Scenarios for a Learning GRID

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Abstract. Learning GRID is both a concept and a Special Interest Group of the European Network of Excellence Kaleidoscope. Kaleidoscope is a Network of Excellence funded by the European Commission which brings together European research teams in Technology Enhanced Learning (TEL). The Learning GRID Special Interest Group gathers researchers who want to contribute to an improvement of e-learning practices through the use of the Learning GRID concept. Its key idea reads as Learning Grid technology allows for a direct and personalized experience in realistic contexts and boosts creation of virtual dynamic communities. After introducing briefly Kaleidoscope, this article presents the learning GRID concept and several scenarios that this technology makes possible.

Introduction

Learning GRID is both a concept and a Special Interest Group (SIG) of the European Network of Excellence Kaleidoscope. Kaleidoscope is a Network of Excellence funded by the European Commission which brings together European research teams in Technology Enhanced Learning (TEL). The key challenge that Kaleidoscope is facing is the scientific and structural integration of European TEL research. The challenge lies in the topic itself which is multi-disciplinary. Therefore, Kaleidoscope gathers researchers coming from various disciplines, from learning sciences to computational technology, which is critical since knowledge and meaning making are key to learning. The challenge lies also in the European dimension of the network, since European countries have different educational systems.

The aim of the Learning GRID SIG is to contribute to the achievement of an improvement in e-learning and training practices through the definition of open, distributed and pervasive environments for effective human learning. This view takes into account that (i) effective learning requires an active attitude of learners (ii) and that learning is a social activity. Therefore, future learning scenarios require a technology that allows for active and realistic experiments, personalization, knowledge creation and evolution, as well as autonomous and dynamic creation of communities.

In this contribution we first present what is meant by the Learning GRID concept, then we present pedagogical scenarios that such a concept allows for.

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1. Learning GRID Concept

The Learning GRID concept, as proposed by the SIG just mentioned, integrates Grid technology, semantics and learning design.

What is Grid? "Grid is a service for sharing computing power and data storage capacity over the Internet". Connecting heterogeneous computers necessitates a middleware called a Grid architecture. This middleware comes between the operating systems of the single computers and the application that runs on all the connected computers. A Web Service is a software component that makes itself available over the Internet and that uses a well-defined standard for messages. Examples of popular services are weather reports, plane real time schedules. Grid architectures and Web services mechanisms are merged in the Open Grid Service Architecture (OGSA). This technology provides a transparent access to distributed (stateful) services and resources, provides interoperability between heterogeneous environments, security, trust and ubiquity. With this technology, students' machines can offer their storage and computing facilities to run parallel algorithms taught in a parallel computing course for example.

What is Semantics? Semantics has to be understood in the Semantic Web context. The Semantic Web is the vision that data on the web are defined and linked in a way that they can be used by machines not just for display purposes but also for integration and reuse across various applications. Nowadays, a Google search with the keywords 'algebra exercises Grade 8' gives Internet pages that do propose algebra exercises for grade 8 students, but also Internet pages on the academic content standards for Grade 8 algebra. Search engines know only that such pages contain the pattern or syntax 'algebra exercises grade 8' but have no clue on the different meanings or semantics that such pages give to these words. This semantics have to be made explicit by an indexation or annotation of the pages using a well defined vocabulary or ontology. Semantics makes it possible to provide services typical of the learning domain and thus allows for resources discovery, service composition and personalisation. With this technology, it would be easier for a teacher to tailor an algebra course integrating many exercises for practically oriented learners.

What is Learning Design? Learning Design [1] is a language to express many different pedagogies. Learning Design allows for creating scenarios able to capture all the identified pedagogical features. With Learning Design, you can construct a pedagogical scenario for a calculus course with activities on Limit first, then on Derivatives and finally on Integrals. Activities can be individual or collaborative.

2. Scenarios

Various scenarios have been proposed inside the SIG for the Learning GRID. A complete description can be found in [2] and [3] and are summarized in the sequel of this section. Scenarios presented in [2] are either already implemented or are extensions of existing teaching and learning practices. Scenarios presented in [3] are more futuristic. All technologies to implement them are available. The challenge is to make these technologies work together.

