The E-Learning Grid: Integrating E-Pedagogy with Novel Technologies

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Abstract:

In this paper we present the approach taken by the European E-Learning Grid consortium in building learning Grids. We focus on combining collaborative and peer-to-peer approaches with the relevant pedagogical paradigms where we can arrive at the E-Learning Grid. We present a framework that supports the creation of multi-user collaborative sessions, allowing users to self-organise and communicate, share tasks, workloads, and content, and interact across multiple different computing platforms and are aiming for heterogeneity in terms of both network and operating system platforms centred on fundamental technologies.

1 Introduction

According to IDC (April 2003) [1], the e-Learning market in Western Europe continues to be one of the fastest growing IT sectors despite a recent slow down. The key trends outlined are:

- The market for e-Learning is becoming much more cost conscious and companies are less eager to begin new projects with significant investment decisions are taken high up in an organization. The result is that vendors of e-Learning solutions need to actively demonstrate the value of their products.
- Consolidation is continuing due to vendors expanding their geographical market reach to create a wide a range of e-Learning solutions as possible.
- Developing multilingual and cross-cultural content remains a major inhibitor in the European market. Consolidation addresses this problem to a degree, but tailoring e-Learning solutions to suit a broad audience is a challenge for e-Learning developers.
- E-Learning still only accounts for a small proportion of organizational training budgets, dwarfed by instructor-led training. Many organizations favour a blended solution where e-Learning is used to reduce cost and increase flexibility in terms of location and time during the training process.

Against this backdrop the overarching aim of our Grid approach is "to create a ubiquitous pervasive open collaborative e-Learning environment focusing on and enhancing the dialogue phases of the learning process that is based on the metacognition principles. This means a learner can take a course of their choice from a common distributed virtual content repository and have it delivered to them at a time/place/format of their choice in a personalized fashion, with support available as and when they need it, from anywhere within the EU and the world respectively".
Our solution to achieve this ambitious goal is to use Grid technology to create infrastructure and collaboratory to enable different players to work together. Thus the E-Learning Grid consortium was created, which currently consists of 22 members: University of Reading, UK, University of York, UK, Trinity College, Ireland, Aristotle University of Thessaloniki, Greece, University Carlos III Madrid, Spain, INESC Porto, Portugal, INSA, Lyon, France, University of Portsmouth, UK, Emory University, USA, University of Westminster, UK, University of Salford, Johannes Kepler University, Linz, Austria, several EC Centres of Excellence and major EC research centres (Bulgarian EC Centre of Excellence, SZTAKI, Budapest, Hungary, Cyfronet, Krakow, Poland) several major IT companies (Intel, Portugal Telecom, Support IT, Giunti Interactive Labs), Ward Education Services and ICEL Ltd, Belgium.

2 The Approach

We apply a multifaceted approach based on the integration of novel e-pedagogy, new technologies and organizational components (see Figure 1). Most of the partners (including all of the partners working in the Infrastructure working group) are members of current European Commission (EC) funded Grid projects such as CROSSGRID and Gridlab as well as national Grid and e-Science projects. Our approach is based on the research carried out in the EC GENIUS [5] project where the following outcomes were exposed:

• Delivery (which may be as technologically enhanced as we wish) is not learning nor can it imply that learning is taking place. Hence there is a need for new pedagogy to go hand in hand with the technology and organizational components.

• Our approach is based on the awareness of and control over one's cognitive processes metacognition. Effective thinking and learning requires frequent checking, goal setting, reassessing, and evaluation. We aim to improve further the quality of learning.

• To improve the quality of learning and minimize the costs there needs to be effective organizational change.

• We should facilitate blended learning, due to the need of socialization [9] as an important element in the learning process. More than 70% of knowledge is not explicit and we need a system where socialization is a fundamental part of the system.

• Collaborative learning and socialization are very important and collaborative environments can facilitate this. By using the collaboration we can integrate workshops and independent learner groups.

• The learning should be personalized and demand driven thus being learner oriented and able to satisfy the demand for life long learning and minimize the costs through sharing of resources.

