Carlo Ferrigato, European Commission, describing the vision of the Technology Enhanced Learning Unit and Francesco di Castri, CNRS, with a presentation on "Access to information and e-learning for local empowerment; The requisite for human development and environmental protection"

The workshop was organized into 3 sessions:

1. Cross-connection between grid technologies and e-learning : 6 presentations
2. From Grid service provision to training service provision : 7 presentations
3. National, European & International policies : 5 presentations

Information about this workshop can be found on the LeGE-WG website.
The paper proceedings are available in an electronic format on the web site of the BCS (British Computer Society): http://ewic.bcs.org/conferences/2003/2ndlege/index.htm.

1.1.3 Workshop 3

The 3rd workshop, with the theme **"GRID infrastructure to support future technology enhanced Learning",** took place on 3rd December, 2003 in Berlin, in conjunction with the Online Educa Berlin 2003, the 9th International Conference on Technology Supported Learning & Training. Our workshop was presented as the first workshop of the Online Educa Berlin Conference, the most important European event in e-learning field.

The workshop was focused on, but not restricted to:

- New pedagogical approaches for e-learning
- Learner models and knowledge representation
- Knowledge and Semantic GRID
- Virtual Learning Organisations and Communities
- Advanced Web based Collaboration Systems
- Service Oriented Software Architecture

These themes were motivated by the vision that we have matured during the project execution.

Indeed, we started from the fact that in current practices, learning processes are based mainly on the information transfer paradigm and are devoted to find the best way for presenting contents in order to transmit information to learners. Accordingly most of the e-learning solutions available on the market are focused on supporting only a

specific aspect of the learning process, notably the content delivery (content centred approach). This traditional paradigm of Information transfer oversimplifies the real human learning situations, as it considers "ideal" learners to react identically. Learning is a non linear process dependent on a great number of variables, so the only good quality of teaching does not determine the effectiveness of the learning phase. For this reason it is necessary takes into account the fundamental importance of the pedagogical component, in order to foster a more effective learning. The learning process, according to recent cognitive theories, can be effective using an approach which considers in a unitary way some fundamental characters of learning such as active, situated and collaborative learning.

Grid technologies show many suitable characteristics to achieve an effective learning, since they are the most promising approach to realise an infrastructure that will allow learning process actors to collaborate, to use and share high quality learning data and to innovate solutions of learning and training. Grid technologies will be able to support learning processes allowing each learner to use, in a transparent and collaborative manner, the resources already existing on-line, by facilitating and managing dynamic conversations with other human and artificial actors available on the GRID, that offer services including those resources.

The workshop has been structured over three sessions.

1. analysis and definition of new pedagogical approaches considering the impacts on the learner models representation and knowledge representation.
2. the use of GRID for technology enhanced learning
3. collecting experience for the implementation and evaluation of the effectiveness of technology enhanced learning in Learning Institutions.

For each session an invited speaker gave a talk. In particular for the first session Pierluigi Ritrovato presented the European Learning GRID Infrastructure integrated project, in the second session Peter Kaufmann from DFN-Verein (DE) presented the EGEE Project and in the final session Prof. Takeshi Utsumi, Founder and Vice President for Technology & Coordination of Global University System (USA), gave a talks about "Globally Collaborative Environmental Peace Gaming with Global University System".

In the following we give a quick tour of the presented papers to the Workshop.

The pedagogical and didactical aspects have been presented in two separate works produced by the Centre of Excellence "Metodi e Sistemi per l'Apprendimento e la Conoscenza" Research Group of University of Salerno, whose DIIMA is the main promoter and the co-ordinator. In one of them the attention is focused on the relations among the different actors of learning process. In fact in the traditional learning process these relations can be synthesized by the triangle "teacher-pupil-knowledge" described by Chevallard, on the contrary the authors of the paper show that in the e-learning platforms these relations assume a more complex structure, characterized by the "author-tutor-pupil-knowledge". So, this work describes the changes of the previous relations, in the transaction from traditional to distance learning. Furthermore in the other paper the same Research Group puts in evidence the necessity to integrate theoretical, methodological and didactical aspects with innovative e-learning systems, in order to hypothesize possible learning models able

to facilitate and qualify the e-learning world. Specifically, the aim of authors is direct to theoretical learning models for Virtual Scientific Experiments to be implemented inside the platforms.

In an e-learning environment these didactical aspects can be supported by a suitable knowledge representation. The paper provided by P. Lemoisson, S. A. Cerri, J. Sallantin, S.-A. Mahe, goes in this direction. The authors first draw a conceptual framework for rational agents in conversational interaction; then they show how to use this framework for describing the processes of co-building ontologies, co-building theories and social interactive learning. Also L. Stefanutti, D. Albert, C. Hockemeyer talk about knowledge representation. In their talk they present the Knowledge space theory (Doignon & Falmagne, 1985; Albert & Lukas, 1999; Doignon & Falmagne, 1999), which offers a rigorous and efficient formal framework for the construction, validation, and application of e-assessment and e-learning adaptive systems. They present some theoretical notes on the efficient construction and application of knowledge spaces for knowledge domains that are both dynamic and distributed in space. Their objective goes in the direction of an exploitation of new technologies like the GRID for building the next generation of learning environments.

Moving in the GRID domain we had several relevant talks ranging from pure technological aspects and approaches to methodologies and technologies adoption implications. Starting from the Cerri's talks focuses on Service Elicitation and Evaluation/Exploitation Scenarios (SEES) wrt to experimental protocols for justifying, motivating, implementing and exploiting Learning GRID's services for very large numbers of potential users and explain that the human learning on the Grid will be based on the synergies between advanced software and human agents. These synergies will be adapted to the ambitious goal of dynamically generating services for human learning. They highlight how conversations may procure learning both in human and in artificial Agents. Interesting in terms of approach pursued is the work produced by N. Bogonikolos, M. Chrysostalis, K. Giotopoulos, S. Likothanassis, K. Votis that presented the COG (Corporate Ontology Grid) EU project, funded under the Information Society Technologies programme. In particular the Integration of the Ontological Modeling Suite (Unicorn system) with Industrial Modeling and EAI Tools is discussed. The COG (Corporate Ontology Grid) project addresses the problem of accessing and communicating data held in heterogeneous data formats scattered across disparate systems. In the D. Haley, P. Thomas, B. Nuseibeh, J. Taylor, P. Lefrere, work they put put in evidence that E-assessment is an important component of e-learning and e-qualification and the authors propose to use the computational power of the GRID in order to support it. This paper first introduces Latent Semantic Analysis, that is a statistical method for inferring meaning from a text, and then explains how LSA works, describes the breadth of existing applications using LSA and how LSA is particularly suited to e-assessment. So the authors propose research to exploit the potential computational power of the Grid to overcome some of LSA's drawbacks. On the other side K. Wulf, in his talk, examines the requirements for eLearning Object Metadata, in order to appropriately support pedagogic and economic goals as well as service oriented architectures like the Grid. C. Colaux-Castillo and A. Krief presented in their work EnCOrE (Encyclopédie de Chimie Organique Electronique). It is an original proposal which is expected to allow to share and transfer knowledge in organic chemistry; it could be supported by the GRID infrastructure. C. Allison and R. Michaelson presented a work regarding some

considerations for a learning GRID Portal. This paper reviews the portal concept with a view to its suitability as a design basis for enabling technology that will address usability concerns. The paper proceeds by summarising the usability requirements of learning environments, reviewing some of the ideas currently associated with different types of portals (enterprise portals, institutional portals, user-centric portals, Grid portals), and concludes by deriving a taxonomy of portal characteristics against which the usability requirements of ELeGI can be assessed.