Parallel Computing Cooperative Learning. In this scenario, the classical clusters of computers for teaching parallel computing is replaced by a GRID. Grid technology makes it easier to connect students and instructors' machines to a dedicated cluster, and to make several institutions collaborate. Such a multi-structure encourages a broad learning experience which includes issues from programming considering communication details to use the networked resources transparently and seamlessly as one supercomputer. Definition of new services would allow teachers to assign tasks to groups of students, to monitor all connected peers, visualize the work of students, access learners' documents, code and results. It would also allow students to share their code and solutions. Such a scenario encourages simultaneous participation of students because computational power is increased as more students join.

A Collaborative Research Environment. This scenario takes its inspiration from Citeseer, a digital library which organizes scientific literature, allowing flexible searching and citation statistics. The use of GRID technology makes it possible to extend the digital library with new forms of collaborative activities. Apart form papers more resources can be share such as formal or informal comments, reviews, summaries, videos, code. Virtual organisations can be defined. A virtual organisation can be specified as research students and their supervisor(s), a research group, or a whole lab. Services can be personalized according to users. Access rights for students or supervisors may not be the same. Such a scenario constitutes a new and useful way of supporting research activities, allowing to easily organize and access all sort of documentation/information, and to assess individual and group progress.

A Distance Programming Course based on Practice. This scenario is based on an existing e-learning programming course running in the Engineering School Léonard de Vinci [4]. In this course, students are learning by doing more than by reading learning material. They are provided with many programming exercises that are automatically corrected. Moreover, all their attempts are stored so that students can consult their history. Compilation and program execution are implemented as services, students do not need to worry about downloading themselves any programming environment. Learning GRID would improve the existing system in two main ways. First Grid technology, by allowing a distributed code compilation and execution as well as a distributed storage of students' answers would make the present system scalable. Second semantics would allow for better personalization and flexible course composition.

Collaborative lab. The traditional lab in computer science is a collection of isolated individuals each pulling their own material and exercises from a dump pedagogical server, and deploying activities invisible for the tutors. Usually informal mails and forums are the only groupware metaphors used by students to break this isolation. The Learning GRID could lead to richer distributed system metaphors enabling teachers to perform actions such as visualizing the activity of students, actively gathering results of students, navigating through these results and making them visible to selected groups

Using GRID Computing for Processing and Analysing Information from on-line Collaborative Learning Teams. This scenario is implemented and working at the Open University of Catalonia [5]. Computer supported collaborative learning (CSCL) applications are characterized by a high degree of user-user and user-system interaction and hence generate a huge amount of data usually collected in log files. In order to extract information useful to the group activity, these files must be processed in real time. Grid technology is used to process group activity log files and, thus, makes it possible to provide timely feedback to users and compute different statistics.

Networking Course by E-learning. The networking e-learning course teaches basic concepts and allows students to design and configure simple networks. On a trip train, a student can access the course from her PDA and perform network simulations. The output of the simulator is automatically adapted to the device and gives numerical results to a PDA and graphical results to a laptop for example. Using the public WLAN infrastructure available in the train, the student can contact a tutor and asks questions, or can chat with other students, share documents and perform collaborative activities. This scenario allows for ubiquitous, active and social learning. GRID technology makes communication between heterogeneous devices and use of simulators possible. Simulations could be completed/replaced by more ambitious virtual lab experiments.

Featuring immersive Virtual Reality. A student is learning water and aquifer behavior by using an e-Learning platform. She can access introductory books to gain initial knowledge on the topic. She can also use a dynamically generated set of services that, according to her user profile and current PC capabilities create an immersive virtual reality. The service also informs the student about immersion requiring special equipment like gloves and glasses and about the nearest locations where such immersions are possible. Such immersions allow her to go deeper on the aquifer behavior and characteristics of water. In these virtual sites, she also meets other students and interact with them. Learning occurs naturally as a result of experiments and interactions with other students. GRID technology combined with user profile is needed to make this scenario work..