• Sharing of educational materials allows the teachers to concentrate in depth while preparing joint courses and at the same time minimizes the cost to the individual institutions of preparing these courses.
To translate this into practice we have to transform the traditional process of learning from constructing knowledge and acquiring skills to constructing knowledge using digital resources through utilizing tools and using digital communication in a virtual community (Peter Revill [4]). The management of this process and organizational clarity are also critical to this process. This will be validated through the EC Erasmus Mundus [12] programme from October 2005 where in collaboration with four other institutions the approach described here will be implemented in a higher education scenario. In the next two sections we will give an overview of our peer-to-peer solution and finally will make some concluding remarks.

3 Pedagogy

Our pedagogical approach, following the achievements in [4, 7], is based on the educational model which assumes that the learning process is an interactive process of seeking understanding, consisting of three fundamental components: Conceptualization, Construction and Dialogue [10]. We are focusing on Construction and Dialogue phases of the learning process, since it is known [5, 10] that most learning is happening in these phases, and on metacognition, which plays a significant role in developing a person's learning capability. Thus we are investigating how to translate learning from theory into practice and especially in the case of e-Learning, using digital tools, digital resources and digital communications [4, 5]. Collaborative learning can facilitate the Construction and Dialogue phases of the learning process and especially: team work and a combination of individual activities, with discussion all along the learning process involving lecturers and instructors from different institutions. On the other hand, the collaborative and Grid approach allows us to:

- Efficiently share resources, e.g. learning material, computing resources, lecturers and instructors.
- Efficiently reuse the learning materials based on common standard.
- Collaboratively prepare learning materials and deliver them.

All this leads to the idea of the E-Learning Grid. Defining such a Grid infrastructure and a collaborative environment based on this infrastructure will allow multiple Virtual Organizations (VO) to co-exist.
4 The E-Learning GRID

As pointed out, our recent work has identified the need for an E-Learning Grid, allowing sharing of learning materials, collaborative preparation of such materials, collaborative learning, demand driven education based on Grid e-Learning services etc. It is apparent that other enabling technologies for content publishing, learning objects tagging to create metadata, Learning Management Systems etc. are also part of the picture and essential components of the E-Learning Grid. From our current experiments it is emerging that a scalable approach should be based on peer-to-peer technologies.

4.1 Collaboratories for the E-Learning Grid

This involves sites in different Universities, Companies, and professional bodies, some developing content, and others developing Grid middleware, e-Learning software and interfaces. We need a common framework in which to interact. Hence we need a collaborative environment in which to work and place the existing components. Our approach here is based on the Collaborative Computing Platform (Coco).

The computing landscape is shifting rapidly. Computer networks are increasingly characterised by heterogeneity and diversity as computing begins to pervade every aspect of our daily lives; new mobile technologies are juxtaposing with traditionally network technologies to become mainstream tools for communication at home and in the workplace; network connectivity is increasingly transient and dynamic. Due to the proliferation of small mobile and wireless devices and the development of a range of network protocols and middleware to support device connectivity, it is likely that in the future network heterogeneity will be the order of the day. Work groups spanning physically distant locations will increasingly rely on a whole range of tools, including personal computers, PDAs, mobile phones etc. to cooperate and coordinate their activities and to bring a sense of cohesion and proximity to teams of collaborators that may be globally dispersed.

The goal of our research is to develop systems and an environment that supports the creation of multi-user collaborative sessions, allowing users to self-organise and communicate, share tasks, workloads, and content, and interact across multiple different computing platforms, network platforms and operating systems when they wish to:

- Form groups with shared interests and secure domains of trust.
- Form spontaneous collaborative sessions interacting over or manipulating shared data or documents.
- Interact with others synchronously or asynchronously.
- Be aware of other users and have access to user credentials for authentication.
- Share arbitrary content using metadata representations.

We are aiming for heterogeneity in terms of both network and operating system platforms centred on two fundamental technologies: JXTA [6] and Java.

