



DISTANCE LEARNING AND SUPPORT

A scientific and technological study undertaken by the ICCC Group a.s , Division
HPC, Prague, Czech Republic (ICCC) for the ENACTS network.

September 2003 – March 2004



ENACTS - Distance Learning and Support

PART I: The ENACTS Project: Distance Learning and Support

1.1 Presentation of the ENACTS project:

1.1.1 Remits

ENACTS is a Co-operation Network in the ‘Improving Human Potential Access to Research Infrastructures’ Programme.

This Infrastructure Co-operation Network brings together High Performance Computing (HPC) Large Scale Facilities (LSF) funded by the DGXII's IHP programme and key user groups. The aim is to evaluate future trends in the way that computational science will be performed and the pan-European implications. As part of the Network's remit, it will run a Round Table to monitor and advise the operation of the four IHP LSFs in this area, EPCC (UK), CESSA-CEPBA (Spain), CINECA (Italy), and BCPL-Parallab (Norway).

This co-operation network follows on from the successful Framework IV Concerted Action (DIRECT: ERBFMECT970094) [1] and brings together many of the key players from around Europe who offer a rich diversity of High Performance Computing (HPC) systems and services. In ENACTS, our strategy involves close co-operation at a pan-European level – to review service provision and distil best-practice, to monitor users' changing requirements for value-added services, and to track technological advances. In HPC the key developments are in the area of Grid computing and are driven by large US programmes. We urgently need to evaluate the status and likely impacts of these technologies in Europe whose goal is to set up European Grid computing. This Grid is a ‘virtual infrastructure’ in which each researcher, regardless of nationality or geographical location, has access to the best resources and can conduct collaborative research with top quality scientific and technological support.

ENACTS provides participants with a co-operative structure within which to review the impact of Grid computing technologies, enabling them to formulate a strategy for increasing the quantity and quality of access provided.

1.1.2 Scope and Membership

The scope of our network is computational science: the HPC infrastructures which enable it and the researchers, primarily in the area of physical science, who use it.

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| <i>Centre</i> | <i>Role</i> | <i>Skills/Interests</i> |
|-------------------|-------------|--|
| <i>EPCC</i> | IHP-LSF | Particle physics, materials science |
| <i>ICCC Group</i> | User | Optimisation techniques, control engineering |
| <i>UNI-C</i> | LSF | Statistical computing, bioinformatics, multimedia |
| <i>CSC</i> | User | Physics, meteorology, chemistry, bio-sciences |
| <i>ENS-L</i> | Society | Computational condensed matter physics, chemistry |
| <i>FORTH</i> | User | Computer science, computational physics, chemistry |
| <i>TCD</i> | User | Particle physics, pharmaceuticals |
| <i>CINECA</i> | IHP-LSF | Meteorology, VR |
| <i>CSCISM</i> | User | Molecular sciences |
| <i>UiB</i> | IHP-LSF | Computational physics, computational biology, geophysics, computer science |
| <i>PSNC</i> | User | Computer science, networking |
| <i>UPC</i> | IHP-LSF | Meteorology, computer science |
| <i>NSC</i> | User | Meteorology, CFD, engineering |
| <i>ETH-Zurich</i> | LSF | Computer science, physics |

Table 1: ENACTS participants by role and skills

Three of the participants (EPCC, CINECA and CESCA-CEPBA) are LSFs providing Researchers' Access in HPC under the HCM and TMR programmes. All were successful in bidding to Framework Programme V (FP V) for IHP funding to continue their programmes. In this, they have been joined by the Parallab and the associated Bergen Computational Physics Laboratory (BCPL) and all four LSFs are full partners in this network proposal and plan to co-operative more closely in the Transnational Access programme.

These LSFs have already provided access to over 500 European researchers in a very wide range of disciplines and are thus well placed to understand the needs of academic and industrial researchers. The other 10 ENACTS members are drawn from a range of European organisations with the aim of including representation from interested user groups and also by centers in economically less favored regions. Their input will ensure that the Network's strategy is guided by users' needs and relevant to smaller start-up centers and to larger more established facilities.

ENACTS - Distance Learning and Support

A list of participants together with their role and skills is given in Table 1 while their geographical locations are illustrated below.



Figure 1: the ENACTS co-operation network

1.1.3 Workplan

The principal objective is to enable the formation of a pan-European HPC metacentre. Achieving this goal will require both capital investment and a careful study of the software and support implications for users and HPC centers. The latter is the core objective of this study. Bids for the former (e.g. RTD proposals) may also be deliverables.

The project is organised in two phases. A set of six studies of key enabling technologies is and will be undertaken during the first phase:

- Grid service requirements (EPCC, PSNC);
- the roadmap for HPC (NSC, CSCISM);
- Grid enabling technologies (ETH-Zurich, Forth);

ENACTS - Distance Learning and Support

- data management and assimilation (CINECA, TCD);
- distance learning and support (ICCC, UNI-C); and
- software efficiency and reusability (UPC, UiB).

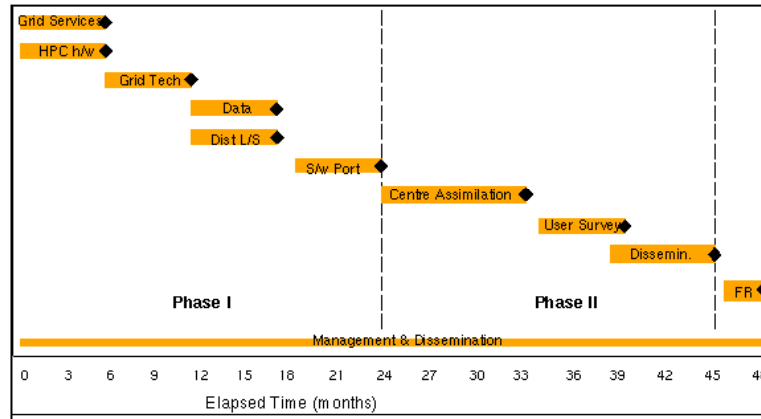


Figure 2: Gantt Chart for the Work of the ENACTS Network

Following on from the results of the Phase I projects, the Network undertakes a demonstrator of the usefulness and problems of Grid computing and its Europe-wide implementation. Prior to the practical test, the Network undertakes a user needs survey and assessment of how centers' current operating procedures have to change with the advent of Grid Computing. As before, these studies involve only a small number of participants, but with the results disseminated to all:

- European metacentre demonstrator: to determine what changes are required to be implemented by HPC centers to align them with a Grid-centric computing environment. This includes a demonstrator project to determine the practicality of running production codes in a computational Grid and migrating the data appropriately (EPCC, UiB, TCD);
- user survey: to assess needs and expectations of user groups across Europe (CINECA and CSC);
- dissemination: initiation of a general dissemination activity targeted on creating awareness of the results of the sectoral reports and their implications amongst user groups and HPC centers (UPC, UNI-C, ENS-L). The Network Co-ordinator and the participants will continue their own dissemination activities during Year 4.

1.2 Joint Scientific/Technological Activities and Studies – Distance Learning and Support

Objective starting points (sources) of this study: users accessing facilities through a pan-European metacentre, typically, requires training and support from remote centers in order to make best use of the available facilities. The WWW-based technologies are emerging to accomplish this, but are largely untried outside intranets. Here, ENACTS aims to determine the most appropriate support and training methods and the enabling technologies.

ENACTS - Distance Learning and Support

1.2.1 Workplan

The principal deliverable from this activity is a Sectoral Report, commissioned by ENACTS, which will hopefully enable the participants to pool their knowledge, to investigate new developments in this area and to come up with recommendations for a collaborative framework for the development of distance learning material. The Sectoral Report is made freely available via the WWW. This activity is coordinated by I.C.C.C. Group a.s. with the support of UNI-C. We make the Sectoral Report available together with this introduction showing our basic goals in order to be able to compare them with our results.

1.2.2 The Participating Institutions

I.C.C.C. Group a.s., Prague, Czech Republic

Since its inception, I.C.C.C. has concentrated on co-operation with its customers and identification of the right solutions designed to meet their needs. During its existence, the company has developed its own methodology and practice covering such areas as product development, project management, ISO standard based information system administration, information system security procurement and many others.

Today, I.C.C.C. belongs among the leading computer and information technology companies in the Czech Republic. The company employs various IT experts specializing in areas like knowledge management, project planning and management, information system administration, data warehousing and analytical processing, custom-built application development, comprehensive information system development, operating systems, communications, replication and information system security, parallel systems, science and technology applications etc. All these people have extensive knowledge in their particular field and they are at the customer's disposal whenever required. They all use the state-of-the-art tools and technology available at the time.

Refer to our web page <http://www.iccc.cz> for hyperlinks to projects implemented by I.C.C.C.

The strategy of I.C.C.C. is based on an active approach to long-term co-operation with the customer. The quality of services provided by the company to its customers is driven by an effort to ensure their maximum satisfaction and prosperity. This is supported by the use of the most modern products and services provided at a highly professional level, by systematically building and enlarging the company's know-how, by co-operating with recognized local and foreign partners and by managing projects according to the company's own time-proven policies and methods.

For its customers, I.C.C.C. is a partner who respects protection of their investment in information technologies. The criterion of the company's success is a customer satisfied in the long run, a customer acquiring a competitive edge by using our services and achieving accomplishments and prosperity in their business area.

ENACTS - Distance Learning and Support

I.C.C.C. is one of the first commercial high performance computing centers in Eastern and Central Europe. The principles of its operations are based on collecting technical equipment and proper human resources to serve various customers.

The I.C.C.C. employees are ready to help customers not only with managing projects but also with preparation, design and even actual implementation of their own software equipment in order to ensure that the advantages of modern computer parallel architecture bring them real benefits. The clients' applications can thus achieve computing effectiveness and performance results which would be either entirely unavailable through conventional operations or the achievement of which would require enormous effort and costs. By using the services of I.C.C.C. the customers can gain time and investment funds to be used for other activities. See <http://www.iccc.cz> for further information.

UNI C, Aarhus, Denmark

UNI•C is the Danish IT Centre for Education and Research. It is a government institution under the Danish Ministry of Education. UNI•C is the driving force behind the technological development in education and research concentrating on IT solutions for education, research and business. UNI•C has a staff of approximately 300, with offices in Copenhagen, Lyngby and Aarhus.

UNI•C is a driving force behind the development of an information technology basis for innovation and improvement of education and research in Denmark. It is kept to contribute decisively towards ensuring Denmark's position in the global information society.

UNI•C strives to contribute towards the implementation of the IT policy of the Danish Ministry of Education and to continue playing a role as a frontline IT organization for the educational and research sector.

UNI•C endeavours to become a preferred collaborator concerning development and utilization of IT in education and research and to utilize our experience to the benefit of the business sector and Danish society as a whole.

See <http://www.uni-c.dk/> for further information.

1.2.3 The Authors

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Josef heads the European Research Programs Division at I.C.C.C. Group a.s. and is its leading expert on telecommunications issues. He oversees several Commission's RTD projects. Previously, he worked extensively in telecommunications (RDT, testing and approvals) and software industries. He acted as Project Manager in a number of software development projects.

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ENACTS - Distance Learning and Support

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Mirek received the MSc degree in Mathematics from the Czech Technical University (1981) and PhD degree from the Institute of Computer Science. He participated in several national and international projects concerning numerical linear algebra and HPC. His research interests concern direct methods, preconditioning and graph theory. He is also an author and co-author of over 20 papers in conference proceedings and professional journals. Mirek works for ICCC as a Mathematical Engineering Specialist in the High Performance Computing Division and his main activities are targeted at logistic planning and optimization of commercial distribution of goods.

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1.2.4 Main Tasks

There are five workpackages in this project, totalling 5.5 staff-months of effort. The elapsed time for the project is 6 months. The workpackages are summarised below.