Other papers have been presented regarding service oriented software architecture together with other projects and concrete experiences of distance learning. I. Dahn described Mobilearn, a project within the 5th Framework Programme of the European Union, whose objective is to investigate the use of mobile technologies in different learning contexts. He explained that a service based software architecture has been developed, in order to achieve this objective and so, in his paper, he described the architectural approach taken within the Mobilearn project. T. Utsumi, an invited speakers, described in his talk the Globally Collaborative Environmental Peace Gaming (GCEPG) with a globally distributed computer simulation system, focusing on the issue of environment and sustainable development in developing countries. His paper briefly describes the history of the GCEPG project and its future direction, regarding the idea to develop a socio-economic-environmental simulation system and a climate simulation system in parallel fashion, both of which are to be interconnected in global scale. K. Baniulis, B. Tamulynas and N. Aukstakalnis presented in their paper a case study of virtual organization learning and knowledge testing environments. The work talks the architecture of student self-evaluation and on-line assessment system TestTool. Another invited speaker, P. Kaufmann, described the "Enabling Grids for E-science in Europe" EGEE Integrated Project.

Information about the workshop can be found on the LeGE-WG website.
The paper proceedings are available in an electronic format on the web site of the BCS (British Computer Society): http://ewic.bcs.org/conferences/2003/3rdlege/index.htm.

1.1.4 Workshop 4

The 4th workshop, with the theme "**Progressing with a European Learning Grid**", took place at HLRS, University of Stuttgart, Germany in April 2004 in conjunction with the 7th public international HLRS Metacomputing Workshop, one of the major events in the Grid computing world.

The Workshop focused on

- Widely disseminating the ongoing developments in GRID technologies
- Providing experience reports from on-going experimentation from projects for making applications GRID-aware
- Discussing ways to introduce GRID technologies into teaching practice
- Demands to GRID technologies arising from teaching practice

The workshop was divided into three separate sessions:

1. Grid Session
2. eLearning Session
3. Joint Session

A brief summary of each session follows:

The Grid Technology session focused on how new technologies developed and proposed within the relevant standardisation bodies and on how the results gained from other GRID projects influence the adoption of GRID technology for making existing applications GRID aware. In addition, there were experience reports from national and international projects on integrating existing applications into a GRID infrastructure from different domains such as Application Service Provision and Scientific Applications. Also, demonstrations of the existing GRID frameworks GrASP and UNICORE were shown. Another topic having been discussed in this session was distributed visualisation and collaborative work.

The E-Learning session concentrated on lessons learned from introducing new media into education, on achievements and new demands and how these demands can be integrated into the implementation of a Learning GRID. Another question being raised within this session concerned the forms of learning that can benefit most from GRID technologies (e.g. distance learning, mobile learning or collaborative learning). Answers on how GRID technologies can augment current teaching practice were also provided. Finally, the specific roles of teachers, learners, authors, content and service providers in using a Learning GRID infrastructure as well as legal issues (confidentiality, data protection ,copyrights) were addressed.

The final joint session compared the emerging potential of the Learning GRID with the demands of eLearning applications. Conclusions were drawn and recommendations were given for future implementations of the Learning GRID infrastructure.

There were three invited speakers: Hans-Juergen Kitzhöfer from IBM Germany was reporting on the on-going Grid projects at IBM. Mr Giancarlo Bo from Giuntilabs Italy gave a talk on mobile learning and XML web services and Mr Theo Arvanitis from the University of Birmingham (UK) gave presented the context-awareness subsystem within the FP5 Mobilearn project.

Information about this workshop can be found on the LeGE-WG website. The paper proceedings have been published in electronic format on the web site of the BCS (British Computer Society): http://ewic.bcs.org/conferences/2004/4thlege/index.htm.

1.1.5 National Workshops

There have also been several national workshops and events organized by or contributed to by LeGE-WG members, in the UK, Lithuania and Spain.

UK
A national workshop, organized by the UK Node, was held in Manchester, UK on 4-5 September 2003. There were about 20 attendees, including some overseas delegates who were attending the LeGE Steering Committee meeting the following day. The main objectives for this workshop were to get the UK members together to discuss UK situation with respect to Learning Grids, get input from users and organizations of user of eLearning and explore the possibility of national funding for projects relevant to the LeGE-WG. Overall, the workshop achieved these aims.

Lithuania
The Lithuanian Node organized together with Lithuanian Distance Learning Association (NDMA) addressed to coming Grid technology and impact of technology on science and studies an International Conference on Advanced Learning Technologies and Applications - ALTA03, 11-12 September 2003 in Kaunas, Lithuania http://www.lege.ktu.lt/ALTA

1.2 LeGE-WG interaction with other initiatives

Working Group members were also individually involved in many other events at national and international level. Some of these events are described here.
In the last two years several national initiatives have been inspired by LeGE-WG activities, in the following we quote some of them.

Note that this is not intended to be an exhaustive survey of eLearning Grid work around Europe, but an sample of some of the current research undertaken by WG members. It is through the experience gained in this work, as well as the sharing of concerns, ideas and approaches within the WG, that WG members are able to identify a number of major research themes that warrant firther exploration. These are described in the next section

1.2.1 Italy

DIIMA, as coordinator of the Italian Centre of Excellence (CoE) on "Method and Systems for Learning and Knowledge", CRMPA and MoMA have organised on December 2002 at the University of Salerno an half day event on the theme "Mezzogiorno e Disoccupazione: la sfida dell'Innovazione Formativa" (Unemployment in the South Italy: the challenger of Innovative Learning and Training). To the event attended more that 300 people from Industry, academics and schools from Campania Region. One of the invited speakers has been the subsecretary for Labour and Social Policy of the Italian Parliament Mr. Pasquale Viespoli.

DIIMA and CRMPA with the support of INFN, as the coordinator of the Italian node in the EGEE (Enabling Grids for E-science and industry in Europe) integrated project, proposed Learning as test-bed application for the GRID infrastructure to be implemented in the frame of EGEE.
DIIMA, CRMPA and INFN made together "SUGAR", a proposal of Special Support Action (SSA) within the 6th Framework Programme of the European Union.
DIIMA and CRMPA representatives attended to the meeting organised by INFN in Padova on December 2002 where the ideas about use of GRID for technology enhanced learning have been presented.

DIIMA has established some collaborations with the Science Faculty of University of Messina. In this work collaboration some seminars have been held regarding "Domain Platform for the Mathematic and Virtual Scientific Experiments in e-learning environments" and "Simulation Advanced Systems based on HLA and GRID".
Some degree thesis works have been assigned to students of University of Messina, with supervisors Prof. S. Salerno and G. Iovane (respectively Director and Research of DIIMA).

In this last period Prof. S. Salerno and G. Iovane held some talks as invited speakers at the University of Messina.

Furthermore DIIMA, in collaboration with University of Messina and other Italian Universities (Bologna, Cosenza, Firenze, Messina, Milano, Palermo), is proposing the creation of a Inter-universities Consortium for the Applied Mathematic (Consorzio Interuniversitario per la Matematica Applicata - **CIMA**).
The purpose of CIMA is to promote the projection, development and management of e-learning system, directed to research activity and on-line high training regarding the Applied Mathematic. In this new structure DIIMA will contribute also to support the technological aspects, proposing an infrastructure based on the GRID.

DIIMA have also received a grant from the MIUR (the Italian Ministry for Education, Research and Universities) for the realisation of a GRID infrastructure for supporting researchers in their daily activities in civil and mechanical engineering, in business science, in optimisation and simulation and e-learning.
Finally, in the last project month (July 2004), MOMA has organized a tutorial on "Technologies and methodologies for the advanced Didactic"[1]. In this meeting MOMA representatives have presented the main LeGE-WG experiences and results and have shown the future developments, considering IWT e-learning platform and it migration toward a GRID architecture.

The perspectives in Italy are very close to those in LeGE-WG. This is partially due to the activities that all the members of the Italian node have done in several contexts (academic research, industry, and political). This is attested by two important facts: the Decree issued on April 17th 2003 concerning the regulations for Telematics Universities (in the view of the Virtual Campus concept of the e-Europe 2002-2005 plan) and the Research National Plan (PNR) for 2004-2006.