Consider now the Coco architecture. Coco has been developed as both a programming environment, through a set of objects and a service APIs, and a runtime environment that allows users to create and announce collaborative sessions. The design focuses on three fundamental aspects that can be summarised as follows:
• **Components** - the component layer contains a set of components that are integral to the platform. Components can be seen as manifestations of concepts and abstractions that were derived from an analysis of the system requirements. All components have an XML-based representation on the network that allows the Coco service layer to build on JXTA core services, providing the underlying propagation mechanism for the dissemination of messages between peers. Current components include **sessions, channels, users, groups, content, and applications**.

• **Services** - services encapsulate the network service functionality of the system. The architecture is designed to provide a number of services (exposed through a set of service APIs) that enable peers to access the resources of remote peers and groups, thus forming an interface that can be built on by applications. The design consists of three core services: the **interaction service**, the **messaging service**, and the **content service**. The services are fundamental to the system design as they completely specify the network behaviour of peers, allowing peers to discover resources, propagate messages, and communicate in the context of a heterogeneous network environment.

• **Applications** - the application layer provides two platform applications that allow users to create groups and to create, discover, and join collaborative sessions within the context of groups.

Layering at the architectural level encourages the encapsulation of components into modules with well-defined interfaces, enabling higher-level services to be built using the facilities of lower ones. Layering also ensures that services and applications are separated (or **decoupled**) and reduces dependencies within the system. The combined elements of the architecture are designed to provide an interoperable substrate that can be built on by applications via the Coco service interfaces.

*Coco* has yet to undergo formal or rigorous testing. However, our collaboration suite already includes an instant messenger with file sharing capabilities, a shared whiteboard, a shared web browser, and we are also progressively developing other components including **MicroCoco** that brings collaborative computing to mobile devices.

![Figure 3. Coco Architecture.](image-url)
Figure 3 shows us that *Coco* being built on Java and JXTA technologies follows to *MicroCoco* that is being developed on Java 2 Micro Edition (J2ME) and JXTA for J2ME (JXME) technologies. As JXME has been designed to be interoperable with JXTA, *MicroCoco* is being built on this platform. The services provided by *MicroCoco* are a subset of *Coco*’s. This is because the hardware constraints allow a limited amount of bandwidth for communication with other full *Coco* peers. For example, a group of *Coco* peers may be able to collaborate with a video conferencing application; however a *MicroCoco* peer running on a mobile phone may not necessarily have the bandwidth to deal with an incoming video stream. A *MicroCoco* peer could however participate in sessions that require more asynchronous communications such as instant messaging, content sharing and co-authoring.

### 4.2 Peer-to-peer Technologies for Content Distribution

Here we would like to give an example of an enabling technology for content distribution. Note that peer-to-peer technologies [2, 3] can also be used for content distribution. *KnowledgeSurge*, based on *Coco* technology, provides facilities that support resilient self-organising content distribution and searching in a P2P context. The service implementation aims to provide similar basic facilities to those offered by popular content sharing applications in a completely decentralised context where nodes (in this case, instances of the content service) act equally as clients and servers. Popular content tends to be distributed and replicated widely in such systems and P2P content-sharing systems exhibit the desirable properties of high availability and resilience in the face of failure. This service uses metadata resource descriptions to describe content using the Dublin Core Metadata specifications [11] for e-Learning content.

### 5 Building Virtual Organizations

In the previous sections we have considered pedagogical and technological components, here we will very briefly focus on organizational aspects. The above infrastructure allows us a high degree of flexibility:

- It offers scalable solution, partners can join and various components such as modules etc being placed in the environment.
- Offers the possibility to form groups with shared interests.
- Offers the possibility to form collaborative sessions interacting over or manipulating shared data or documents.
- Interact with others synchronously or asynchronously.

Based on the above we can form different Virtual Organizations which can co-exist for delivering specific modules, courses etc. The collaborative capabilities allow facilitation of collaborative learning, collaborative preparation of materials etc.

### 6 Conclusion

In this paper we have presented a peer-to-peer approach to the E-Learning Grid. We have outlined a layered collaborative computing platform facilitating most of the functionality required for collaborative learning on the Grid. This platform has also been used to provide a distributed and decentralized content distribution service. These technological foundations to
the E-Learning Grid will facilitate the effective Virtual Organizations for collaborative learning.

References:


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