Table 2: Distance Learning Workplan

| | Workpackage | Effort | Produced By | Accepted By |
|-----|------------------------------|--------|-------------|----------------------|
| WP1 | Survey of current experience | 1.0 | ICCC, UNI-C | Network Co-ordinator |
| WP2 | Sectoral Report | 2.5 | ICCC, UNI-C | Network Co-ordinator |
| WP3 | Dissemination | 1.0 | ICCC | Network Co-ordinator |
| WP4 | Final Report | 0.5 | UNI-C, ICCC | Management Committee |
| WP5 | Project management | 0.5 | ICCC | |

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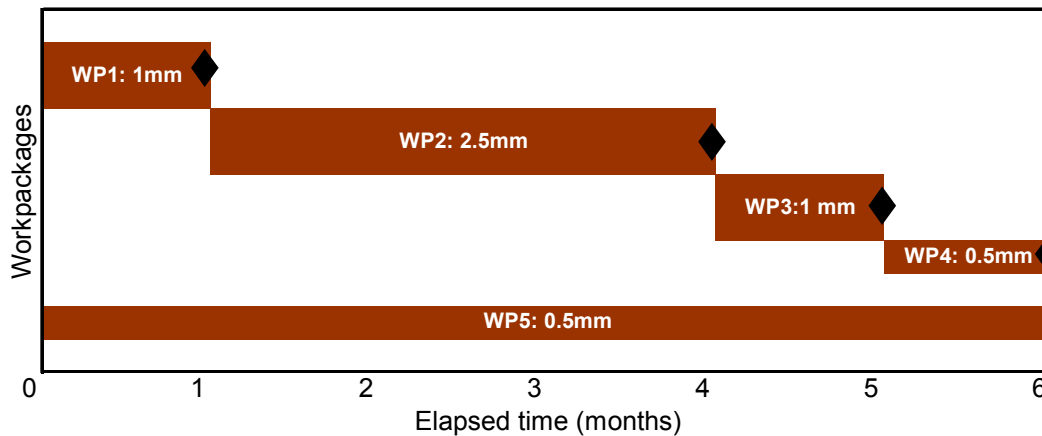


Figure 3 : Gantt Chart for Distance Learning Study Project

- WP1: This is a survey of current experience and practice in the development of distance learning material. The deliverable will be a report, which will be produced by ICCC Group and UNI-C, with input from other participants. This workpackage has a duration of 1 staff-month.
- WP2: This is a Sectoral Report, covering three areas of interest in establishing a collaborative environment:
 - Tools
 - Standards
 - Pedagogy

This deliverable is a report. This workpackage has a duration of 2.5 staff-months.

- WP3: This is to enable general dissemination of the findings of the Sectoral Report cost-effectively. This will take the form of publishing the results on the ENACTS website and encouraging participants to present the findings at appropriate conferences. This workpackage has a duration of 1 staff-month.
- WP4: This is the Final Report which is a deliverable for the EC and for the ENACTS General Meeting. ICCC and UNI-C will produce this. This workpackage has a duration of 0.5 staff-months.
- WP5: This is the management of the Study Project. ICCC will undertake this activity. This workpackage requires 0.5 staff-months of effort, over the 6 elapsed months of the project.

1.2.5 Technical Objectives and Conditions

Let us describe now the technical objectives and conditions for our study. They are implied by the necessity to agree on a framework for collaborative development of distance learning based course material. The objective is to make it easy for participants (and other institutions in Europe) to develop or customise re-usable training material.

ENACTS - Distance Learning and Support

The widespread availability of distance learning material will increase the accessibility of HPC systems. One of the aims of the metacentre is to make training in appropriate tools and techniques available to researchers who are remote from the facilities they are accessing. The provision of an appropriate framework for course development makes this more feasible.

1.2.6 Potential Benefits

The advent of Grid computing will make it ever more likely that users will be using facilities remotely. This means that the same networked technologies must be used to provide training and support. Currently, there is little standardisation in the technologies used to develop training courses and none in the area of distributed support.

Distance learning is thus of interest to all infrastructure operators and research groups in Europe, but the cost of developing and maintaining training material has discouraged most centers from committing time and effort to it. Collaborative projects offer the potential for sharing the costs and the effort, but it is vital to select an appropriate development environment. A focused study, reviewing the state of the tools, the standards and the methodology will be of practical benefit.

ENACTS hopes that the project will result in a proposal to a European funding agency to develop distance learning material for users of the European metacentre.

1.2.7 Organisation

UNI-C and I.C.C.C. have worked on this study, with I.C.C.C. as the Study Co-ordinator. They have worked together on WP1, WP2, WP3 and WP4 (the Survey of Current Experience, Sectoral Report, WWW dissemination and Final Report). Their activities were split between the participants. I.C.C.C. has undertaken WP5 (the Project Management).

The 5.5 months of effort for this activity has therefore been split as follows:

Table 3: Effort by workpackage by partner

| | UNI-C | ICCC | Total |
|-------|-------|------|-------|
| WP1 | 0.25 | 0.75 | 1.0 |
| WP2 | 0.75 | 1.75 | 2.5 |
| WP3 | 0.0 | 1.0 | 1.0 |
| WP4 | 0.25 | 0.25 | 0.5 |
| WP5 | | 0.5 | 0.5 |
| Total | 1.25 | 2.5 | 3.75 |

The Management Committee has performed quality assurance on project deliverables and accepted them on behalf of ENACTS. The Final Report has been presented to the EC and to the General Meeting.

ENACTS - Distance Learning and Support

1.2.8 Rationale

The definition of distance education may seem straightforward enough, but there is an ongoing debate as to what is involved in the process and concept of distance education. Glenn Hoyle's Distance Learning on the Net (<http://www.hoyle.com/distance.htm>) provides a list of definitions of Distance Learning from various sources. His own summary is:

"Distance Learning is a general term used to cover the broad range of teaching and learning events in which the student is separated (at a distance) from the instructor, or other fellow learners."

There are many different distant learning definitions. They will be discussed at the beginning of Part II. With few notable exceptions, the actual beneficiaries and users of tomorrow's Grid technology have not yet established a dialogue regarding standardization of technologies and tools used in education. Remarkably, formal remote training and distance learning are not rated highly in our survey. Yet, it is appropriate to raise a question about what would be the most relevant and effective distance learning method in the context of European and international Grid communities.

1.2.9 Outline of the study and changes during the project

Let us emphasize once more that the main task of this study is to describe and analyze the role of distance learning and support within the field of grid computing. It often happens that grid computing tools have a strong feedback on the strategies and efficiency of the distance learning.

The original plan of the composition of the study was as follows. It had to be composed of the four main parts:

- **Part I:** Presentation of the ENACTS project, of the Distance Learning and Support Project, the envisaged workplan, technical objectives and benefits. We also give a short description of participating organizations together with the list of research team members (this section).
- **Part II:** Various definitions of distance learning and education. Presentation of basic distance learning tools and models, including a discussion of their features, limitations, and benefits for prospective users. Although this text is relatively general, the authors want to focus on three main user groups which have been identified: HPC centers (service providers), Scientific Grid community (researchers and users) and Industrial Grid community (vendors and end-users). These three target groups are shortly discussed in the end of this section.

This section was written by ICCG.

- **Part III:** Results from a comprehensive survey distributed among 85 and undertaken among 25 major European research groups. It focuses on different aspects, such as the needs and requirements of various potential target groups and the pedagogical and organisational approach, which fits best with identified target groups. The survey

ENACTS - Distance Learning and Support

includes a clear analysis how to ascertain the feasibility, viability and relevance of adapting a proper distance learning strategy to the training requirements and leads into a evaluation and agreement on a framework for collaborative development of suitable distance learning based course material.

This section incorporated in the Final Report was written by I.C.C.C. in close collaboration with UNI-C.

- Part IV: Conclusions and recommendations. The purpose of the survey presented in Part III is to gain a better understanding of these key user groups' needs and requirements in view of establishing a proper framework for distance learning and support. The analysis of this survey, together with Part II, which presented general concepts and technological issues, will be instrumental in establishing key recommendations for target groups. This section will provide a summary of the distance learning features offered by the leading but still rather small groups of Grid specialists and users and it will make recommendations on a possible strategy that supports a successful uptake of Grid technology around larger communities. This section was written by ICCC.

Based on the results of the questionnaire, we have changed the structure as follows. Keeping Part I, Part III and Part IV as they were proposed, replacing Part II by a short introductory text on distance learning definitions and identified user groups. The basic reasons for this change were the following: evaluation of the results implies unexpected conclusions. While it seems that distance learning is relevant to grid computing, it should be applied in a special form with which we deal below.

The authors would like to acknowledge the support by the European Commission. The ENACTS project is funded under the 'Improving Human Potential, Access to Research Infrastructures' programme. Project reference: HPRI-2000-40015.

See <http://www.enacts.org/> for up-to-date information on the ENACTS project.

ENACTS - Distance Learning and Support

PART II: Distance Learning: basic models, tools, technologies and main target groups

Part II addresses the basic theoretical issues regarding distance learning. In addition, we added also a few comments concerning the distance support that plays an important but a subsidiary role. It depends on the distance learning process. The text also summarises the problems and challenges. It can be roughly divided into three parts. The first recalls several definitions of distance learning. The second part describes the tools, standards, methods and techniques used. Due to a large number of different distance learning approaches, the authors of this study decided to discuss a representative selection dealing mostly with distance learning in general and concentrating on the examples and techniques used in grid computing. The rationale is to come up with a practical solution that fits with not only the requirements of an ordinary user, but of scientific grid and industrial grid communities as well.

Our main questions are:

1. Why (we feel that it is useful to cover distance learning – related questions in any study on learning or education in a broader sense)?
2. What (should be the subject of the massive intellectual exchange between involved subjects)?
3. Who (should profit from the subject of our study in the framework of grid computing)?

Our preliminary answers to these questions that form an underlining idea of our contribution are as follows:

1. Why? To help another groups to develop or customise reusable training material and to agree on a framework for developing a course material for distance learning.
2. What? To make distance learning material available increasing the accessibility of HPC systems and effectiveness of their use.
3. Who? Research groups remote from centres involved in grid computing.

Part III then describes these questions and answers in a thorough way including a survey of reflections obtained from real users of grids.

2.1 Definitions of Distance Learning

The definition of distance education may seem straightforward enough, but there is an ongoing debate as to what is involved in the process and concept of distance education. A Continuing Education group at the University of Wisconsin-Extension (<http://www.uwex.edu/disted/definition.html>) provides this definition: „*Distance Education is a planned teaching/learning experience that uses a wide spectrum of technologies to reach learners at a distance and is designed to encourage learner interaction and certification of learning.*” Further definitions of distance learning can be found at the following websites:

ENACTS - Distance Learning and Support

The Distance Learning Resource Network (DLRN) provides this definition by Virginia Steiner (<http://www.dlrn.org/text/library/dl/whatis.html>):

“Distance Education is instructional delivery that does not constrain the student to be physically present in the same location as the instructor. Historically, Distance Education meant correspondence study. Today, audio, video, and computer technologies are more common delivery modes.”

Michael Moore, the director of The American Center for the Study of Distance Education, Penn State gives the following definition in *Distance Education: A Systems View*, co-authored by Greg Kearsley [California: Wadsworth Publishing Company, 1996]:

“Distance education is planned learning that normally occurs in a different place from teaching and as a result requires special techniques of course design, special instructional techniques, special methods of communication by electronic and other technology, as well as special organizational and administrative arrangements.”

The Instructional Telecommunications Council (<http://144.162.197.250/definition.htm>) has the following definition: *“The process of extending learning, or delivering instructional resource-sharing opportunities, to locations away from a classroom, building or site, to another classroom, building or site by using video, audio, computer, multimedia communications, or some combination of these with other traditional delivery methods.”*

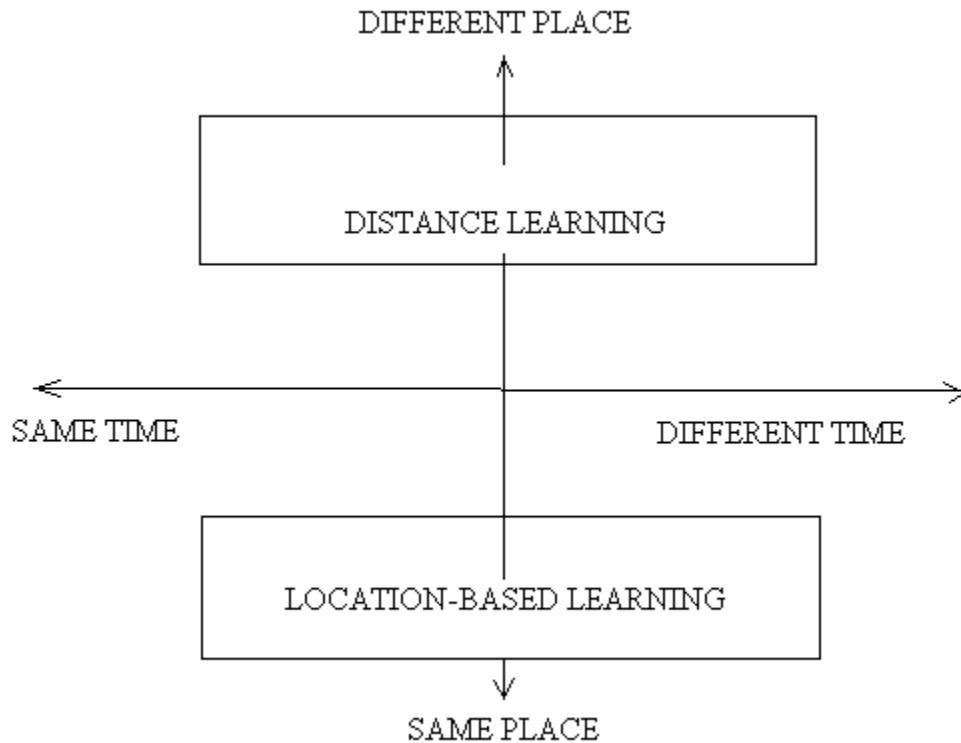
The Institute for Distance Education at the University of Maryland University (<http://www.umuc.edu/ide>) gives in its Conceptual Planning Tool the definition:

“The term distance education represents a variety of educational models that have in common the physical separation of the faculty member and some or all of the students. As with all types of education, the various distance education models are built around the central components of the instructional process: presentation of content; interaction with faculty, peers, and resources; practical application; and assessment. Each distance education model uses technologies in various ways to address some or all of these components.”