In the Decree particular emphasis is given to the use of experiential based and collaborative learning approaches as well as the pedagogical issues for a profitable adoption of these approaches. From the technical point of view (an annex is completely devoted to the features that the technology infrastructure that will be used for supporting the telematics Universities should provides) other than the usual requirements for common learning standards compliance and the common features provided by the traditional learning and content management systems are required true adaptability (in terms of content selections and learning approach) to learner preferences and capabilities, fine grain user profiling and support of different learning approaches.

Concerning the PNR, that is a programmatic document for the definition of the research calls through which will be provided the research funds at national level (very similar to the IST workprogramme), the actions for the ICT include the Distance Learning, the GRID technologies in general and their adoption in several domains such e-health, e-work and e-learning. For the Distance learning actions the research activities will be centred on the definition of pedagogical models for the adoption of the experiential based approach using virtual scientific experiments and business games. In this context will be studied and experimented aspects related to the content

[1] This tutorial held in the seat of "Il Torchio" Association, in Somma Vesuviana (Napoli).

preparation, models validation as well as contents indexing through knowledge representations approaches such us ontology. Studies will be supported for using this new form of indexing for the creation of systems capable of adapting themselves to the learner behaviour, skill and preferences as well as for advanced searching capabilities moving towards the fully semantic web adoption and exploitation.
Regarding the GRID the focus is on their development for the definition of advanced service oriented infrastructure that are domain specific, taking into account aspects related to the automatic service indexing and orchestration. The studies will lead to the definition of the next generation Grid (semantic and knowledge GRID). For the learning domain the research activities will be focused on the definition of a Learning GRID.

1.2.2 Germany

The 'Federal Ministry of Education and Research' (BMBF[2]) provide the technical and organizational infrastructure, as well as a variety of educational software products for virtual learning in all public institutions of education.

- The programme 'New Media in Education' (Neue Medien in der Bildung = NMB[3]) promotes the development of educational software, especially for primary, secondary, higher and vocational education, with about € 204.5 million in the period 2000-2004;
- The 'Future University Initiative' encourages innovative concepts of virtual campuses and their respective course material, as well as other forms of multimedia learning and teaching (e.g. notebook-universities) with funds of € 127.8 million in three years;
- The project 'Lifelong Learning – Further Education as basic Need' represents a holistic concept of social and technological integration. The intention is to create a type of 'learning centres' that are connected to a modern infrastructure of services. Funds are about € 11.8 million for four years.

One example of the projects promoted in the programme 'New Media in Education' (*Neue Medien in der Bildung* = NMB) is 'eLearning and eTeaching in integrated Teacher Training and Continuing Training' (*eLernen und eLehren in der Lehrer-Aus- und Weiterbildung* - eL3[4]), carried out by FIM-NewLearning (University Erlangen-Nuremberg) in cooperation with the University Oldenburg. In the project, web-based training offers for teachers and prospective teachers were developed and tested. Teachers were enabled to use new media in education in a subject-oriented and pedagogically sound manner.

A follow-up to the programme 'New Media in Education' foresees funds of € 40 million in the years 2005 to 2007 for

a) the sustainable integration of eLearning offers in universities and
b) the subject oriented, cross-institutional bundling and transfer of eLearning solutions for new target groups on national and international level.

[2] http://www.bmbf.de
[3] http://www.medien-bildung.net
[4] http://www.el3.de

A priority is given to projects that comprise the newest technologies (explicitly mentioned GRID) and eScience Infrastructures (www.d-grid.de). Part b) will enforce the building of "Virtual Organisations" for the dissemination of existing eLearning offers. Innovative projects may use Grid technology to realise the integration of heterogeneous and distributed eLearning resources and services for that purpose.

In most of the 16 Bundesländer, initiatives towards virtual universities have been taken up during the last years. As an example, the 'Bavarian Virtual University' (*Virtuelle Hochschule Bayern* = VHB[5]) founded in 2000, is a network including all Bavarian universities and polytechnics. The aim is to build up a system of study offers that offer the possibility to graduate, to a large extent, over virtual channels. For the term 2002/03, 'vhb' offers a total of 46 courses to complement traditional university lectures and seminars.
FIM-NewLearning coordinated the design and implementation of the vhb, offers several courses and is responsible for the quality assurance within the vhb.
As the "vhb" follows a decentralised approach with a central portal for student registration but distributed course management, it is an ideal example of a "Virtual Organisation" and will be a sophisticated scenario for implementing a Grid infrastructure solving the issues of access to distributed resources and single sign-on.

Koblenz has been part of the FP6 IST project Telcert since January 2004 which deals with the profiling and certification of open standards in order to promote the interoperability of learning content and learning software.
Moreover we are involved in the design of the service based learning architecture developed in the Mobilearn project. This has been presented at the eLearning Summit in Sestri Levante in April. At this meeting it was apparent that there is a tendency in the eLearning development community towards the implementation of service based systems. It is expected that this will further accelerate when the MIT led Open Knowledge Initiative OKI will publish its WSDL description of web services for OKI.
An important event to improve the interoperability of eLearning systems was the ADL plugfest held in Zurich in February. In connection with this event Mr Ingo Dahn from the University of Koblenz-Landau gave a presentation on the SchemaProf tool developed in Koblenz to adapt XML schema based specifications to the needs of specific communities.
Discussions at the LearnTec fair in February showed an increasing interest in interoperability, reuse and open standards. It also revealed some misconceptions in the pedagogic community, unjustified perceiving eLearning standards as being in conflict with personalized learning.
A new call for proposals of the German BMBF to support structural changes in favour of eLearning explicitely mentions Grid as an interesting potential basic technology.

Concerning technology for eLearning we can see remarkable activities on the development and use of open source software dedicated to eLearning, not only as "prototypes" with local use, but as mature, stable applications with increasing user and developer communities. This is a remarkable step, because light-weight, open source solutions are especially important for smaller, non profit organisation who try

[5] http://www.vhb.org

to apply eLearning for new target groups and cannot afford expensive commercial servers.
As a prominent example, the web-based learning management system ILIAS[6]) is available as open source software under the GNU General Public License (GPL). Universities, educational institutions and every interested person may use the system free of charge and contribute to its further development. The software development worldwide is coordinated by a team at the Faculty of Economics, Business Administration and Social Sciences at the University of Cologne. FIM-NewLearning adapted ILIAS in its eLearning projects successfully to the demands of different target groups (e.g. students, school teachers, administrative employees, elderly people) and contributes to the development process by making its enhancements available as open source. Further plans foresee the incorporation of web services in ILIAS, to enable the interoperability with external systems.
Making wide-spread, mature open source systems like ILIAS Grid-aware will boost the application and dispersion of Grid technology in the eLearning domain.

1.2.3 UK

As highlighted in my presentation to the LEGE-WG UK node meeting last September, at Durham and since December, at the University of Lincoln, we have concentrated on the research issues related to e-Learning and the Grid, in particular, the emergence of universal software applications and the issues of openness in this context. There are two important aspects of openness that we have considered:

1. user accessibility, and
2. software and content accessibility.

Ideally there should be no bars to access: physical, economic, social, or political with respect to public services, such as e Learning and the Grid. Similarly there should be no bars to access to the underlying software, both systems and content of these public services. Thus, there is pressing need for Free i.e. Libre Open Source Software in the e-Learning and Grid domain (here we mean free as in free speech), e.g. the MIT initiatives, such as OpenCourseware and the Open Knowledge Initiative.

While grids are a potential means to be deployed in the creation of effective teaching and learning environments, more research is needed in determining the most effective methods for bringing together technologists and educators committed to exploiting new technology-mediated modes of learning delivery. Here we believe that there is much to be learnt from the Open Source Software community. The grid concept is particularly relevant to tertiary education, especially in the support of distance learning by bringing learning opportunities through access to powerful computational resources and data sets to remote learners at home, in the workplace, and in traditional academic settings, and where there is already a history of collaborative web-based curriculum development.