Featuring the virtual laboratory. Students can access a virtual remote chemistry laboratory using different terminals (PDA, laptop, PC etc.). Students are identified by the system and a status of their work is stored at their user profile. Such information makes it possible to break and resume experiments that may require distributed simulation or aggregation of distributed information. Supercomputer facilities allow specifying and testing complex analysis, typically performed by groups of three students. Output of experiments may be numerical or graphical and adapted dynamically to the devices used by students. From time to time a synchronization period allows for comparing results between groups and getting partial marks. As above, this scenario uses user profile and GRID technologies.

The Field Trip [6] (see Figure 1). Students, equipped with PDAs, go on a field trip. While performing their activities, they store information under the form of photos, videos, text notes, audio comments, etc. Students can also access digital libraries and documents necessary for their work. The PDA, using user profile and context dependent information, automatically indexes these contents using appropriate meta data. All the contents stored by all students are sent, via an appropriate network to the Field Trip (FT) GRID service created before hand by the teacher. The PDA uses biometric data for secure access and for data ciphering. The FT GRID service uses external services like high performance computing services to provide 3D reconstructions of photos, or to to orchestrate speech to text and for text interpretation. Using an ontology based knowledge representation, the FT GRID service can compare students' work with learning objectives and prepare a summary for the teacher in terms of progress and weakness. Using semantic based service searching and location capabilities, the FT GRID service makes it possible for students to contact other students with similar interests or other students who are geographically near. This scenario uses the typical GRID approach in combination with mobility. Semantics is required for knowledge based services.

English plan. Students with a similar English level are sent to an immersion program that consists of a 1-week-trip to New-York. Each day they have to send a report about the activity planned by the tutor that they have performed. Let us take the 'visit to the stock-exchange' activity as an example. The night before the visit, students prepare themselves using their PDAs and the hotel WI-FI network to consult documentation, contextual vocabularies, access on-line dictionaries as well as a pronunciation service. They can also perform collaborative work. After sending all reports, a student can access the evaluation virtual network, authenticate himself and take an official exam. This scenario uses primarily mobile GRID technology.

How to elaborate a business plan. While flying to a meeting to Japan, a business man has to complete parts of a business plan. As these parts are quite tricky, while at the airport he downloads on his PDA a course about business plan using the WI-FI network of the airport. During the flight, he seeks further advice by connecting to a GRID service that allows him to locate a tutor and discuss with him via a video-conference service. He also accesses a profitability simulator service to complete his work. As above, mobile GRID technology is essential for this scenario.

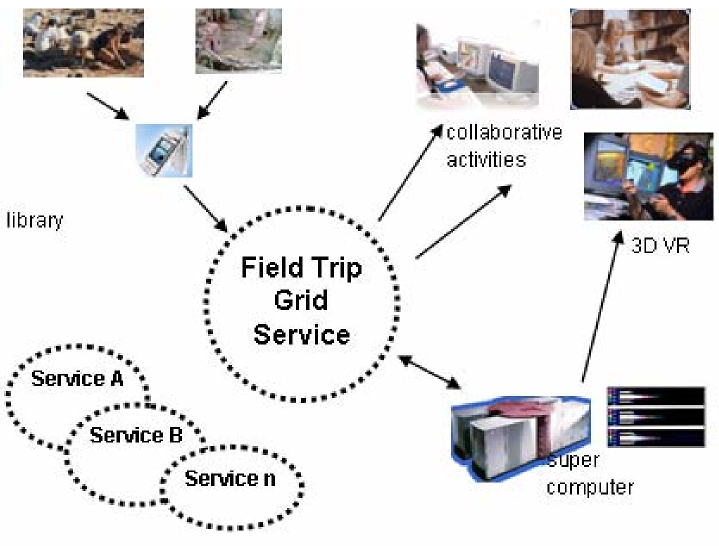

Figure 1. The Field Trip Scenario

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