The Consumer’s Guide of the Western Cooperative for educational telecommunications (<http://www.wcet.info/resources/publications/conguide/index.htm>) gives the definition which will be a good start for the next subsection on models and technologies:

“Distance education is instruction that occurs when the instructor and student are separated by distance or time or both. A wide array of technologies are currently used to link the instructor and student. Courses are offered via videotape, broadcast television, ITFS (instructional television fixed service), microwave, satellite, interactive video, audio tapes, audioconferences, CD ROM, and increasingly, computer networking – including email, the Internet and its World Wide Web”.

ENACTS - Distance Learning and Support



There are many other names which more or less cover one or several features of the distance learning. **The open and flexible learning** is the term for learning methods by means of which students have some control of their time, place, pace and processes of their study of particular parts in the curriculum. The term open learning is wider than the term distance learning that applies to (open) learning which takes place at a distance from the provider of the learning materials. A very popular name is **E-learning**. According to Derek Stockley from Melbourne (<http://derekstockley.com.au/elearning-definition.html>) it is “*the delivery of a learning, training or education program by electronic means. E-learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to provide training, educational or learning material.*” The other term is the **blended learning** which is e-learning combined with other training methods. The use of (personal) computers for education and training is also called under acronyms **The Computer-Aided Instruction (CAI)**, **Computer-Assisted Learning (CAL)**, **Computer-Based Training (CBT)**. These names put more emphasis on specification of the device used for education process, while the name **Computer Supported Collaborative Learning (CSCL)** stresses the fact of introducing more interactive partners into a computer-supported educational system increasing the effectiveness of the education itself. The term **Web Based Training (WBT)** goes even further with specifying the system for organising and structuring the information. This is the definition of the distance learning that we use.

ENACTS - Distance Learning and Support

2.2 Methods, models and technologies: historical overview

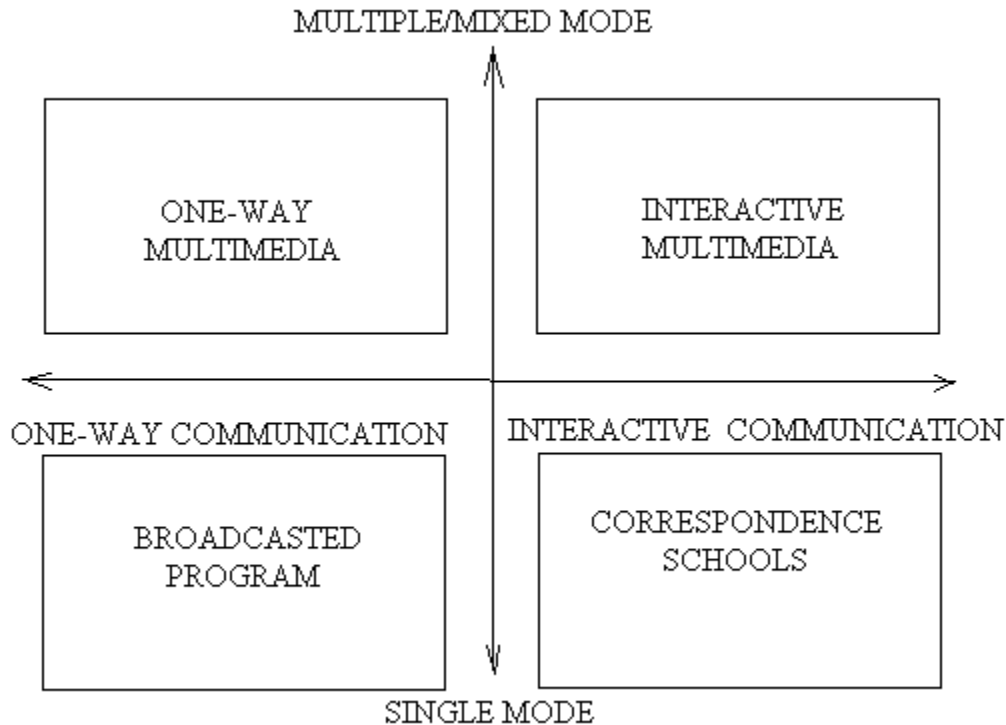
2.2.1 Historical remarks

As we have mentioned in the previous section, the most characteristic feature of distance learning consists in the location difference between the teacher and the students. A brief overview describing the historical development of basic distance learning tools and techniques is appropriate at this point.

The traditional or conventional campus based learning can be characterized as a single mode education with instructional design. Typically, the teachers at universities and schools prepare their lectures in advance and present the content to students using a single medium such as printed handouts, oral or visual presentation. Education having first distance learning features was delivered at correspondence schools in the second half of the 19th century using traditional single mode delivery tools, such as the railroad network and postal service that expedited the pedagogical content exclusively in print. With the development of various technologies, the printing technologies were enriched with such media as audio cassettes and videotapes. Particularly popular became the adult education using radio broadcast (University of the air) and cinema programs at the beginning of the 20th century.

The rapid development of computers and striking advances in magnetic storage technology in the 1950s have lead to the already mentioned Computer-Aided Instruction (CAI), Computer-Assisted Learning (CAL), Computer-Based Training (CBT) schemes, in which the mainframe computers and later PC's were used to present lectures. The single-mode delivery integrating various voice, video and computer technologies into a single accessible delivery system lead to the mixed-mode and "blended" learning. Thus the development of distance learning tools was not restricted only to the computer technologies in the 1970s. Significant advances were simultaneously achieved in the field of such multimedia distance learning tools as was the usage of books, radio programs, television instruction and audiocassettes (somewhat later also videotape) distribution. However, these tools were used only as passive content carriers.

ENACTS - Distance Learning and Support



Another important step in the development of distance learning tools was implemented in the late 1980s by means of interactive multimedia and networks. This phase produced conditions for real collaborative distance learning. Various technologies have been used since that time: such as Laserdiscs, CD ROM, satellites, Computer mediated communication (CMC) and videoconferences (small room or classroom videoconferencing). The dual (two-way) or mixed mode has become even more important with the invention and implementation of the Internet.

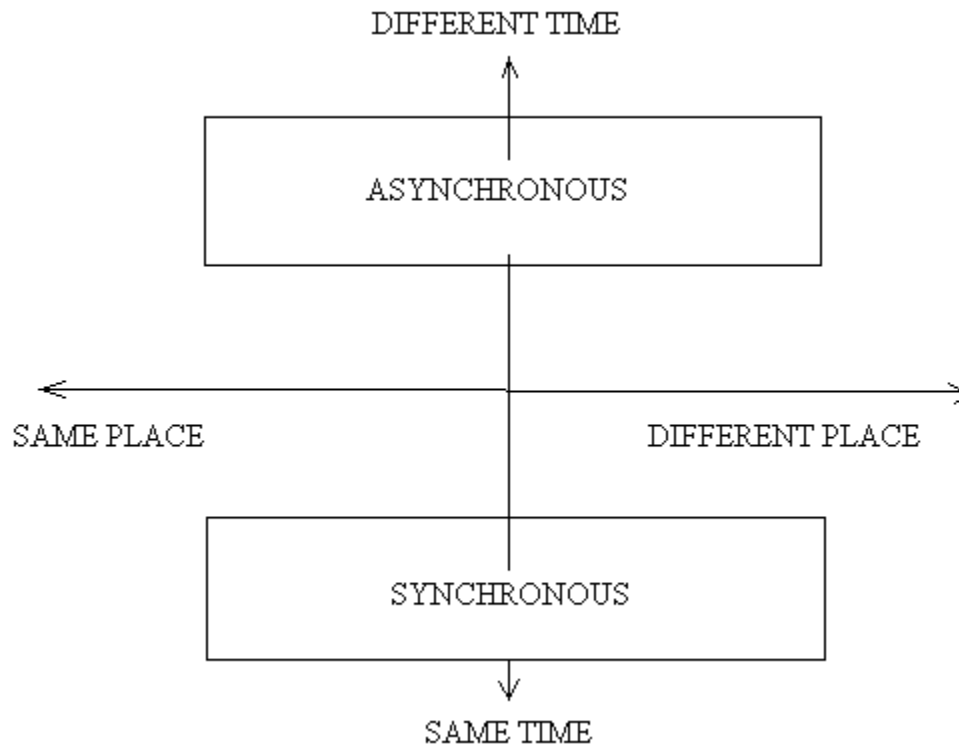
The Internet is nowadays a global computer network that provides an open, free and global backbone infrastructure for communications and for distance education as well. The vast resources on the Internet can be accessed via World Wide Web, a front-end system for organising and structuring the information over the resources in the Internet. The introduction of an easy to use graphical interface (browser) that permits to access various text, audio and video data in a unified way— embedding all into a single system — has brought an information revolution whose impact on distance learning is significant. Distance educators can use the Internet and WWW via various communication models, learning management systems, tools and technologies, which are described in the following subsection.

2.2.2 Communication and pedagogical models

The most characteristic features of distance learning are the location separation of the teacher and the students, the preparation of learning materials (courseware) organised by the instructor, the appropriate delivery of the courseware, some form of interaction as well as pedagogy of the learning process. There are basically just two pedagogical models. The first is based on **behaviourism**. It is an approach that is virtually identical with the traditional teaching and its **instructional design** by means of which students benefit from a well-designed syllabus, courseware and presentation. The instruction design is thus very close to the traditional teaching forms with one exception, namely: teaching at a distance has a minimal face-to-face contact. As a result, distance learning is rather challenging for both teachers and students who must have access to the same

ENACTS - Distance Learning and Support

technology. Only then can such a teaching be effective and interactive among students and teachers. The communications schemes used thus indicate a trend from a passive, one way-media to two or multi-way media using synchronous tools.



While the instructional design model seems to be linear with respect to the delivery of the content, the second pedagogical model is based on the **constructivist** approach to learning. This approach is significantly more individually oriented. The student can benefit from the dynamic or “chaotic” access to the content imparted – a content often having strong asynchronous features. The interaction of students who use various delivery systems, such as one-to-one calls, e-mail, occasional video and computer conferences, is very important giving rise to the **collaborative approach**. There are several classifications related to the underlying pedagogy. Different learning styles and approaches to learning with respect to students’ specific requirements can be further considered. The learning styles can be classified into styles formed by activists, theorists, pragmatists and reflectors. With respect to the approaches to learning we can distinguish between deep learning, surface learning or strategic learning (see, e.g., Karen Bradford: Deep and Surface Approaches to Learning and the Strategic Approach to Study in Higher Education; Based on Phenomenographic Research. (<http://www.arasite.org/guestkb.htm>), The Centre for Teaching and Learning, University College, Dublin (<http://www.ucd.ie/teaching/good/deep.htm>) and the references therein)

For details we refer to Stanchev et al or Logan and Thomas, 2002. Another important factor deals with a proper evaluation strategy, which determines the effectiveness of the distance learning process. Various assessment tools, such as tests (multiple choice, multiple answers, false-true, drag-drop) and monitoring tools (“history”, finger and footprints, download records) can be applied.

As we have seen above, one of the most important factors affecting the distance learning models is synchrony. According to (<http://tecfa.unige.ch/edu-comp/edu->

ENACTS - Distance Learning and Support

[ws94/contrib/peraya.fm.html](#)), synchrony means the time differential of each participant in the learning session. If the learning session is attended simultaneously, it is **synchronous communication**. When the teacher and student show up at different times to complete their duties, it is **asynchronous communication**. These two models are strongly related to traditional education schemes. The asynchronous model is originated from self-study and correspondence schools, while the synchronous model has its roots in classical location based learning, such as class courses, group-study or lectures.

From a pedagogical point of view, the synchronous model is closer to the methods of instructional design in which teacher and students attend the lecture simultaneously. The learning material is usually prepared in advance and the whole instruction is given via some network application. The learning process can be defined as passive (**one-to-many communication**) offering no interaction which, however, occurs less and less frequently. What is more common during the session is that the student asks questions and the teacher answers them in real time. The real time interaction between teacher and students and between individual students is perhaps the most important advantage of synchronous model. The collaboration between all participants requires then **many-to-many communication**.

Synchronous distance learning sessions are technologically challenging, as they require a lot of multimedia information about the network bandwidth and computer hardware. To the class of synchronous sessions, one should add tools such as chat, interactive audio and video conferences (where again one can distinguish between **point-to-point** or **point-to-multipoint** videoconferencing). There are several synchronous systems on the Internet based on videoconferencing. For example, one can refer to Interwise's enterprise communications platform for Web conferencing (<http://www.interwise.com>). See also the Guide to Web Conferencing, Online Conferencing (<http://www.thinkofit.com/webconf/>).