There is much existing material developed by universities which could be deployed over the grid, but at present is not immediately reusable. Here we have proposed applying the established methods and techniques of Reverse and Re-engineering well known in the Software Engineering field to these learning artefacts. The resultant artefacts have the potential to become the basis of repositories of reusable learning objects. Here there is a large corpus of research in software reuse that is directly

[6] http://www.ilias.de

applicable to the work that needs to be done. The experience of the Open Source Software Community also needs to be brought to bear in this research. Much of the grid infrastructure and core software is being developed as open source; and in this research to develop e-learning grid applications, following the open source approach will lead to truly accessible systems and contents in the second sense above.

One result of our research in LEGE-WG here at the University of Lincoln has been the participation in the MasterLibre consortium. MasterLibre has proposed the development of an European Master's programme in Open Source Software. One aspect of this development is that it is proposed to carry it out as a series of open source projects; thus all the courseware developed will itself be open source.

1.2.4 Greece

Representatives of the Greek node have already participated into a number of events related or even triggered by the Lege Working Group.

In addition to the attendance at the 2nd LeGE-WG workshop titled "e-Learning and Grid Technologies: a fundamental challenge for Europe" that was held in March 2003 on the 3rd & 4th in Paris, France, representatives of the Greek node attended the 1st IST Concertation meeting on Grid Research that was organised by Directorate General Information Society of the European Commission and Accompanying Measure project titled GRIDSTART on the 18th and 19th of June 2003 and the Information Day on IST-Call 2 "Grid-based systems for complex problem solving" on the 20th. Both events were held in Brussels, Belgium.

Lege-WG-related scientific themes were presented by representatives of the Greek node in international workshops, such as:

- 2nd international workshop in "eLearning for e-inclusion" that was held in Athens, Greece on the 23rd and 34th of May 2003 within the frames of the eLearning Initiative
- International workshop: "Acquisition of complementary competencies through open & distance education" that was orgainised by the Technical University of Cluj-Napoca, held on the 23rd of May 2003 in Cluj-Napoca, Romania.
- International workshop titled "GRIDs in the eHealth sector", held by Cancer Research UK in London, UK between the 28th and 31st of August 2003.
- "IST 2003: The Opportunities Ahead" representing the Greek node of the Working Group, held in Milan, Italy between the 2nd and 4th of October 2003.
- 4th International workshop in "e-Learning for e-Inclusion", held in Ostrava, Czech Republic between the 15th and 18th of January 2004 within the frames of the eLearning Initiative.
- 2nd IST Concertation meeting –GRID Research, held on the 30th and 31st of January 2004 in Nicosia, Cyprus.
- 3rd international workshop in "eLearning for e-inclusion" that was held in Murcia, Spain on the 5th of September 2003 within the frames of the eLearning Initiative.

- International workshop: “Learning Facilitation via Grid Environments” held by Cyfronet International on the 9th and 10th of September 2003 in Czestohowa, Poland.
- Intenrational workshop “Knowledge-based Workflow System for Grid Applications”, held by the Slovak Academy of Sciences in Bratislava, Slovak Republic between the 30th of September and the 9th of October 2003.
- International workshop titled “Business modeling frameworks for enabling cross-transparent Utility Grids”, held by CNR in Rome, Italy on the 2nd of October 2003.
- International workshop titled “Information Grid in the Corporate World” held by the Institute for Informatics of the University of Innsbruck on the 10th of December 2003 in Innsbruck, Austria

1.2.5 Spain

In Spain, Atos Origin is related with ongoing research projects at National level as GRASP, TRUSTCOM and AKOGRIMO. Besides, Atos Origin is in touch with The Grid and peer-to-peer middleware for cooperative learning environments project funded by the Spanish Ministry of Education.
Atos Origin is also involved in e-learning through its participation in the MetaCampus REAL Project, an eTEN Program project continuing the IST MetaCampus Project. Finally, and thanks to its knowledge acquired on e-learning standards and platforms, Atos Origin is involved in a local project in order to build an e-learning platform allowing the follow-up of the employee training for the electrical company of Cantabria (region of Spain).
UOC is looking into a Generic platform for developing CSCL applications using Grid infrastructure. The goal of this work is to explore the possibility of using CSCL component-based software under a Grid infrastructure. The merge of the three technologies represents an attractive, but probably quite laborious enterprise if we consider not only the benefits but also the barriers that we have to overcome. This work presents an attempt toward this direction by developing a generic platform of CSCL components and discussing the advantages that we could obtain if we adapted it to the Grid. We then propose a means that could make this adjustment possible due to the high degree of genericity that our library components is endowed by being based on the Generic Programming paradigm. Finally, a CSCL application example is proposed both for validating the adequacy of the platform which it is based on and for indicating the possibilities gained by using it under the Grid.
For a more detailed information about the work done in the field of CSCL applications see the paper attached in Annex 2.

Workshop in Valladolid (ES) organised by the Grid and peer-to-peer middleware for cooperative learning environments project (June 2004)
This event is the fourth of a series of semestral workshops that are taking place within the project *CRAC: GRID and P2P middleware for CSCL applications*, financed by the Spanish Ministry of Science and Technology. This series follows a tradition of small scale workshops within several national projects in which the specific research teams from University of Valladolid (UVA), Polytechnic University of Catalonia (UPC), Open University of Catalonia (UOC) have been collaborating.

Its participants include researchers (professors, doctoral or senior undergraduate students) from all teams. Although the majority of participants come from technological departments (Computer or Telecommunication engineering), there are also researchers from education departments (ICT in education) that give a multidisciplinary character to the workshop. Besides that, a reduced number of invited researchers participate, thus providing their own experience in related fields.
A special characteristic is the open nature of the workshop, promoting the critical but constructive attitudes, either internal or external to the project. Participants are invited to keep their presentations short enough, in order to give more time for discussion within the sessions, with special emphasis to the panel and parallel sessions.

The workshop schedule was designed in order to provide a continuous interaction among the participants. In general terms, the first day besides general introduction focuses on Grid middleware for (collaborative) learning, while the second one focuses on P2P architectures, as well as general CSCL issues. The last days aims to provide for work in small groups, as well as for general conclusions, discussion and future actions.
See Annex 1 to get more information about the specific topics addressed in this workshop and the abstracts of the papers presented on it.

1.2.6 Lithuania

The partnership in the LEGE-WG enabled Lithuania, a new member of the EU since May 2004, to get seriously involved into Grid development activities for academic and science communities. Lithuanian node activities were focused mainly on dissemination and raising awareness of grid technology in order to segregate, educe appropriate applications, especially from higher education and graduate level studies. Dissemination activities was carried out in various forms and at many organizational levels – within the University, city, region, state and internationally. There is the list to mention the main of them:

a) Projects FR6 ELEGI and FR5 LEGE-WG were presented in Lithuanian Exhibition Centre "Litexpo" Vilnius, Lithuania in the biggest Baltic States Science, Innovations and High Technologies Exhibitions: "INFOBALT'2003", October 20 – 23, 2003 and "SCIENCE 2004" May 25-28, 2004.

b) Addressed to coming Grid technology and impact of technology on science and studies was organized International Conference "Advanced Learning Technologies and Applications" (ALTA'03) at Kaunas University of Technology, September 11-12, 2003. Conference web site http://www.lege.ktu.lt/ALTA;

c) Language Processing and Multilingual Communication as possible part of language technologies in the e-learning Grid infrastructure were discussed in the papers in the International conferences in Moscow (Protvino, June 11-16, 2003) "Dialog 2003" and in the BALTIC IT&T 2004 FORUM: eBaltics First Baltic Conference: Human Language Technologies – The Baltic Perspective [Riga, Latvia, April 21 – 22, 2004]

d) Many presentations about Grid technologies and Use of them in e-Learning were made in the national conferences "Information technologies: theory and practice" organized by Alytus College, Lithuania [April 30, 2003], [May 25, 2004] as well as in the national conference "Information Technologies 2004" organized by Kaunas University of Technology, Lithuania [Kaunas, January 28-29, 2004],

e) Different aspects of implementation Learning Grid services were presented in International Conferences:

- 17th International Conference "EURASIP – BIOSIGNAL 2004" [Brno, Czech Republic, June 22-26, 2004]
- EuroWeb 2002 Conference / The Web and Grid: from e-science to e-business [Oxford, UK, December 15 – 19, 2002]
- IEEE International Conference on Advanced Learning Technologies ICALT2002 [Kazan, Russia, September 08-13, 2002]
- World Conference on E-Learning in Corporate, Government, Helthcare, & Higher Education - E-Learn 2002, [Montreal, Canada, October 15-19, 2002]

As the result of intensive activities under LEGE-WG programme, the Lithuanian partner prepared two proposals for EU structural funds:

- Project proposal: April 05, 2004. ESF-KO-2.5.-105 "Development and implementation of GRID technologies in Lithuanian academic and science institutions (2005-2007)" (According to the EU structural fund support programme in Lithuania BPD2.5 „Improvement of Human Resources Quality in Scientific Research and Innovations"). Partners: Kaunas University of Technology, Vilnius Gedimino Technical University and Vilnius University.
- Project proposal: September 24, 2004. Project title: "Improvement of Qualification of Informational Technologies Specialists" (According to the EU structural fund support programme in Lithuania BPD2.4 Measure 2.4. "Development of Conditions for Lifelong Learning"). Proposer: Kaunas University of Technology.

Besides that, e-Science Baltic grid consortium has started recently http://www.mif.vu.lt/grid/ where Lithuanian partner takes an initiative to lead WP for training and education. We became fully ready for that due to our partnership in the LEGE-WG and E-LeGI.

2 Research vision and directions

The main driver behind eLearning, and indeed conventional education as well, is the Knowledge Economy, with its emphasis on *globalization* – as work and hence workers are outsourced to distant locations; *knowledge intensity* – where 70% of developed world workers are information workers; *connectivity* – as e-commerce enhances cost savings, efficiencies and market reach; and *ICT infrastructures*. Add in the drive for *inclusivity* (avoiding the Digital Divide) and *employability* that most governments promote, and the need for "anytime, anywhere" learning becomes clear. eLearning is the way to deliver this.

The general increase in (broadband) access to learning possibilities still represents one of the major changes that will affect the potential for integration of ICT in learning scenarios, and fulfilling the vision of lifelong learning. Unfortunately, the current "technology push" typified in most European and national eLearning initiatives, using ever more advanced technology to package and deliver information to effectively passive learners, is unlikely to achieve this. There needs to be a fundamental shift from such applicative projects to "learner driver" systems targeting experiential, contextualized and personalized development of the learner's knowledge.

2.1 New learning paradigm

For many of last years the teaching and learning practices have been based mainly on the information transfer paradigm. This focuses on content, and on the key authoritative figure of the teacher that provides information. Teachers' efforts have been mainly devoted to find the best way for presenting content in order to transmit information to learners. Unfortunately the current generation of "e-Learning solutions", which has arisen in response to political pressure, has adopted the rather narrow pedagogic paradigm of "information transfer", which features the teacher as someone who selects particular pieces of information and makes them available to students on the Web. This approach very conveniently gives the surface impression that C&IT is being put to good use. However, there is no evidence that this approach to technology enhanced learning is in anyway effective. It has been adopted simply because it is an easy way to use the Web's basic facilities – material is selected and organised by the teacher on a web site, and students then browse and download it. Failures, such as massive drop out rates, are usually explained by a lack of staff awareness in the use of the Web, rather than critical reflection on the limits of this approach. Furthermore, it is not even clear that it has achieved reduced costs.

In our vision research should move towards the realisation of a paradigm shift that focuses on the learner and the new forms of learning. In our vision the learner has an active and central role in the learning process. Learning activities are aimed at facilitating the construction of knowledge and skills in the learner, instead of the memorisation of information. In fact, according to the recent cognitive theories, the learning process can be effective using an approach which considers in a unitary way some fundamental characters of learning as active, situated and collaborative learning. Keeping the learner at the centre of the new learning processes personalisation and individualisation became relevant aspects to be supported by technologies through the creation of the right context. Individualisation is related to the didactical process

adopted allowing diversifying the path for guarantee the acquisition of basic competences according to specific didactical objectives. Personalisation means the possibility to reach specific didactical objectives fully exploiting the learners' intellective capabilities and competences and giving certain freedom in the choice of contents and approaches (playing with several simulations) in order to facilitate the creation of specific skills and knowledge. Personalisation and individualisation should happen at different level (contents, didactical models, pedagogical approaches) and should take into account the contents (the knowledge to be transferred during the process), the learner skill and preferences, the didactical objectives.

2.2 Service orientation

This new vision has two strong implications: teaching and learning moves toward the form of service and hence the technology must support this implication; teaching and learning process will push the creation of virtual communities where find service (contents, tutoring, searching for learners for sharing experiences, etc.). Technologies must be selected according to these implications. This the reason because we suggest to look at service oriented technologies for the realisation of widely distributed environments.

An open distributed service model is based on the concept of service that, in our context, is a kind of predefined combination of processes yielding some result (the goal of the service) from distributed, heterogeneous, asynchronously communicating and available resources. A service has access to some distributed heterogeneous resources and assuming the communication language is known to each resource, it performs a series of operations (queries of information, requests of computation, controls, redirection, ...) by interacting with these resources.

The basic difference between a service and a product, we believe, is in the "truly" conversational, dynamic nature of services. In order to clarify the difference, the following are some consideration regarding products and services[16]:

- product is developed by the producer with a clearly predefined goal for the potential consumer, a service is offered within a service domain – or competence area, yet the consumer-specific objectives have to be defined during the initial conversations between the provider and the consumer of the service;
- a product is supposed to be in correspondence with a well established and a clearly identified need; a service often anticipates to the customer combinations of needs that were not clearly recognised as such by him/her before;
- a product is most often designed and prototypically developed once, produced many times; the value added by a product increases with the number of copies effectively distributed; a service must be conceived, designed, developed and distributed once for all, as it is custom made for a specific customer with specific needs; the value added by a service increases proportionally with the customer's satisfaction that entails an indirect publicity for the service producer and generates new customers ready to invest more resources in order to have similar services;
- a product's evolution is slow, as it requires modifications in the conception, design and development; shortly, a revision of the whole life cycle. A service evolves naturally as it is a combination of basic services and products on the fly as a consequence of a service definition and tuning during the conversations with a customer;

- a product is often chosen as a solution for an established need, even when the customer does not really "trust" the producer's performance (e.g.: even if I dislike cars and prefer a car-less city centre, I need one for very practical reasons, and I choose the cheapest one because I plan to use it as little as possible); a service requires trust by the customer on the producer (e.g.: I do not go to a dentist or a lawyer unless I believe (s)he is trustable).

According to the needs of real applications, we can try to classify services in:

- "stateless services": these are represented as pure functions. The advantage of easy composition of purely functional services comes at the cost that they can hardly represent state;
- "conversational services": these are the most generic stateful services. Hard to be realized within a distributed and asynchronous context, heavy to be supported and maintained, they however maintain their fundamental interest for the most advanced applications. We believe that higher level services such as those emerging from semantically rich domains will require this model to co-exist with the other ones.

2.3 Grid services

Recently, Grid community efforts are related to the definition of a base framework for an Open Grid Service Architecture [3]: the Web Service Resource Framework (WSRF) [4].
Starting from experience gained from the definition of the Open Grid Service Infrastructure (OGSI) [8], WSRF proposes an evolution of the Grid Service, which can be classified as a "conversational service", towards "stateless service acting upon a stateful resource".
WSRF proposal is involved also in defining service and its needs, and the proposed definition is a middle way between pure stateless services and stateful conversational ones, thus allowing a simple way to compose services without loosing the advantages of state management.