The asynchronous model requires no simultaneous presence of the teacher and students in the session. The teacher can prepare the course material in advance putting it on the network. Students can then study the material after a certain time delay. This model is advantageous for both the teacher and students and it enables higher flexibility of the learning process. In addition, the implementation of such a model is easier than the implementation of synchronous models. Such a learning scheme is, however, much more individualistic giving no more occasions for real-time interaction between the teacher and students; nor is it ideal for the collaboration between students. For time delayed interactions, one can also consider either **one-to-many communications** or **many-to-many communications** schemes.

In the class of asynchronous distance learning tools, one can mention here the computer conferencing (see e.g. the comprehensive overview <http://publish.uwo.ca/maandrus/Table.htm>). Distance educators and their students with access to the Internet can use electronic mail (e-mail), bulletin boards (USENET, LISTSERV, <http://www.bulletinboards.com>). For an example of asynchronous systems, please see products and services of the Blackboard.com (<http://www.blackboard.com>). Many academic institutions use so called virtual learning environments (VLEs) for distance learning. The main commercial products come from Blackboard.com (<http://www.blackboard.com>) and WebCT (<http://www.webct.com>). There are also many freeware VLEs, some of them have simultaneously asynchronous and synchronous features. We refer e.g. to Fle3 (<http://fle3.uiah.fi>) developed by Learning Environments for Progressive Inquiry Research Groups, UIAH Media Lab, University of Art and

ENACTS - Distance Learning and Support

Design Helsinki, ILIAS Opensource (<http://www.ilias.uni-koeln.de/ios/index.html>) developed at the University of Cologne and the COSE VLE developed at the Staffordshire University Enterprises Ltd. (<http://www.staffs.ac.uk/COSE>).

2.2.3 Tools and technologies

Technology plays an important role in education. There is now a wide range of technological options available to organisations and individuals who provide some kind of teaching or instructional activity. According to (www.online-colleges-courses-degrees-classes.org/q-and-a-online-accredited-college.html) there are four main categories of technological media:

Text (both in its printed and online version) is the basic technology; it is actually present in virtually any pedagogical system starting from classical location-based delivery (schools and universities) through classical correspondence schools to the computer-assisted learning and Web based training. Clearly, the text's printed version has been dominant in traditional forms of education while its online has become more frequent with the advent of computer-aided or –assisted learning. It has become even more ubiquitous with the introduction of the Web technology. Thanks to the evolution of this originally passive (i.e., one-way) tool, it has recently become a two-way means allowing two-way communications in all its models (one-to-many, many-to-many). In its printed versions, various formats are available including books, user guides and handbooks, scientific papers and journals, study cases, or course syllabus. Text component, especially in instructional delivery teaching schemes, can also be available in electronically stored-online formats, such as the postscript or pdf files.

Audio is used to present class lectures orally or to present other sound content. Again, one can distinguish between passive audio tools, such as audio cassettes and radio broadcasts and interactive technologies as the telephone, audio-conferencing and short-wave radio. These tools offer the possibility of real time voice-to-voice interaction. Their common feature is that they can be combined with video tools frequently embedded into newer technologies forming multimedia technologies.

Video is used to present visual content or to present the lectures on pre-recorded video tapes. These tools thus again vary from passive instructional video tools, such as still images or slides, to real-time video conferences combined frequently with audio-conferencing (one-way or two-way video with two-way audio). The Video on Demand is a service which enables television viewers to select a video program or have it sent to them over a channel via network such as a cable or satellite TV. (<http://www.itvdictionary.com/vod.html>).

Data is a common term for various formats of electronically stored, sent and received information. This includes Powerpoint-like presentations, simulations or animated demonstrations (application training) as well as various computer applications used in education. For instance, electronic e-mails, fax, interactive computer conferencing and various WWW applications.

From the point of view of media typology, one can distinguish between analogue and digital technologies whose borderline is nowadays well understood. Both can be synchronous and asynchronous. With synchronous tools, all the participants are

ENACTS - Distance Learning and Support

connected and communicate at the same time. This resembles a traditional concept of classical education in the sense that the technology emulates to a certain degree the traditional concept of a class. Asynchronous tools allow asynchronous communications with delayed-time messaging.

As we have already mentioned, recent technologies often merge. One can discern a common trend from single-mode media (such as text, audio, video or single data format) to multimedia. Another apparent trend moves from passive (one-way) media used mainly for an instructional design to interactive (two-way or multiple-way) media. Very frequently, the old concepts are put into new technologies. For instance, many technologies have been integrated into the Internet platform.

There are many experimental settings and commercial products available. Here are some typical examples that illustrate the most frequent tools and perhaps the mainstream in the distance learning and education.

For the more or less text-based or print-based education programmes one can refer to programmes provided by the Institute of Educational Technology at The Open University (<http://iet.open.ac.uk/courseonline/>). The Institute of Educational Technology is a centre of international excellence for the teaching, research and development of educational technologies.

The Instructional television (ITV) is a relatively old concept that can be either passive or interactive. The passive ITV involves pre-produced programs distributed by video-based technologies such as TV broadcast, cable or satellite. The interactive ITV provides opportunities to view and interact with the teacher. As an example of embedding the ITV into new technologies, one can mention Stanford Online and the Stanford Center for Professional Development (www.scpd.stanford.edu) which integrated the ITV philosophy into Internet platform. The courses held at Stanford University are posted to the Web site in the Online Classroom (www.scpd.stanford.edu/scpd/students/onlineClass.htm) and they are fully indexed and synchronised with all slides in the lecture. Students can also interact asynchronously from their desktop through chat. Stanford University was one of the first high-learning institutions that incorporated the video with audio, text and graphics in its distance learning offerings.

Another example of integrating audio and video is Access Grid (www.accessgrid.org) which is an ensemble of resources including multimedia large-format displays, presentation and interactive environments, and interfaces to Grid middleware and to visualization environments. It is being used by several hundreds of institutions – each of them has at least one node that contains the high-end audio and visual technology. The European Access Grid (<http://euroag.accessgrid.org>) is a loose grouping of Access Grid sites in Europe such as the EPCC's Access Grid Node in Edinburgh University (<http://www.epcc.ed.ac.uk/computing/grid/accessgrid/>). The nodes are specifically targeted to provide “group” access to the Grid for remote visualisation, interactive applications or virtual meetings and events.

We have mentioned several distance learning technologies that have been evolving over the time. The question remains, however, whether the learning content can survive the rapid technological changes. This has made the learning content less transparent and many excellent learning materials are underused or even completely forgotten. Other aspect is related to the lack of interoperability. The users want not only to find the content

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easily, but they also want to incorporate it into their courses and move their learning records between the institutions. To achieve this, there is a trend towards standardization of learning technologies. The standards are important for e.g. “future-proofing”, reusability and sharing of course content, and for compatibility across different virtual learning environments. Several projects have been launched in this field. For instance, the Center for Educational Technology Interoperability Standards (CETIS) represents UK-based higher and further educational standards initiative (<http://www.cetis.ac.uk/>). For a good overview of learning technology standards including the standards-compliant products directory we refer to the website (<http://www.cetis.ac.uk/static/standards.html>).

2.2.4 Distance learning support

There are important tools that can enhance the whole distance learning process in order to make it more efficient and more robust. Let us mention, e.g., additional fax and text distribution, check-out of video and audio information tools, access to these tools, test proctoring and, last but not least, general learning assistance. They serve to users and may be possibly completed by other additional tools.

2.3 Three main target groups

Let us now classify the main target groups of the study and of the questionnaire, respectively. In an horizontal classification, we see the three main groups of interests: 1) **scientists (Scientific Grid community;** counted individually or considered as smaller compact subgroups), 2) **large-scale computing (or HPC) centers** and (3) the **application (Industrial Grid) community.**

Please note that our intention is only to point out some of the most important features.

2.3.1 Scientists and their environment

The scientists and researchers indubitably form an important part of the whole community in question. They are far from being uniform. There are doctoral students, postdoctoral fellows, young scientists, but also experienced researchers and leading experts. Such a community of scientists is an ideal source of new ideas, innovations and original approaches. Note that this community has significantly contributed to grid computing. For instance, in 1990, the system world wide web was started in CERN in Geneve.

2.3.2 Large-scale computing (HPC) centres

This target group is even more heterogeneous than the previous one. The HPC centers constitute a nontrivial collaboration of various people, such as technicians, hardware developers, software developers, system engineers, computer operators, etc. In addition, these centers include also individuals or groups from various scientific communities creating an important **interdisciplinary** character of HPC centers. They might be also called service providers. While some scientists might have only a very limited knowledge

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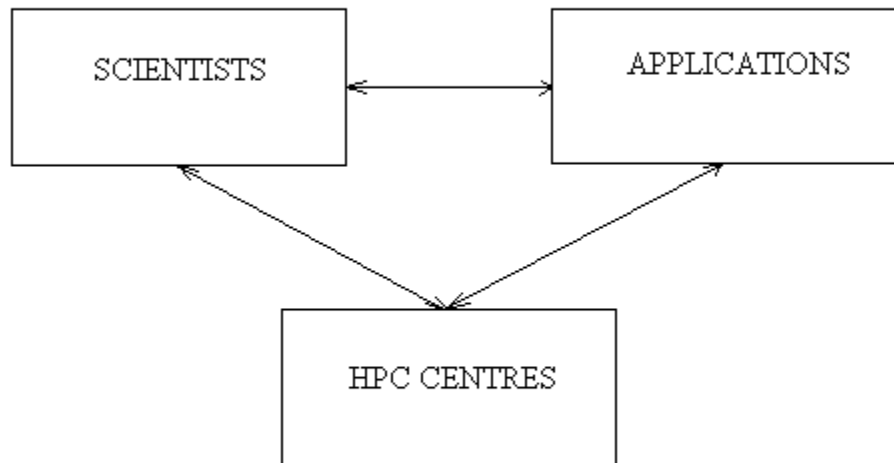
of other scientific disciplines, their horizons might be broadened through their work at HPC centers.

Thus it seems that the centers do play an important role as a target group of this study.

2.3.3 Application community

What we understand by this term is not only a traditional mixed research-application environment, but also an interface of the two previous groups: those who are involved in business or those whose influence is transferred via business interface by means of software and hardware vendors. This group may be experienced with software applications and hardware productions than other groups. It has, however, a limited impact on the community as a whole due to its one-sided experience. Yet, the entire community has the **broadest spectrum of knowledge possible**.

Putting it all together, we see these three user groups as a well-balanced mixture of user types for which HPC centers form a bridge connecting the two more extreme parts of the user spectrum: scientists and computer scientists. Their relationship is depicted in the picture below. The arrows correspond to the important feedback relations and directions of influence.



ENACTS - Distance Learning and Support

PART III: The Study

Introduction

One of the most important pre-conditions of emerging technologies is that they must reflect users' requirements and needs, as the new technologies must serve end-users improving their flexibility, mobility and overall efficiency. Only such a development process can really bring a remarkable progress and long-lasting success.

This pre-condition is also important for Grid Computing and Distance Learning. Unlike other techniques that users had to deal with in the past, the Grid technology offers a real globalisation of our shared computational and organisational tools. Our study considers the role of Distance Learning on High-Performance Computing in general with a special attention to Grid Computing.

Initially, we aimed to focus on the Grid Computing Technology from a point of view of special features and their mutual relations with the Internet covering such details as various API interfaces and hardware technical specifications. After obtaining the preliminary results of the study, however, it became clear that the technology in question has other limitations. These limitations are perceived as very important when applied in the field of Grid Computing. As a result, it would not be worthwhile explaining the whole subject matter in its depth. Hence, we have rather opted for summarising the results of our research.

Explanatory and Philosophical Evaluation

The questionnaire addresses a sample of users representing various European countries. Unfortunately, only twelve of them replied and answered our questions in full. As a result, after analyzing their answers, we formulated our results in an explanatory and philosophical manner while omitting less important statistics.

Let us not mince words: we did not get many questionnaires back because of the interdisciplinary nature of our questions. The Grid community is rather limited and only a few have any direct experience with Distance Learning. If the users in general, and the ENACTS members in particular, didn't feel the need to answer the questionnaire, there is not much interest in the story of distance learning at first place. Moreover, while those institutions or users who have some experience with Distance Learning have no experience with Grid Computing, there is hardly any remarkable intersection between these two communities. Therefore, in order to produce a somewhat more complete picture on certain particular issues, the authors of the questionnaire have asked other people separately: by emails, by telephone and in person. What they have got is enough for making objective conclusions complementing them with authors' personal views.

What are the goals of the descriptions? It is advisable to ask and answer this question before any evaluation effort starts. The goals are to determine how relevant the subject matter of distance learning is for grid computing. This was one of the questions of our questionnaire.

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3.1 User and Organisation Profile

First, we have to discuss the user groups that were the target of the study. As it turned out, they generally do not have much experience with distance learning, let alone with Distance Learning in the framework of High Performance Computing. This does not mean that the target groups have no experience with education or learning activities. In fact, some of them participate in teaching or are affiliated with a university.

Second, our methodology is tightly attached to the results obtained in previous studies. First answers we got from the questionnaire deal with the institutional and geographical distribution of various user groups. As we have mentioned above, a general experience with distance learning is relatively low due to many factors discussed later. Let us point out at this point that we had to complete this questionnaire by further discussions and interviews with those experts who are familiar with distance learning and grid computing. Selected on a relatively wide geographical basis, they are, more or less, involved in scientific computing, design the modern high-performance computer architectures and have a general interest in Grid Computing. Therefore, their views are considered as application-biased or field-of-interest dependent.

3.1.1 The Type of Institution

As for the institutional distribution of our users, it is remarkable how evenly they share the distribution between academic users and applications' end-users: we have received answers from around 50 percent of academic users and around 50 percent of the users from industry or applied research. This split enables us to conclude that the interest was relatively well balanced.

Here is a list of institutions whose members replied:

two institutions from France (CEA and CERFACS), four from Germany (Supercomputing Center in Julich, Max Planck Institute, Astronomisches Rechen-Institut and University of Karlsruhe), ICS-Forth from Greece, Birkbeck College from Great Britain, University of Coimbra (Portugal) and three partners from the Czech Republic (AMM Systems, DIAMO state enterprise and University of Liberec). In addition, we have three additional answers from our ENACTS' partners.

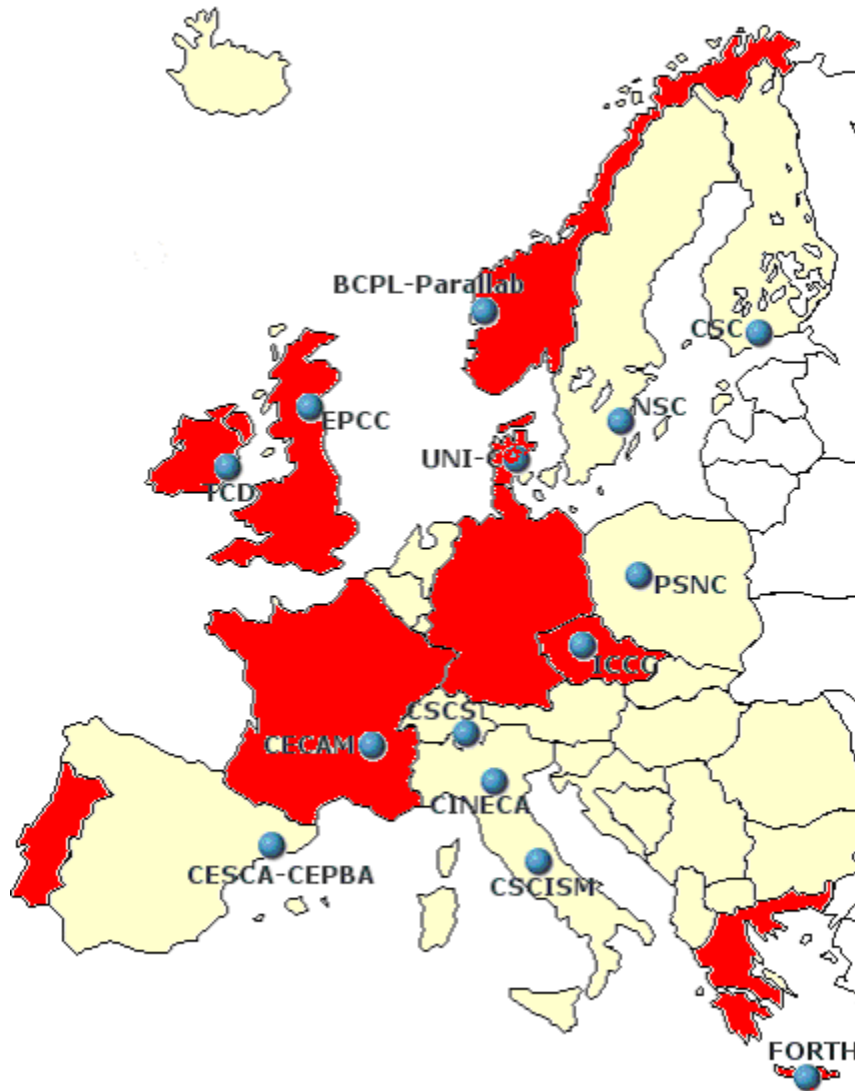
3.1.2 Geographic Distribution

The geographical distribution was fortunately pretty favorable, as it covered a large part of Europe. Let us have a look at the map's locations (below). Those countries from which we obtained information are colored red. Only one of them, the Czech Republic, submitted two complete questionnaires.

We have added also opinions of people who did not formally answer the whole questionnaire but expressed their views on certain issues. Note that a good geographical distribution is a precursor of a good result in general. Our distribution seems rather uniform. Although one can expect that a uniform geographic distribution is a good one, we may face serious objections. Would it not be better to get more answers from those who live and work in countries with many grid users? Perhaps. By contrast, however, our uniform distribution may offer more attractive ideas and proposals for the future.

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The geographic distribution and clear differences in answers from different parts of Europe remind us that its uneven history of different countries really matters. We can possibly explain some differences in answers by historical background. To put it concisely, there is a bigger potential for future development of grids in some European countries.



3.1.3 Research Interests

The research interest and the application field enable to explain why and how the results were obtained. Not surprisingly, most of the answers come from user groups related to computing; more specifically to scientific computing. This applies both to the groups, which do some kind of basic research, and to the groups from the area of applications and applied research. Other groups claim certain subparts of scientific computing, such as CFD (computational fluid dynamics), computational astrophysics, the porous media flow or the transport of contaminants in the air and in liquid. Less than twenty percent of the answers comes from researches who support other activities such as a graphic tool development or others. The research interests then determine the results mentioned

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above. One persistent feature of some groups is that their activity is often connected to the constant support of those tools that are routinely used in the real-world applications. These groups providing such services have much less to experiment with new technologies notwithstanding these technologies offer new promises, new functionalities and new results. For this reason, they suggest to create a portal which would support the dissemination of the new grid technologies within the realm of “classical” computation tools.

3.1.4 User / Research Group Composition

Approximately half of the users groups addressed are composed of researchers from the same institution and are not involved in international collaboration. They mainly develop application tools for scientific computing including technologies applied to some critical parts of human activity, such as computation of static and dynamic stability of urban constructions, development new sophisticated technology tools, etc. Because of this challenging nature, some form of careful rigidity is appropriate here. The widespread use of grid technologies in scientific computing is a sign that this technology is mature enough.

3.1.5 Size and Scope of User Groups

The data deployed by the questionnaire can be roughly divided into two parts. Data from groups with a relatively small number of members. Among them are mainly code development groups whose size vary from 2 to 10. These groups use current technologies that support code development in small teams of several programmers. But there are also groups from large institutions having a non-negligible potential to increase their size substantially. The answer to the question what is a tendency for the groups' size remains unclear. One thing is certain, however. Benefits of the grid technology are expected to increase considerably over the next few years. They will influence not only small teams but also groups of medium and large sizes. Ultimately, the grid technology will lead to more frequent contacts between geographically widespread groups introducing a new level of coordination. This trend will have a strong impact on all imaginable tools of communications (secondary effects). It also will likely increase the team size. If not hindered by some obstacles, its increase seems inevitable while impediments and obstacles will be slowly but steadily disappearing. For example, an enormous progress was made since the introduction of email and standardization of electronic data formats. Many scientists now perform their basic research by means of electronic communications and electronic preprints making the standard role of libraries obsolete.

3.2 Grid Activities and Experience in Organisations

This section deals with the questions and answers related to the mutual relationship of grid activities and institutions. The answers indicate the user's activities, their platform specific experience and problems. Some questions inquire into the neighboring areas of the HPC systems and/or large-scale computing devices.

3.2.1 Grid Activities and Experience with Grid Computing

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As far as the experience with Grid Computing is concerned, the answers can be divided roughly into three parts. The first part includes those who have no experience with Grid Computing. It coincides with the set of users who have only limited access to the HPC systems. These users are usually involved in very specific activities being afraid of various features that might emerge with computing, such as openness, security or galloping development. The second group of users seems to appreciate the advantages of Grid Computing. Since the groups of users are hardly distinguishable by one another, we tried to complete the observations by asking them separate questions. It is clear that even those who think that the Grid Computing is a good way how to cope with ever larger computations are aware of its contemporary fragility. Thus there is a third group of users whose understanding of grid computing is somewhat limited and confusing.

It might be instructive to focus on the various types of experience with grid computing with respect to the neighboring activities that include: computing, grid services, grid portals, application scenarios, grid application toolkits, remote visualisation and steering, data management and grid testbeds, internet computing, basic infrastructure implementation (using Globus toolkit), work with the small-scale grids and development of grid middleware.

3.2.2 Grid Models and Experience of User Group

Those who have some experience with grid computing are keen to learn further; for once grid computing is one of the standard tools at their facility, it shows, sooner or later, its benefits and advantages.

As for the grid models, answers are not very specific. Two answers indicate the AccessGrid as a tool the users like. Globus toolkit was mentioned as well. Some respondents do use internet computing. One user specified the NEOS optimization server. All say that they need a portal for their computing. Some users have access to small-scale grids which are not operated by a grid software but by standard computational tools supported by parallel libraries as PVM or MPI.

3.2.3 Access to Large-Scale Computing Services

First, we should answer the question what the large-scale computing services are. Some users understand by them large-scale computing services that correspond to vector supercomputers claiming that they do not use them. Other users use clusters but they do not consider them as part of the HP computing facilities. In many places, the clusters started as an amateur approach to construct a powerful multiprocessor computer. Although making a cluster-like machine by assembling a few personal computers seems to be an easy task, one important thing cannot be forgotten: a high-performance computing machine must have an appropriate and balanced software. Some users often use powerful computing clusters which can be viewed as important large-scale computing facilities.

Seven users claim that they have access to the large-scale computing services. On the other hand, the remaining four individuals who answered our questions state that they have no access to such services. More information about the HPC systems and their use is summarised in the following subsection.

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3.2.4 How user groups use the HPC systems

Most of the users do use their HPC systems for experimental purpose. Simply, they do use them to run their codes with the intention to verify new methods, strategies and algorithms. Other users run a standard agenda using the HPC system. For example, one user specified that the system is used to run routinely a weather-prediction system, or, better put, its basic computational core MM5. The HPC technique is used to run the code a few times a day and front-end machine then interprets the results. He would be interested in the possibility of "more" large-scale computing using a specific portal server.

After classifying various ways of HPC usage, we provide a list of answers. Some users simply use supercomputing centers in their countries in the centralised form of computing on shared-memory machines or as (Beowulf) clusters for data production and numerical simulations. While some users rely on numerical libraries, others develop their own software with limited pieces of the third party software. There was one answer claiming to integrate HPC resources into grids which seems to be an excellent example of the progressive development.

3.2.5 Main Problems Faced in Grid Computing

All specified options appear among the answers from users in the questionnaire. The most important problem they face is the speedup limitation. The other important problem deals with data confidentiality and reliability of computation, not excluding the configuration and management problems. One user specified that he has no problem with Grid computing.

Frankly, the importance of the speedup limitation reveals a lot about the state of user knowledge and the relative importance of certain problems in grid computing. The speedup limitation is not only a problem for grid computing. It is an inherent crux in parallel computing as well. Consequently, there seems to be considerable room for developing a new generation of adaptive implementations which would behave more user-friendly. From the point of view of learning and its distance variation, in particular, a lot of training will be necessary.

Let us consider an example typical for fully heterogenous grids, or for cases when one cannot specify the architectures for processing user jobs in advance. In this case, an important drawback of numeric computation is that one never knows what one gets. Namely, if floating-point operations are shared among different computers, one cannot predict what the result will be. Simply there is no rounding error model which would cover the results. Thus computing ill-conditioned problems with unknown arithmetic in strategic applications such as weather predictions is a hazard. Some features stem from various hardware platforms. This is an easier part of the story since current hardware supports IEEE floating-point convention. The bigger issue is software.

3.3 Educational and Training Activities

3.3.1 The Role in the Process of Educational and Training Activities

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Approximately twenty percent of the people addressed are active lecturers at schools of higher learning. Some are both lecturers and students. Yet, there exists a certain educational consistency within each group – a necessary condition for a sustainable life of groups in various scientific fields, as one person in each group takes care of administrative duties and supports training activities. As far as distance learning is concerned, the teams tend to increase their size. The new technologies will remove the obstacles against the increase of the size. Also, the distance learning tools may replace the role of a teacher who performs his lecturing duties. The majority of our groups are, however, too small to get over a natural boundary of self-education with the exchange of the roles of lecturers and students.