The next generation of Grid solutions will increasingly adopt the *service-oriented model* for exploiting commodity technologies. Its goal is to enable as well as facilitate the transformation of *Information* into *Knowledge*, by humans as well as – progressively – by software agents, providing the electronic underpinning for a global society in business, government, research, science, education and entertainment (*semantic aspects*) We refer to these efforts as the "Semantic Grid".
The Semantic Grid brings together Grid and Semantic technologies.
Semantic and Knowledge technologies are mainly focused on giving a well defined meaning to resources, services and information dispersed on the Web [5], they provides tools for knowledge representation and management, annotation of data and resources, semantic discovery of services and resources, automatic composition of services and inference over metadata and ontologies.
Current technologies, based on industrial standards and initiatives (e.g. UDDI [7], BPEL4WS [6]), allow composition of services with an a priori knowledge of services meaning and processes between services.
In contrast, Semantic Web and Knowledge technologies provides an expressive and semantically enriched description of services, by the use of ontology description languages as OWL-S [1], and allows for automatic selection, location and composition of services in order to achieve the required objectives.

According to this vision the new research direction should look at the creation of a semantic GRID for human learning: The Learning GRID.
The Learning Grid is a semantically enriched Grid that, bringing together the features of Grid and Semantic technologies, represents our solution for creation of the future learning scenarios.
It is based on the OGSA model, so it inherits all the features of that architecture. Two aspects, in particular, are important:

- the *openness* of the architecture, where open means extensibility, vendor neutrality, and commitment to a community standardization process;
- the *service orientation* and *virtualization*, where the first is related to definition of service interfaces and the identification of protocols that can be used to invoke a particular interface, and the second is related to the encapsulation behind a common interface of diverse implementation, so everything (tools, resources, scientific instruments, activities, etc…) in this environment is a service.

In our opinion, the Learning Grid is an ideal environment providing support during all the phases of a Learning Design.

2.4 Scaling

Grid technology can enable both advanced support for distributed activities and the necessary functionalities in a collaborative learning experience, and crucially, it can scale to handle large numbers of participants and actions/events and large quantities of data and processing in a cost effective manner. In addition to providing access to large facilities, it is possible to add a P2P architecture to a Grid infrastructure so as, on the one hand, to improve even more the Grid potential of robustness and resource availability and on the other hand, to allow participants to include computers at home, schools and businesses, and to scale to several millions of concurrent participants. The inherent decentralization of P2P systems provides interesting social benefits that a Learning Grid could fully take advantage of, such as not to depend on exclusive information, decision capacity, or central control as well as to support auto-organized groups, spontaneous groups and so on.

2.5 Learning Documents

Authoring tools for production of learning scenarios can rely on knowledge-based decision making systems that can suggest what should be the best pedagogical models and/or activities for the learning scenario also on the basis of knowledge (e.g. starting skills, personal profiles, etc…) about the actors of the scenario. Furthermore, experts can also exploit the collaborative features of the Grid to cooperate in order to model the scenario. In this way, the Learning Grid supports analysis, modeling and development phases of Learning Design documents.
Even if this represents a good approach, collaborative and knowledge based, for modeling and definition, it is in the Delivery phase that the Learning Grid infrastructure shows its potentialities. The goal of this phase is the understanding of the Learning Design document and the execution of its content in order:

- to reproduce the didactical experience for the learner, and
- to supply to the teacher the capability to support the didactical experience.

The Learning Design document, describing the phases (in IMS-LD terminology, the plays) of a learning scenario, is parsed by an engine that is able to understand and execute the different acts and activities of a play. In order to execute the Learning

Design document, we have to bind each activity with an environment that is a set of resources and services able to execute the activity. We can say that each activity points to an environment and, obviously, each environment has some requirements based on the pedagogical model adopted and learner preferences.

2.6 Resources

To find inside the Grid the resources and services that best match the requirements of an environment, we rely upon OWL-S ontologies to index the core elements of the infrastructure. OWL-S provides three types of knowledge about a service: the *profile* that describes what the service does, the *model* that describes how a service works and the *grounding* that describes how a service can be accessed [10]. If a resource is virtualized through a service, its description can be semantically enriched by the use of OWL-S and this feature can be used to compare the requirements on a service against its description to find the service that best satisfy the requirements.
Indexing services and resources of a Grid can be used:

- by the Grid itself, in order to "know" its infrastructure and to provide machine understandable information about its resources and services,
- by knowledge tools, services or agents inside the Grid, in order to perform an automatic discovery of services matching demand's requirements vs supply's offers.

In this way, the Learning Grid uses its knowledge to bind the learner preferences and the pedagogical model against tools, resources and activities available on the Grid., in other words to provide the best environments for the IMS-LD activities.
In some conflict cases, where more than one appropriate resource is found, knowledge based support system can help in the selection.

2.7 Learning scenarios

To support interactions among the actors involved in a scenario, trusted collaboration groups can be dynamically created where learners and teachers can join and resign the scenario. These collaboration groups are created when in a play there are acts containing shared activities among actors with different roles. Groups can share the same environment and rely upon collaborative features of the Grid to allow communication, either in a synchronous or asynchronous mode, among actors running the shared activity. In this way, actors can reach the objectives of the shared activity exchanging knowledge and experiences.
The Learning Grid makes available a learning scenario with all its "implicit knowledge" (pedagogical model of the scenario, learning goals of the scenario, resources and activities involved, etc…) as a building block for creation of more complex and interactive learning experiences composed by different scenarios.
A learning scenario, once produced and virtualized as a "Human Learning Service", can be indexed and stored in a knowledge base, thus becoming a shared unit of knowledge reusable in other contexts.

2.8 Knowledge Reuse

These scenarios, and indeed the raw content supporting them, have to be managed properly. There is a need for improved knowledge management and in this case, it is public reuse repositories that will need to be managed rather than private. The maintenance of large reuse repositories is a challenge that the software reuse community has struggled with for years; here successful open source software

repositories may have some insights to contribute [17]. One key lesson is that the provision of accessible, open source material encourages both the refinement of existing components and the understanding of what is required (leading to new innovative components). Therefore, the application of software reuse research to e-Learning development will lead to a better theoretical underpinning for developments, and could potentially lead to new strategies for e-Learning and improved technology to support it. This will likely to lead to multipurpose modularisation of learning content rather than learning content specifically course-oriented.

The collaborative nature of open e-learning development requires an improved understanding of collaboration and supporting technology. Here again the use of SourceForge like environments is an interesting development. As in Software Engineering, the need for quality and standards is an important research direction, and necessitating the development of higher level standards for open educational content and open e-learning domain specific middleware and applications over grids.
Social issues

2.9 Learning Context

During this shift from content to context of learning, it is crucial that the learner is provided with sufficient support. Most of the above discussion focussed on the learner and the learner support provided during the Delivery phase.
Typically, learners first encountering e-Learning welcome the benefits (added-value) of standardised, comparable support services and learning processes (interactivity, virtual communities, learner support, clear and credible information for decision-making, learner feedback and transparent certification). However, the current high drop-out rates (over 80% in some cases) cannot be blamed totally on inadequate, "information transfer"-oriented tools and methodologies which frustrate the learner. While the importance of the social and collaborative aspects of learning has been highlighted above, it must be remembered that many learners will still prefer tutor-lead education and training, in spite of the current trend towards learner managed learning (and in fact learner managed learning requires even more skill on the part of the tutor setting up the learning environment and providing the underlying resources). This implies that tutors must be considered and supported almost as much as the learners themselves. Tutor support ranges from tools to filter and manage the knowledge and experiences provided to the learner, to tools to monitor and assess learner performance. Tutors are also key in evaluating quality of learning resources and the wider relevance of the material being studied.
With increasing experience the learners focus widens to include those service components which facilitate learning itself. Validation of learning outcomes then becomes more important (accredited transferable qualifications, support for individuals integrating acquired competences into their everyday work).
The more quality and standardisation of approaches succeed in 'inner areas' (like content, technical platforms, basic interaction and feedback, certification standards), the more the scope and quality of 'sandwich services' will highlight the competitive advantages of e-Learning. At this phase, tutors become less central to the learning process, and collaborative learning can take off.