3.3.2 Kind of Educational/Training Process

We distinguished between local (in-house) courses, the courses or education on the national level and the courses on the international level. Most of the lecturers are involved in the in-house courses. Their lack of awareness regarding the latter is, however, striking, even though some of them are involved in international workshops, application meetings, grant educational meetings and training activities. Some of these courses may fall into the class of EU-funded courses. Nowadays, however, most of them do not strictly follow this pattern and they are organized or have participants from overseas.

3.3.3 Average Number of Days per Staff Member and Year Spent in Educational/Training Process

The average time spent in training was one of the parameters that varied a lot in terms of users' answers. Some of them specified very small number of training days. Others were bold enough to claim frankly that they are educated nearly constantly. This variance was no surprise. In fact, we know that some users try to spare time as much as possible in order to focus on their work. Habitually, these users have a clear goal to reach avoiding activities that would lead them astray. Others are exactly the opposite. They attempt to get as much information as possible before setting their goals.

3.3.4 Percentage of Staff Members Taking Part in Educational/Training Process

While the previous quantity was very much individualistic having a strongly personalized character, this quantity is completely opposite. Clearly, the results here depend on the type of the user group, its background and tradition. There was only one team claiming that the percentage of staff members involved in the training process is less than ten percent. Nearly all users need to be involved in such a process today. For example, even the secretaries have to be educated in many disciplines starting from work on computers with more and more sophisticated software to courses regarding social behavior. The majority of the groups have a percentage of staff members involved in the educational or training processes between 30 and 50 percent. These processes have a tendency to be larger in the technologically less developed countries. We know it from personal experience in the Czech republic. In some technology fields, there was a significant gap accumulated over the last fifty years in the technology, especially with its advanced features. The user groups from some eastern countries are particularly aware of this handicap. They know that it is important to get as much knowledge as possible. Yet, the question remains open as to whether this trend is constant or disappearing. Or whether it codifies a new paradigm for the post-communist countries. Answering these issues is

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difficult task to do. What we got in the personal interviews was mostly the confirmation that there is a non-negligible information-hunger among researchers who were deprived of benefits produced by new technologies. The grid technology is one of them.

3.3.5 Preferred Type of Information Source Used in Training Process

First, nearly half of the respondents have shown a non-negligible preference for the training process based on text. There is a strong overlap between this group and those who are interested in a classical research, particularly, in our case, in scientific computing and related fields whose specialization relates to the text-based training. Other type of information sources was relatively uniformly distributed among the user groups bearing in mind the non-negligible role of software development.

Audio input was mentioned only in two answers. It seems that audio is considered as a specific variation of the text-input. We understand that plenty of text information is distributed by this means, as visualisation plays only a minor role in training. More important, most teams use more than one source of information – with the exception of those users who prefer the text. In addition, we have found that the internet is an interesting alternative. It is symptomatic that some users consider the internet as a brand new tool, whereas others consider it as an information output combined with other sources. We assume that a lot of users interpret the internet in a different way. Particularly, they consider it as a one of the sources listed in the questionnaire based on the information type they retrieve. There is no unique classification available. Therefore, we did not try to interpret the results in a more rigorous manner.

3.3.6 How to Keep up to Date in the Field of Expertise

The set of answers to this question reveals how different the groups of users really are. The answers were related to the text-input information and specified in various different ways. While some read scientific papers, others the manuals, texts on the internet, scientific monographs or textbooks. The second answers mentioned the use of more sophisticated data inputs, such as video conferences or simply educational videos. Videoconferences are, in fact, becoming indispensable in solving the large grant projects whose developers live in different parts of Europe. Educational videos are important rather for more popular subjects, which are usually less targeted than a current research in the computer science. The use of video, picture and audio input might be typical for the user groups whose software development plays an important role. In addition, we found a group devoted to high-end visualization of a software fluid flow software where the study of visualised data is one of the most important part of their everyday activities. Others use it only for routine tasks, such as the transfer of texts and other specific information. Instead, they use it globally for search, browse, reading, discussing and, last but not least, entertainment.

3.3.7 Preferred Type of Training and Communication

The answers to this question are strongly correlated with the user background similarly to some of the previous questions. Personal meetings and visits are important more to those whose everyday work depends on reading the texts, preprints and other scientific inputs. In addition, individuals strongly need to communicate with others. Their meetings are important also for other user groups. In fact, there is something like a strong human

ENACTS - Distance Learning and Support

factor in some of these activities. Even when working on a grant where most of the communications is based on video conferences, people need to meet occasionally to discuss various issues and problems they encounter. These meetings help motivating the working teams. The use of e-mails is a natural continuation of the mail communication. While the majority of users claim that the e-mail communication is very important, it is not the main type of their training. It simply completes any training. The courses are very important for both training and communication. They enable the so-called “short distance” communication, as one of the users noted. “Long distance” communication is therefore a target of seminars and workshops.

In general, courses are very important for training on somewhat more general things like introducing new communications protocols or standards. By contrast, the seminars and workshops are more important for introducing special concepts in various research fields. The same conclusion can be said about the role of conferences in scientific communities. We noticed that some users were really reluctant to clearly distinguish between seminars and workshops on one side and conferences on the other side. They considered both as nearly equivalent. The reading of printed scientific documents remains important for a large part of our community, even though some of its members read these documents in electronic form. One of its convenient benefits is that scientists need not print them or, at least, the entire documents. Web surfing, both database based or database-free, is a way preferred by one quarter of our users. The pure database information pages are important as a source of information as well while other ways, such as e-discussions or xchat, will likely play a minor role in the future.

3.3.8 Average Frequency of Using Web in Training/Educational Activities

As in some of the previous answers, the frequency of the web use is very difficult to specify exactly. Note that some training activities need to be performed regularly, almost on a daily basis. Other activities, be they of pedagogical nature or otherwise, are performed from time to time. While seminars, for instance, can be organised on a weekly basis, the conferences and international workshops happen only a few times per annum.

3.4 Distance Learning Activities and Experience

The whole distance learning activities are the ones in which the user’s experience is very limited. Therefore, we tried to extract “underline” information and complete it into a set of opinions fully representing harmony of voices within the investigated community. Many users have a specific experience with some distance learning activities. If they deal with scientific computing only, traditional tools, such as books, journals, conferences and workshops typically pass their knowledge from one generation of researches to another. A particular attention is given to email communication. In fact, the email has become an extraordinary way to share ideas. It has also provided the opportunity oft collaborating worldwide. Nearly everybody has taken part in an email conference. Yet, nobody thinks that this is a real predecessor of distance learning. Distance learning is considered as something more progressive that changes completely the everyday research experience accumulated over the years. The users were thus reluctant to admit that the distance learning is here and it is closer than they think.

ENACTS - Distance Learning and Support

3.4.1 Experience with distance education

There was only one real lecturer experience among our user groups. One user performs the individual training of students and collaborators mainly on informal basis. In spite of very poor experience, we positively know that some distance learning tools and materials are used in classical courses. For instance, lectures on linear algebra in pdf form or in ppt format might be easily converted into a student distant learning course material. Therefore, the most respondents are familiar with distance learning. It is hard to say whether it is more difficult to start being involved as a student or as a lecturer. In any event, the student must quickly adapt to the new way of education and must work hard from the very beginning. Later, when the courses are in the full swing, the learning process may be even a fun depending on the personality of the teacher (or course creator).

3.4.2 Preferred communication scheme

The most frequent communication scheme is asynchronous. It is based on emails, email conferences, direct ssh, telnet and ftp. The most personalised way, on the other hand, is one-to-one communication. Considering the email, one targets typically only a small number of recipients. While the one-to-one communication is not dominant within the framework of distance learning, the email itself is a frequent communication tool in distance-learning courses. The email communication can occur between various groups of recipients. With the larger groups we usually have the less informal and more formal sort of communication. The second principal form of asynchronous communication is a web tool. A perfectly done web learning page can be enormously useful. At the same time, it might be an advertisement for distance learning.

Apparently, modern synchronous communication has not attracted much attention yet. Classical meetings and conferences share the same kind of importance. Some aspects of conferencing are inherently human and seem to remain that way. Therefore, one cannot exaggerate the role of videoconferencing although it has become standard in certain fields.

3.4.3 Other details related to the communication

Let us mention some other details related to the communication model. In the previous paragraph we have discussed communication tools such as email and web. These tools offer some interactivity (there exist highly interactive applications like chat; similar interactive applications like talk daemon are embedded for a long time in operating systems). Nevertheless, their general use is typically not interactive. A partially interactive tool is represented by educational and simulation codes. The educational codes are tools that provide interactivity on a small scale. Although the codes can communicate, their possibilities are always limited, as they communicate within the embedded patterns. A higher form of an educational code is a code that can simulate behavior of a natural, human or artificial system. Such simulation codes are very often used in education since they might not only train users to deal with standard situations, but they also come with new and unexpected problems whose solutions may be surprising. The simulation codes are, therefore, useful even in advanced courses. The interactivity of simulation codes can be still considered in the framework of asynchronous communication model, while there are other tools based on synchronous communication model. Based on our research, the synchronous tools with pure audio information are used rarely. The main trend is represented by distance learning tools

ENACTS - Distance Learning and Support

supporting multimedia, either in more personalised but very common one-to-one format, or in one-to-many or many-to-many communication formats which are more difficult to manage.

3.4.4. Prevailing type of information from the Web

The prevailing form of communication exchange of data from the web has been based on papers, reports, preprints etc. For example, there is a strong inflow of journals today. They are more convenient (cheap) to get in electronic format. Moreover, even the well-established journals are converted into electronic form. While in some fields it might be considered only as an interesting point, this trend is a crucial accelerator of development in some traditional research fields such as mathematics. Having deep historical roots, math is difficult to “modernise” by distance learning tools. The second important form of web tools are the databases. We have quickly become to use the web as a powerful search/storage system in which we can look for answers, explanations, and, of course, new problems. Video and picture formats are a shopping window of the web but they are not used so often as one would expect. They often come in an attractive coat but their content might not be deep enough.

3.4.5 Benefits of distance learning

Based on the previous and other chapters, it seems to us that distance learning might have strong benefits in at least four directions. First, it pushes user groups closer together. Second, distance learning in the many-to-many model offers much more interdisciplinary benefits. Even if the user groups are relatively homogenous, their mixture as students and/or lecturers brings together incentives from close but different fields. Third, distance learning seems to accelerate development in various disciplines by bringing in more competition. Fourth, distance learning radically decreases operational and maintenance cost of the learning process.

Note that this is our evaluation based on the results of the questionnaire. As we will see later, there will be an important additional requirement. The mainstream in distance learning tools (Soren Nipper, UNI-C, personal communication) has to be changed in order to fully serve to the grid computing community. Simply, the basic features of Grid computing do not correspond neither to these four issues nor to our evaluation of user needs.

3.4.6 Distance learning relevance to Grid computing

Distance learning is a well-established technology with precisely defined terms. In the framework of Grid computing one cannot apply distance learning tools in a straightforward way. Instead, a modified version must be used. Thus we summarise broadly feedback on the distance learning subject from users in the questionnaire. The overall classification of tools with respect to standard definitions and conclusions are discussed below.

Distance learning is relevant to Grid computing. This is clear more or less from the fact that all four aspects from the previous paragraph fully apply within this framework. We

ENACTS - Distance Learning and Support

need to decrease overall costs, increase an overall competitive advantage among and within the groups, promote interdisciplinary efforts and support the general perception of relevance in scientific research. We believe that the era of the distance learning tools and methodology is just at its beginning.

An example of (contemporary) distance learning techniques in math illustrates the situation in the second half of the 1990s in the U.S. The demand for university teachers was so high that the interactive courses had to be developed in a relatively short period of time. Electronic courses have become very frequent since then, see, e.g., the tools used at the MIT and the University of California at Berkeley.

3.5 Future Needs and Recommendations

3.5.1 Is a Grid-Training Portal a Useful Tool for the Grid Community?

Most of the answers to this question were positive. There is an affirmative attitude towards the idea of a customisable, personalized web interface for accessing services that would use contemporary distance learning tools, communication models and technologies. The portal would provide a common gateway to resources useful to all sides that participate in the Grid community. This uniform view no longer depends on the geographic location or composition and size of the user group nor on the type of institution (such as university, research organization or HPC center). Although having relatively small feedback from the business Grid community (vendors, technical staff), it shares the same affirmative attitude toward the portal.

We need to add one important comment. When asked about the grid-training portal, different users understand by it different technologies and portal organisation schemes. Their different perception varies from simple databases up to very complicated portals with hardware and software, access paradigms and control units and mechanisms. Some of these issues were examined in more details, while the question related to particular technologies and tools are outside the scope of this study.