This process of de-institutionalisation in the acquisition of skills and competencies, (only partly driven by e-Learning), emphasises the role of each individual learner in

collecting and integrating all their own competencies, regardless of source, into a personal portfolio.

The more Lifelong Learning spreads the acquisition of skills and competencies over different educational institutions, educational sectors, regions and nations, through formal/non-formal and informal learning processes, the more important becomes the transferability of the underlying accreditation as well as the embedding needed to successfully deliver those competencies in changing environments.

Many aspects of e-Learning (increased transparency, de-institutionalisation, standards, self-documentation, capacity of technology supported learning, use of products and services in a wide range of different educational/learning settings etc.) suggest its strategic role in improving transferability as a key element, leading to a better coordinated learner-oriented framework of Lifelong Learning provision, whilst providing for economies of scale.

Integration of language technologies into e-learning Grid infrastructure. Language technologies is a mater of great relevance to small language communities for sharing experience/expertise and learning materials also. Despite the rapid development of IT, multilingual computer-based technologies do not exist for many small languages. For example, in spite of the availability of Internet access, more than 65% of Lithuanian population are barred from the e-content of the Internet, due to the lack of English skills. Thus, particular groups of inhabitants with lower education level, residents of rural areas, elderly people, etc. are in danger to be cut off from the development. Recent online translation service provides text and web page translation from English to and from main EU languages only. Because software packages rather than human translators create these translations, absolute accuracy might be an issue. But if they are used to share a general understanding of the material, they can be an effective support system for learning and communication.

For learning and understanding purposes when sharing information there is no need to have a high accuracy language translators, a flexible set of language application tools like taggers, parsers, lexicons, etc. integrated into e-learning service infrastructure may help considerably. We suppose that the problem of multilingual dissemination of eLearning materials will still remain in the next 5-10 years. So, the development of multilingual communication services and the language application tools implementation as *services* will be particularly important for the expanded EU.

2.10 Social factors

It should be asked why anyone should want to learn the material that is provided in the first place? Take the situation of training at the place of work. Academics tend to see work as a means of self-development, self-fulfilment (see Maslow's hierarchy of needs). But for the majority of the work force this is not the case. They do their job because they need to earn a living, so although their employer might see a need for further qualification through training, they themselves do not. How can they be motivated?

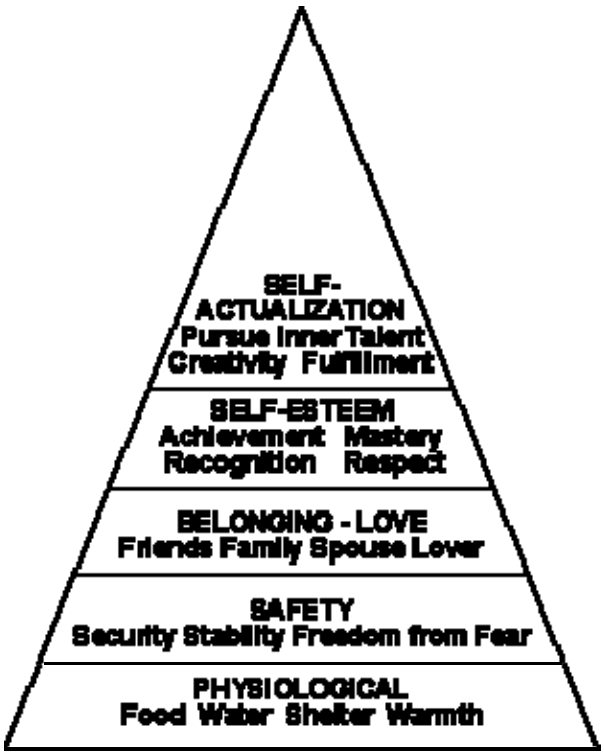

Figure 1: Maslow's hierarchy of human needs. (taken from Maslow, A. (1970). Motivation and personaIity (2nd ed.). New York: Harper & Row)

The first need for research from a more social point of view is how the organizational settings / the socio-technical system could be best designed to motivate the learner to also finish a course. This area is significantly under-researched.

Another issue is the "Knowing the customer"-problem. There is no such thing as a typical eLearner. As mentioned above, most talk about technology enhanced learning excludes a lot of people from the investigation – people in the developing countries, elder people and computer illiterate people in general (digital divide). Further, the learning situation of a travelling salesman is very different to the one of a full-time student at a university. While in the first case ubiquity, the use of mobile clients and having the right light-weight teaching material at hand whenever there is a time slot for learning available is very beneficial, nearly the opposite is true for the student. He will be able to use a heavy desktop computer and will need learning units that go much deeper into a topic.

Additionally, only the potential advantages of eLearning are seen such as the possibility to learn anytime and anywhere. But the use of impersonal media also takes away the social component of learning. Moreover, this happens in the context of more and more lonely people in industrial countries due to intensive use of mediated communication in all areas of life. Mitigate this negative effect through organizational and/or technical measures should be given high priority in research, as it is a critical success factor for eLearning initiatives. Improved collaborative tools to strengthen a sense of community are certainly the way to go, but at present all these tools more or less reduce the richness of communication and the applications are still much too restrictive as to what can be done during the interactions with other distant people. So improving the usability of collaborative tools for synchronous as well as

asynchronous communication to make communication more natural is another big research challenge.

It has often been claimed that soft / social skills cannot be taught through a computer at all. This does not apply to the theory behind social skills, which is shown by quite a big variety of commercial computer-based trainings in e.g. the area of job interview training and personnel management. However, practising social skills is currently not possible via the computer. It would be interesting to do research on things like a role play in a job interview in a Virtual Reality environment.

2.11 Economic factors

Of course, eLearning does not occur in a vacuum. As stated at the beginning of this section, there is a strong commercial need driving the uptake of lifelong learning, and eLearning as a means of achieving it. The use of Grid for providing eLearning is considered promising. The policy for the adoption of any new technologies should also consider cost minimisation and maximise return on investment (ROI) in all levels: from administration to the delivery of learning. In the latter case, new services should be designed in way that:

- fully utilise existing resources,
- can be expanded in order to support a large number of users while minimising costs,
- they ensure flexibility and are able to respond to the rapidly evolving global market,
- increase the power of core resources without creating the need for investing in additional hardware or hosting infrastructures,
- support expansion policies.

Another socio-economic driver that has a significant influence on eLearning is Intellectual Property Rights. Intellectual Property (IP) is increasingly seen as a valuable commodity, but it is the combination with other IP that generates added-value for the end-users. To protect their IP and ensure a decent ROI, owners increasingly want to control their information, even after it has been passed on to others. Grid technologies, in particular the high speed/high capacity networks, allow end-users to access and use IP without that IP having to leave the owners IT environment (and hence control). In addition, the tools used to control and manage the Grid infrastructure (security policy enforcement, certificates, etc.) can be used to protect data and processes from copyright and patent infringements.

The increasingly evident entrance of Universities into the e-Learning market in the role of providers is leading to the emergence of new business models in Higher Education. e-Universities are starting to appear, mainly resulting from partnerships and consortia of already existing institutions willing to keep their dominant position on the market by responding to the changing needs of demand and technological innovation challenges. The provision of on-line courses is further reinforcing the process of internationalisation of higher education and, at the same time, strongly impacting on the shift of learning provision from a regional to a global perspective. One corollary of this economic viewpoint is a focus on quality of courses and materials. The most likely approach to quality turns out to be reliance on reputation of

publisher, use of brokers or consultants to advise, rating against published criteria of what constitutes quality materials, accrediting the producing organisation, public sector authority prescribes products which can be purchased.