3.5.2 The Main User Groups in the Grid-Training Portal

Related to this question we got a very good agreement with our expectations. We have assumed that the main user groups in the Grid-training portal will coincide with our three main target groups (universities and research institutions, HPC centers and industrial grid community). From the results of the questionnaire it follows that the biggest user group is represented by universities, or more generally, by educational facilities that provide some training or course-based education. The equally large number of the answers are the HPC centres and service providers. These two large groups are followed by research institutes, which actually belong together with universities to our first target group. In this sense one could consider this target group as the biggest, although there may be a nonzero intersection also with the group of HPC centers or service providers. Some individuals have indicated relatively large interest in the portal, among whom are researchers, developers, members of technical staff and operational support. Companies, vendors and end-users manifested somewhat less interest. This is probably given by a small number of

ENACTS - Distance Learning and Support

answers from the industrial grid community and also by practically zero interest in vendor or copyrighted products (see the subsection related to the distribution policies within the Grid-training portal).

3.5.3 Resources in the Grid-Training Portal

This question was related to the content categories and sources. Here we do not distinguish between materials developed originally for the portal and the adapted materials. Due to the trend of low investments for production of a specific content and operational costs, we expect that the approach of “bookmark libraries” and adapted materials will dominate on the portal. The majority of respondents ask for specific and free software tools (see also the subsection related to the distribution policy) and for libraries that contain articles and papers. Given the scope of our target groups, which require a regular access to various software tools and repositories of scientific articles, research or technical reports, this requirement is understandable. There is also a high demand in having access to collections of lectures distributed over the portal. Here we distinguish between having access to some collection of lectures given in the past and stored in a distributed way and active participation in running the course in the portal by some participating organization or individual. Somewhat less interest has been declared in the need of having access to different databases, as various user groups have usually their own databases or they have a direct access to databases they are really interested in. Surprisingly, however, there is significantly less interest in optimisation techniques and benchmarking than in previous decades.

As mentioned in some answers, the portal should include both the available software and documentation related to both its use and learning. In fact, access to materials leading to mastering the software would be very important. What level of interactivity the portal should offer is not clear at this moment. We believe that it should start with a broad spectrum of web services. Additional services should be provided on demand. Of course, this conclusion assumes a strong interaction between the users and portal management. The relation between individual parts of the portal will be mentioned below in the section discussing our recommendations.

3.5.4 Communication Methods in the Grid-Training Portal

It follows from the answers that in global numbers a significantly higher interest is in asynchronous communication model (bulletin boards, mail, computer conferencing) rather than in synchronous model (chat, audio and video conferences, audiographics). The users dominantly ask for access to various websites and portals. In this sense a Grid-training portal should enable the access to various grid portals, since the portal computing (workbenches) and advanced portals represent one of the most frequently used grid models. A considerable interest has been expressed in using bulletin boards and computer conferences. The most important representative of synchronous models is the videoconferencing (using such tools as, e.g., Accessgrid). Here the number of answers assenting has almost reached the number of positive answers to the most popular asynchronous tools. Less interest has been declared in chat (three positive answers) and in audio communication (actually only positive answer). The trend from synchronous communication model to asynchronous communication model is clearly visible and we believe that this is not a big surprise. On the other hand, this does not mean that

ENACTS - Distance Learning and Support

synchronous communication will disappear. Actually our results indicate that videoconferencing in particular becomes more and more popular tool for communication.

3.5.5 Distribution Policy in the Grid-Training Portal

The user groups dominantly ask for Open Source Freeware. They are somewhat less interested in Binary Freeware and Shareware products. There is practically no interest in distribution of vendor and copyrighted products. This lack of interest can be explained in terms of particular copyrighted products that can be obtained directly from the authors and providers. One answer has also stated that the distribution policy is not important. Such an answer probably implies our basic conclusion that the distributed content within the portal will be mostly free indicating that some user groups are willing to invest some money and pay for the content distributed by the portal.

3.5.6 Operational and Maintenance Strategies

The answers concerning the operational and maintenance strategies have relatively high variability, although the leading opinion is that the portal should be EU-centralised. The second biggest says that it should be fully decentralised and/or distributed among the HPC centers. Two answers, coming probably from our euro-sceptical colleagues, asked for national-wide distributed operation and maintenance. We believe that this difference of opinion can be explained by two possible interpretations. The first assumption is related to the institutional or organisational point of view. It is clear that some kind of centralisation must take place. The EU-centralised European Grid-training and support resource seem to be a reasonable option if such a portal is funded by one organisation. Yet, one of the biggest constraints in providing such a portal is financial. The second possible interpretation is related to the operation of portal, namely to the delivery and distribution of its content. This must be clearly done in a decentralised way, either fully decentralised around all participating sides or distributed among leading HPC centers, which may serve also as content providers. As far as the maintenance of the portal is concerned, it must be done by one or a few organisations. It can be either an EU-funded host organisation or some pre-assigned HPC center.

3.5.7 Technologies and Accessing Facilities

We obtained practically no definite answer to the question which technology and accessing facility should be used within the grid-training portal. The answers are restricted into rather general statements that there is a need for interaction with the systems in training use. The users ask for interaction with experts, or just make a statement on insufficient experience. It shows a weak general knowledge of distance learning technologies even in such a specialised community.

3.5.8 Constraints in a Development of the Grid-Training Portal

The most important issue has something to do with the financial cost for development, operation and maintenance of the grid-training portal. This is tightly connected to the strategies discussed in the corresponding subsection above. The organizational and reliability issues are also important. The host organisation should be reasonably funded and should be at least organisationally responsible for the content development and

ENACTS - Distance Learning and Support

distribution. The operator should take care of the maintenance while guaranteeing a satisfactory level of services and reliability of portal operations. The portal operations and its maintenance alone were considered as a constraint in one answer. It indicates that the user groups worry less about the maintenance when there is a reliable organization or user group responsible for these activities. The copyright and security issues are not perceived as problems because there is practically no interest in a vendor or copyrighted content.

ENACTS - Distance Learning and Support

PART IV: Executive Summary and Recommendations

This section contains three subsections that cover the following subjects:

1. Related projects and activities
2. Recommended distance learning concepts and tools offered by contemporary technologies
3. Key requirements and needs of users in the Grid community

The first subsection summarizes the relations to related projects and partners' efforts. We decided to put such a subsection here in order to see a few important facts: to see some projects dealing with the issue of distance learning from another perspective; to understand some of the concepts considered here in different frameworks and with different results; to motivate further investigations.

Other subsections are based on answers from Part III, their interpretation and derivation of general conclusions. The way the results were assembled was mentioned above. We believe that the proposed strategies and recommendations should help to establish a proper framework for distance learning and support. Consequently, they might contribute to the successful uptake of Grid technology even in larger communities in Europe and all over the world.

4.1 Related projects and activities

There are a number of projects and activities closely related to ENACTS. An important contribution will be probably played by the results of the LeGE working group whose main task is to facilitate the establishment of a European Learning Grid Infrastructure. This project is interesting for both its goals and for the way grid technologies attempt to achieve these goals (LeGE-WG: Learning Grid of Excellence Working Group; <http://www.lege-wg.org>). It clearly distinguishes between primary scientific and technological objectives on one side and operational objectives on the other. The former set of objectives is devoted to basic technological and pedagogical issues, legislative conditions, new European methodologies and standardisation of emerging Grid-aware solutions. The latter set of objectives deals with the practical steps to promote e-learning activities. A non-negligible feature of these activities is an information portal with up-to-date information. The project addresses a much wider target groups than ENACTS' goals. In fact, they include the whole European Higher Education, European Scientific and Engineering Research communities and the like. In a sense, LeGE might be considered as a very general metaproject with respect to our research.

An important dual view could be provided by a research project which would try to generalize our target groups horizontally. In other words, one may consider a general target groups of students, researchers or computational scientists. It is difficult to predict how important is distance learning for each group. An overview of their interests, needs

ENACTS - Distance Learning and Support

and requirements can be found at ILIAS Opensource, University of Cologne (<http://www.ilias.uni-koeln.de/ios/index.html>).

Another interesting project somewhat related to ENACTS is the EGEE project (Enabling Grids for E-science in Europe). This project is to be launched on April 1st, 2004 (<http://public.eu-egee.org/>). Its goal is to describe and interpret current national and regional grid efforts. The project covers a large portion of the industrial partners.

4.2 Summary of recommended distance learning concepts and tools

As we have seen above, there is, predictably, a non-negligible interest in **acquiring scientific and technological information**. What we did not expect was that most of the users acquire this information by means of traditional sources. In particular, the users prefer standard research papers and non-research articles, manuals, booklets, hardware, software and software documentation. Yet, there is one modern feature. The ways to access are based on electronic tools (e-mail or internet). The web environment is the new wrapper that includes mainly the classical sources of information as listed above.

The new scientific and technological information can be extracted not only from a paper-based agenda. Another important way to obtain it includes workshops, conferences, congresses. As far as the size of such meetings is concerned, there is typically a reasonable limit. It is well-known that meetings with larger number of participants are less effective in passing scientific information and for the learning process. Rather, they play a social role in the scientific society. They are important for celebrating important personalities, awarding prizes and the like.

We have investigated the role of the training type in the overall educational process. Based on the previous study, there are basically two important types of training: **informal and organised training**. The former is individualistic and tries to understand the subject matter from scratch. In such cases, for instance learning a programming language, it is important to start with reading examples and not reading user guides or manuals. These tools are more important later when the informal training transfers smoothly into an organised training. Users often really need to check carefully basic ideas of the new subject. The amount of time spent in these initial exercises which we might call a setup time is rather individual. Then the user might attend intensive courses on some software or hardware products, learn new ways how to cope with new communication tools and how to use grids.

ENACTS - Distance Learning and Support

If we try to point out the consequences of the basic user proposals, we can see that they may need a **peer-based (community facilitated resource)** rather than organised instructor courses. Such courses or training should come later when the user requires more advanced information. One example from previous times was a community of users of parallel computational tools. The individual access was much more important than an organised learning of various formalisms. Note that an organised training might be in this case not very effective since the techniques of parallel programming and using parallel machines are rapidly changing. In addition, parallel programming tools are typically very individualistic.

Users are interested in “**Open source**” approach to training and information resources and materials. They need to have access to databases in order to be able to **see closely related information**. They need to be able to have enough material in order to extend their knowledge in various directions.

The next section will try to analyze the obtained results from the point of view of distance learning. Then a specific distance learning way will be proposed.

4.3. A proposed strategy and recommendations for establishing a proper framework for distance learning and support in Grid community

As we have seen, five basic features can characterize the mainstream of distance learning (conservative definition):

- 1. it is a highly structured activity**
- 2. it deals with a highly structured content**
- 3. it is typically a one-to-many process (teacher-centered process) in which the tutor plays really a key role**
- 4. it is characterised by a frequent monitoring of its participants by tests, assignments etc.**
- 5. it is based on combination of various web-based tools.**

Consider now questions the users may ask. They may need large data resources that do not precisely correspond to the previous distance learning characterization. Although the activity might be considered as highly structured in both its form and content, it is **not teacher-centered** in the strictest sense of the word. The database-oriented learning serves more for information exchanges between two partners: those who create them and those who use them. Nevertheless, this database-oriented learning has a tendency to develop in the teacher-centered way. While the first encounters with the teaching in grid computing might be very unorganised, they have to change. They have to transform into a fully organized training.

We see another conclusion concerning the role of teachers and students in distance learning. It appears that the delayed form might be further developed by increased activity of the students. Let us try to explain this conclusion more carefully. There are many types of specific grid computations. Just now it would be very costly and inefficient to prepare very specialized experts in the field of Grid Computing that is changing so

ENACTS - Distance Learning and Support

rapidly. Nowadays, it is more important to increase the general level of knowledge of Grid Computing in particular communities. Deep training of experts might be more useful once Grid Computing becomes a generally accepted form of computation. In such a future scenario, students will play a more active role in the learning process than current distance learning analysis based on the questionnaire suggests.

In this context, let us distinguish two basic user groups: experienced users entering the new emerging field of grid computing and students who are getting their first qualification. One important difference between these users consists in their possibilities. While for an experienced user there is no difficulty in attending a couple of workshops per annum, this could be a problem for students because of a lack of funding. Consequently, the students are a very specific class of users with a much more open attitude to **distance learning techniques**.

Now let us take into account a user-friendly environment -- a reasonable compromise of users' demands for a flexible distance learning framework. We will call it a grid training portal. It is a customisable, personalised web interface for accessing services using distance learning and education tools. It would provide a common gateway to resources with special attention to the tools mentioned above. That is, **personalised and delayed distance learning forms** must be preferred.

We do not aim to present a fixed form of what we call the distance learning portal. Instead, we would like to summarise our conclusions and subsequent recommendations in terms of a **flexible** tool "under construction". Of course, it should reflect available technologies as well. We will describe its basic structure putting an emphasis on its most important features.

1. **Control (management) unit**
2. **User resources**
3. **Information resources**
4. **Communication subsystem**

Let us now describe these parts of the proposed portal system. The **control unit**, or more accurately, the **management** unit contains basic institutions and individuals jointly with tools that run the portal. Although there should be various specific rules how to handle the portal organisation, it is important to solve the problems of its technical updates, financial support, technological development, software upgrades etc. Some of them might need a rather sophisticated strategic decision. The control unit should contain two specific layers: **service (maintenance) layer** for implementing the control mechanisms and **evaluation layer**. One of the most important tasks of the control unit is to balance two basic functions. First, there will be a strong pressure of technological developments on hardware tools which will include both the **node demands** and the **network demands**. Technologically, these demands will present themselves in the need to make the nodes more powerful and to make the network with ever-larger bandwidth. Nevertheless, there is a strong gap between very fast processors and relatively slow connections. In other words, the network technology is lagging behind while increasing the network bandwidth is a real technological challenge. Second, the management unit must take care of financial resources including:

1. The start-up development costs,
2. The cost of the hardware and software tools connected to the portal including regular updates and upgrades,

ENACTS - Distance Learning and Support

3. The operational cost of the technology,
4. The management cost and
5. The technology remediation costs.

The cost function must be carefully evaluated and balanced with the technological requirements that increase the overall portal cost. Once these two items are balanced, we should take care of the overall efficiency. Mr. Soren Nipper in [14] proposed and presented a picture showing the user groups on top of the pyramid with its large base corresponding to the overall costs. This might be a figure which is temporarily valid now. However, it does not need necessarily correspond to the future development. Therefore, when taking into account such models, a realistic **forecast** has an important role. As of now, this figure might represent large startup costs since we are still in the **start-up period** of the Grid technology.

By **user resources** we mean the groups of portal users. Their leaders will be engaged in strategic decisions. The learning mechanism will not be strongly teacher-centered but more or less teacher-student balanced. The users will come with new initiatives in order to offer overall improvements. As far as the target groups are concerned, they should not be very large assuming the results of the questionnaire. On the other hand, we do not have an exact idea how they will develop in the future. Some hints, however, suggest that the target groups may increase, such as parallel computational tools two decades ago. After a long period of relatively small user groups, we can see large teams collaborating over a net on the development of large-scale HPC applications using distributed tools like SourceForge and dealing with powerful version of synchronising software that enables collaboration of tens of developers.

Information resources are the third part of the overall portal system. By that we mean the technological content of the portal covering both its hardware and software parts, particularly information databases with papers, lectures in written or recorded forms, simulation software and technological tools to present all these various materials. As of now we do not have very large multimedia resources for Grid Computing in our field. This will likely change in the future, however. In any case, the development of mechanisms how to store, protect, develop, update and clearly organise these data items is a more challenging problem. There will be a specific layer in this item. A specific feature of the information resources will be its hierarchical nature. In our case, the grid content will be first discussed on the level of HPC centers then on the national level (if there is some) and finally within the European grid community. In fact, this subsystem is exactly the one which must be organized hierarchically.

As far as the portal content of the information resources is concerned, it can be stratified into independent layers. The first layer may contain databases of written and electronically distributed information. The users accessing the portal have different needs. Therefore, the documents contained in its databases should be sorted out according to their requirements. Other data, such as test codes, video and audio material, should be stratified in a similar manner, thereby creating an user-friendly environment for grid users.

The final item is the **communication subsystem** -- a mechanisms that of exchanges information among the three previous items. The communication patterns do not need to be uniform for the whole portal. In fact, various ways of communication can be supported. For some types of information exchanges, the synchronous connections, such

ENACTS - Distance Learning and Support

as videoconferences, audio conferences or Access Grid, are preferable. Sometimes asynchronous mechanisms are preferred. In general, we distinguish two types of information signals: control and service ones. The first type serves for keeping the portal in good shape and supporting its development. The second type (which should prevail by a large margin) serves the users.

While creating a portal is our main recommendation, the question remains open as to whether this is not something we had in mind even before evaluating the answers. In other words, we need to ask whether the answers do not hide some other possible and even completely different solutions. We have aimed at minimizing this hidden risk by our methodology in which we give to some standard technologies a new, well-defined content.

ENACTS - Distance Learning and Support

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22. (http://tecfa.unige.ch/edu-comp/edu-ws94/contrib/peraya_fm.html)
23. Interwise - enterprise communications platform for Web conferencing (<http://www.interwise.com>)
24. Guide to Web Conferencing, Online Conferencing, e-Conferencing, Data Conferencing... (<http://www.thinkofit.com/webconf/>).
25. <http://publish.uwo.ca/maandrus/Table.htm>
26. Blackboard.com (<http://www.blackboard.com>).
27. WebCT (<http://www.webct.com>).
28. Fle3. Learning Environments for Progressive Inquiry Research Groups, UIAH Media Lab, University of Art and Design Helsinki (<http://fle3.uiah.fi>)
29. ILIAS Opensource, University of Cologne (<http://www.ilias.uni-koeln.de/ios/index.html>)
30. COSE VLE, Staffordshire University Enterprises Ltd. (<http://www.staffs.ac.uk/COSE>).
31. The Centre for Educational Technology Interoperability Standards (CETIS) (<http://www.cetis.ac.uk/>).
32. LeGE-WG: Learning Grid of Excellence Working Group. (<http://www.lege-wg.org>).
33. Distance learning projects in EU. (<http://www.know-2.org/index.cfm?PID=1>).

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Appendix A: The ENACTS Questionnaire

THE ENACTS PROJECT QUESTIONNAIRE: DISTANCE LEARNING AND SUPPORT

Users, vendors and other target groups accessing remotely the high performance computing facilities typically require training and support via the same networked technologies. The advent of Grid computing makes it even more likely that users will be trained and supported remotely. This survey aims to assess some problems related to distance learning and support; especially we aim to determine the most appropriate support, training methods and technologies towards pan-European or global Grid-training portal. To accomplish this we would like to know more about their current experience with general training and in particular distance learning activities as well as about their future needs so that we could come up with recommendations for a collaborative framework for the development of distance learning material and other activities.

The questionnaire is divided into five parts. Please answer the sections in order - the introductory section first, followed by the section on Grid Computing, the Educational Activities section, the section on Distance Learning and finally the Future Needs and Recommendations section. No question is compulsory and you have the right to remain anonymous if you so chose. We would be grateful though if you could answer as many questions as possible. You should try to answer the questions on behalf of the group or institution you work with and/or take part in training or education rather than yourself , but we would be glad also at your experience as a passive student or participant of the course. If you supply your email address you will be emailed back a copy of your response. All responses will be treated as anonymous unless we explicitly ask otherwise. Thank you for your time. We believe that your contribution will help us to accomplish the main goals of this study.

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1. Your organisation

1.1 Name of the Institution / Company:

1.2 Please, specify the country where you are working:

Austria
Belgium
Bulgaria
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Latvia
Liechtenstein
Lithuania
Luxembourg
Netherlands
Norway
Poland
Portugal
Republic of Cyprus
Romania
Slovakia
Slovenia
Spain
Sweden
Switzerland
United Kingdom
Other, please specify

1.3 Type of organisation:

University / Educational Facility
Research Institute / Laboratory
HPC Centre / Service Provider
Company / Vendor
Other, please specify

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1.4 What is your position in the organisation?

Head / Representative of Institution / Group

Research Fellow / Member of the Staff

Student / Assistant

Other, please specify

1.5 Please, specify the area or field in which you are working:

Astronomy

Biochemistry

Biology

Chemistry

Climate Research

Computing Sciences

Ecology

Engineering

Genetics

High Performance Computing

Industry

Mathematics

Medical Sciences

Physics

Telecommunications

Other, please specify

1.6 Please, specify your research interests or your main activities:

1.7 What is the composition of your group?

Only people from my Institution / Company

Only people from my Department

People from several institutions but within my home country

International collaborative group but within Europe

International including transatlantic collaborative groups

Other, please specify

1.8 Approximately how many members / researchers work in your group:

1

2 - 10

11 - 50

51 - 100

>100

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2. Grid Computing in your organisation

2.1 Do you have any experience with Grid Computing?

Yes

No

2.3 What kind of experience do you have with Grid Computing? Please, specify:

2.4 What is the type of Grid Computing you have the experience with?

Basic portal computing

Advanced portal computing

Small-scale Grids

The toolkit approach

Internet computing

2.5 Do you have an access to large-scale computing resources:

Yes

No

2.6 If yes, how do you use HPC systems:

2.7 What are the main problems which you face in Grid Computing? Please, choose relevant options:

Data Confidentiality

Data Integrity

Reliability of Computation

Speedup Limitation

Other, please specify

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3. Education Activities - Training Profile, Infrastructure and Tools

3.1 What is your position within the educational or training process in your institution?

- Active Lecturer
- Passive Student
- Course Support and/or Administration
- Both Lecturer and Student
- Other, please specify

3.2 What kind of the educational / training process are you involved in?

- Local / In-House Courses
- Courses or Education on National Level
- Courses or Education on International (EU) Level
- Other, please specify

3.3 Level of educational / training process:

- Undergraduate
- Graduate / PhD. Courses
- Postgraduate
- Research Oriented
- Administration or Management Oriented
- Other, please specify

3.4 Average number of days per staff member and year spent in the educational / training process:

- 1
- 2 – 5
- 6 – 10
- 11 – more

3.5 Percentage of staff members taking part in the educational / training process:

- < 10 %
- 10 – 30 %
- 30 -- 50 %
- > 50 %

3.6 Preferred type of information source used in the training process:

- Text
- Simulation
- Visualisation of Data
- Video
- Audio
- Hands-On
- A combination of above
- Other, please specify

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3.7 How do you keep yourself up to date in your field of expertise? Please specify:

Personal meetings and visits

Mail or E-mail Communication

Courses (face-to-face)

Seminars and Workshops

Conferences

Reading Printed Scientific Publications (Books, Journals, Preprints)

``Websurfing``

Using Databases

Other, please specify

3.8 How often do you use Web in training / educational activities:

Daily

Weekly

Monthly

Occasionally

Never

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4. Distance Learning

4.1 Do you have any experience with distance learning or education?

Yes

No

If "No" please go to question 4.9

4.2 What kind of experience do you have with distance learning or education?

Student of the Distance Learning Course

Lecturer of the Distance Education Course

Distance Education Course Support and/or Administration

Only information from Colleagues, Friends or Family

4.3 If you take part in distance education or training specify your current experience:

4.4 How would you characterize the communication exchange:

Synchronous

Asynchronous

Other, please specify

4.5 What is the most frequent communication principle in your distance training process:

One to One

One to Many

Many to One

Many to Many

4.6 Could you provide more details related to the communication model of the process:

4.7 Prevailing type of information from the Web used in the training / educational process:

Articles and Papers

Databases

Educational Codes

Simulations

Visualisations

Audio Information

4.8 Preferred type of communication in the distance training / educational process:

E-mail Messages

Listservers

Videoconferencing

Streaming Video

Bulletin Boards

Audio Communication

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4.9 Would your institution benefit from distance training / education?

Yes

No

Do not know

Please explain shortly why.

4.11 How relevant is distance learning to Grid Computing?

Not relevant

Of slight relevance

Relevant

Very relevant

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5. Future Needs and Recommendations

5.1 Do you consider a Grid-training portal a useful tool for Grid-specialists (researchers, professionals, students)?

- Yes
- No

5.2 Who should be involved in such a Grid-training portal? Please, choose relevant options:

- Individuals
- Universities / Educational Facilities
- Research Institutes / Laboratories
- HPC Centres / Service Providers
- Companies / Vendors
- Other, please specify

5.3 What types of resources would you like to be able to access on a Grid-training portal?

- Software Tools
- Databases
- Libraries (articles, papers)
- Collections of Lectures (video)
- Courses
- Other

5.4 Could you determine appropriate methods of communication exchange in such a Grid-training portal?

Please, choose relevant options:

- Chat
- Videoconferencing (AccessGrid)
- Websites (portals)
- Bulletin Boards and Computer Conferences
- Audio Communication
- Other, please specify

5.5 Could you determine which distribution policy is suitable for a Grid-training portal?

Please, choose relevant options:

- Shareware
- Binary Freeware
- Open Source Freeware
- Vendor / Copyrighted Products
- Other, please specify

5.6 Could you determine the most appropriate operational and maintenance strategies for a Grid-training portal?

- EU Centralized
- Nationwide Distributed
- Distributed among HPC Centres
- Fully Decentralized
- Other, please specify

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5.7 What kind of resources / the WWW-based enabling technologies and user accessing facilities

do you consider as the most efficient in this framework? Please, specify:

5.8 What do you consider as the most relevant constraints in a development of such Grid-training portal?

Financial cost

Organizational problems and reliability

Portal operation and maintenance

Copyright and security issues

Other please, specify