2.12 Summary

We conclude this section emphasizing how our vision of the Learning Grids presents some of the properties described in [9] and is projected towards the Next Generation Grids:

- *it is open and standard based* – our vision is based on widely adopted standards and specifications,
- *it is person centric* – our Grid manages knowledge in order to satisfy learner requirements and preferences also on the basis of what the Grid know about the learner. Also the goal of the learning scenarios is person centric: they try to stimulate group of persons to acquire knowledge in many different fields,
- *it is transparent, easy to use and program*– an expert wishing to produce a learning scenario has only to learn how to use an authoring tool. He hasn't to know tools and resources of the Grid: the Grid itself, by the use of its knowledge, suggests the appropriate core elements available in the Grid. Furthermore, the adoption of expressive languages, as the OWL-S, could be a success factor from a programming viewpoint,
- *it is scalable* – our mechanism for indexing resources integrated with Grid tools for resource management allows for an easy and transparent joining and resigning of "nodes" in the Grid. Furthermore, indexing the resources brings the Grid to have some knowledge about its infrastructure, thus simplifying monitoring and self management of the infrastructure,
- *it is pervasive and ubiquitous* – our vision is based on the anytime-anywhere-anyhow paradigm inherited from the Grid (in some way, it is part of the Grid paradigm). But, from our viewpoint, the term "ubiquitous" is referred, more generally, to the ability to support multiple diverse pedagogical models and to automatically adapt them in different contexts. Furthermore, the Learning Grid allows creation of pervasive learning scenarios: an actor is immersed in all the aspects of a learning process that takes care also of cultural and social context,
- *it is secure* – even if not clearly emphasized in this disseration, the Learning Grid has to address many security aspects from both technical and legal viewpoints (trust, confidentiality, security, etc.).

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3 Specific areas requiring research

Firstly, it should be said that human learning is a complex and quite obscure phenomenon; attempts to take existing technologies and just apply them to eLearning are actually approaching the problems from the wrong end. eLearning needs to start from a research vision based on new foundational paradigms for human learning – these will in turn drive the advances in distributed computing, etc. that are necessary (think of SmallTalk and LOGO in the 70s – both intended to support learning and both driving major advances in computing). The ELeGI project goes some way towards this, adopting a social constructivist view of learning and focussing on the new approaches, methods and tools that this requires. However, within such a new framework, there are a number of specific (non-pedagogical) research issues that can be identified.

3.1 Service Orientation:

In terms of underlying technologies, the vision emerging from the Working Group (and the ELeGI project) is of a service-oriented view, as opposed to the traditional product oriented view. Service in these terms" is not computational (as in Web Services, etc) but refers to learning services. Creating useful learning services to support new pedagogies will necessitate a lot of underlying work on the IT infrastructure, in areas such as: adaptive content, dynamic content aggregation, personalized learning environments, just-in-time and mobile learning, management of the learning process, etc.

3.1.1 Example topic: Interoperable user services

Context: Many units of learning are embedded in particular situations and use fixed sets of tools, for example those provided by particular VLEs. Generic descriptions for services are under development (e.g. OWL-S, the Sakai project, http://www.sakaiproject.org) but need to be applied to end user services in a way that enables them to be described in one context and then used in another.

Body: Typically elearning tends to be embedded within a particular system and, for example, refer to tools for conferencing or assessment submission that are locally available. The designer is not supplied with an easy way to characterise such tools, and anyone reusing the design has no direct way to substitute other tools. The Learning Grid should look for ways to describe such services and then discover and use alternative available services when the user needs them.

Research: Semantic descriptions of services. Tool sets for learning.

3.2 Social aspects

There are two aspects to this. The first is the need to support learner-learner interactions, not just at the social, community-building level but also to support true collaborative learning. The second is the wider community aspects, ranging from digital gaps – social, geographic, economic, etc, through legal issues – IPR, privacy, plagiarism, etc, to economics – new business models, etc.

3.2.1 Example topic: Task models for learning

Context: Theories of learning and human organisation such as Activity Theory, Socio-cognitive engineering and social-constructivism value the learner activity and collaboration over the content.

Body: The development and recognition of approaches such as task models that acknowledge the interaction between the design of the task and the learner's context in terms of their social and technical environment to produce the activity that they will carry out. This activity will vary across the learners in a way that will adapt to their requirements, motivation and opportunities. The Learning Grid needs to provide a rich environment of resources, data-sets, and computational power to enable a broad range of activities. The separation of task from the eventual set of resources that might be used to carry out the activity implies that there needs to be trust of the quality of the environment that will be used. Links with the community of peer learners will be an important part of shaping the experience of each learner.

Research: The investigation of task models. Peer-peer methods. Trust models. Adaptability to learner's context and profile. Ubiquity/mobility and location sensitivity. Consistent QoS from the infrastructure.

3.3 Tutor / institution support

It is important that the new eLearning services take the tutors and administrators into account. The learner's need for support and guidance implies the need for knowledge management/filtering and learning environment creation/ management faculties for the tutor. In addition, the institutional background in much (semi)formal learning implies the need for integration with student administration systems, support for assessment and examination, benchmarking and evaluation of courses/technologies, etc. When this is added to the need for new pedagogical approaches, it is clear that extensive work is required on new Virtual Learning Environments which focus on the whole cycle of knowledge in didactics (generation, capture, representation, retrieval, sharing and reuse) but also provide the necessary feedback to support the tutoring and institutional needs.

3.3.1 Example topic: New concepts of learning

Context: There needs to be increasing value placed on all forms of learning as there is a move from formal learning to other forms.

Body: Learning can be considered as having formal, non-formal, informal and self-directed elements (see e.g. Livingstone, http://www.oise.utoronto.ca/depts/sese/csew/nall/res/21adultsifnormallearning.htm). The widespread use of an interconnected environment, such as the web, offers scope to blend together these different forms and to bring greater recognition to the less formal ways in which learning occurs. The Learning Grid can develop ways to keep persistence for the user across their different devices, locations and methods for learning.

Research: New concepts for learning and the changes required in organisations. ePortfolios to store and transfer descriptions of learning.

3.4 Infrastructure

Increasing number of learners, particularly if accompanied by increased inter-student cooperative working and anywhere, anytime learning will impose significant loads in

the infrastructure in securely monitoring and tracking learner actions/behaviour. Videoconferencing, real-time animation and simulation, etc will only exacerbate the situation. Ambient, Grid and P2P technologies will have to provide a suitable pervasive infrastructure, and it is important that eLearning (and mLearning) VLEs have a significant influence on the way these develop.

3.4.1 Example topic: GRID computing

Context: It is already almost true that everyone has a connection (ubiquity) and that everyone carries a connection (ambience) and there are moves towards there always being devices in the immediate environment having a connection (flow). The GRID represents the stage when everything works together to give the power of the world's devices.

Body: The mobile learner may operate in an environment where not only do they carry devices that might help them learn (mobile phones, PDAs, wireless computers) but also they come across devices that can help them learn (televisions, video systems, computers, information systems). All of these may be connected to the wider environment and potentially both provide information input and access information. The Learning Grid should enable the use of this broad resource and also allow the learner to work through the most appropriate media, perhaps at a later time to or in a different location.

Research: Mobile learning. Persistent storage.

3.5 Reuse

In a service oriented world, interoperability between the services is essential. This implies the need for standards, both for the services and for the raw materials used by these services. It has to be ensured that existing and emerging standards (SCORM, LOM, etc) address the areas needed for interoperability in a learning services world. Beyond interworking, however, the diversity of potential Virtual Learning Environments and the need to personalize these implies sharing of experiences between developers and between tutors and developers will be critical. The Open Source movement in software should provide a good model for this.

3.5.1 Example topic: Representation of Learning Services

Context: Development of Learning Design descriptions and an increasing use of potentially interoperable systems means that there is scope for capturing and sharing good practice as models.

Body: Learning Designs can be represented in specific ways such as the detailed XML descriptions suggested by the IMS Learning Design specification. Alternatively such designs can be conveyed through lesson plans or as narrative descriptions of patterns with a much greater expectation that the user will have to adjust the description to their own context. The Learning Grid can offer the chance to discover and work with either approach or some representation combining elements of each approach.

Research: The capturing and exchange of best practice. Ontologies and metadata descriptions of Learning Design. Systems to combine designs with local user services.