Grid based software solutions to manage the lifecycle of collaborative learning environments

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Abstract

In this paper the authors present two software solutions, developed in the context of the Business Experiment in GRID project (BEinGRID), and discuss on their applicability in the creation and management of distributed collaborative learning environments. In particular, the presented solutions are deemed useful to complete the current tools for the creation and management of these environments by addressing gaping issues like trust management and ensuring quality of service.
The software solutions have been validated in the context of a concrete case study related to the creation of a collaborative environment to support the execution and provision of Massive Multiplayer Online Games. As a case

study, this paper will provide a description of the way the presented solutions can be applied to create collaborative learning environments, like for example the Virtual Learning Community defined in the context of the European Learning Grid Infrastructure project.

1 Introduction

Business Experiment in GRID (BEinGRID[1]) is the European Union's largest integrated project co-funded by the Information Society Technologies (IST) research, part of the European Union's sixth research Framework Programme (FP6). Its mission is to generate knowledge, technological improvements, business demonstrators, and reference case-studies to help companies in Europe and in the world establish effective routes to foster the adoption across the EU of SOI technologies such as Grid and Cloud Computing and to stimulate research that helps the development of innovative business models using these technologies.

To achieve this goal BEinGRID has undertaken a series of 25 targeted case studies[2] designed to implement and deploy Grid solutions across a broad spectrum of European business sectors including the entertainment & media, financial, logistics, manufacturing, retail and textile sectors.

The authors have been involved in the design and execution of one of these case studies, namely the one relating to the entertainment & media sector whose purpose was to design and develop a collaborative environment for the execution and provision of massive multiplayer online gaming applications. This case of study was developed by identifying a set of design patterns and software components to address recurring problems in SOA and Grid environments, mainly related to Secure VO Management. Interested readers can refer to (Gaeta A. *et al*, 2008) for more information on the case study and on the experimentation and assessment carried out.

In the following after a brief overview of the research works related to the use of collaborative paradigms and Grid technologies for e-learning (Foster I. *et al*, 2001), there is an introduction to the software solutions developed to support the governance and lifecycle management of a collaboration, avoiding details that can be found in (Gaeta A. *et al*, 2008). Then, it is explained how the solutions can support the most common e-learning requirements, motivating why the authors believe the results can be usefully exploited in the learning domain. Among the potentialities identified for these solutions there is the possibility to properly implement the Virtual Learning Community concept investigated in the context of the European Learning Grid Infrastructure (ELeGI) project (Gaeta M. *et al*, 2005). Lastly, conclusions and future work are presented.

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[1] http://www.beingrid.eu

[2] http://www.beingrid.eu/casestudies.html

2 Related Work

The use of Collaborative Networks (Camarinha-Matos *et al*, 2005) in the e-learning environment is not a new concept: Bates (Bates,1997) in 1997, even before the wide diffusion of web technologies, postulated that internet and its increasing broadband capacity would encourage the convergence of campus-based organizations and distance education organizations. This field has been investigated by other researchers like Koper (Koper *et al*., 2003), who affirms that "A Learning Network for Lifelong Learning (LN) is a network of distributed persons and organisations who create, share, support and study learning resources ('units of learning') in a specific knowledge domain. These networks support the seamless, ubiquitous access to learning facilities at work, at home and in schools and universities". Since then collaborative networks have taken benefit from emergent technologies like wireless communication, which has made ubiquitous learning possible, and Web 2.0 tools, which encouraged collaboration and sharing of resources.

In recent years the integration between e-learning processes and the Grid Computing technology has become one of the most analyzed topics. In most case studies related to the use of Grid technologies in the e-learning domain, these tools have been used to exploit the obtained computational power for multimedia applications or to connect geographically distant resources together.

ULabGrid (Ardaiz *et al*, 2003), an Infrastructure to Develop Distant Laboratories for Undergrad Students over a Grid, describes an architecture for the design of remote collaborative laboratories for university students using the Grid infrastructure and the Globus toolkit[3]. It was one of the first practical experiments of use of the Grid facilities to achieve resource sharing and motivate collaborative work in an e-learning domain. Students are provided with access to a Grid of computational resources where to execute their laboratory assignments from university labs or from their homes.

KGTutor, a Knowledge Grid Based Intelligent Tutoring System (Zhuge, 2004), is a Knowledge network for adaptive e-learning based on Knowledge Grid, an internet application environment that enables sharing and managing explicit knowledge resources and provides on-demand services to support cooperative teamwork and problem solving. The KGTutor analyzes each student's profile and learning goals and uses them to generate personalized courses. It also provides suggestions and evaluations according to the student's performance. This system is focused mainly on student centred learning concerns, though it could be further strengthened through the use of aspects of semantic description of learning services.

The latter idea has been investigated in (Samaras *et al*., 2004), where the

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[3] http://www.globus.org/

authors investigated means of enhancing current Grid technologies to support semantic descriptors for resources, a subject also known as Semantic Grid. They created a Self e-Learning Network (Se-LeNe), a test application relying on semantic metadata to describe educational material integrated with a set of services which are implemented with web service technologies and standards. The experiment showed that the usage of semantic data is indeed an improvement and can be applied to multiple architectural models.

The edutain@grid project (Ferris *et al.*, 2008) aims to develop a service infrastructure for ROIA applications (Real-Time, On-line, Interactive Applications) that are mainly used for Massive Multiplayer Online Games and edutainment. Its ending goal is to open the benefits of GRID technology to the wider public through the development of middleware that will give other application developers access to this powerful technology without the need for Grid infrastructure management. The infrastructure allows all the actors involved in the production, release and distribution of ROIA software and services to organize themselves in 'value chains' whose links are formed by business agreements like SLA (Service Level Agreements).

3 The software solution for managing virtual organisations

In the BEinGRID project several components have been implemented to support governance and lifecycle management of a Virtual Organisation (VO). A VO can be considered as a special case of a Collaborative Network (Camarinha-Matos *et al*, 2005). A key feature of a VO is that it is established in a short time to dynamically respond to a collaboration opportunity (business, scientific, educational) and its nature may be transient, i.e. its lifecycle may have a defined duration and may also be short. To ensure the achievement of the VO's objectives, adequate VO management is required.

To the purposes of this paper, only two of the developed components are described in this section: the VO Set Up and the Application Virtualisation.

The VO Set Up is a web service providing functionalities to support the VO Identification and Formation phases where members of the VO have to be identified and a circle of trust among them has to be created. The component allows for the management of VO-related registries and secure federation lifecycle.

The Application Virtualisation is a web service that enables the management of the deployment, distribution, coordination and configuration of capabilities and resources required for offering applications distributed over a federated set of network hosts. A competitive differentiator is that this software component provides a unifying layer for managing security (e.g. identity, secure service integration), Service Level Agreements fulfilment and performance monitoring across multiple platforms.

Section 4.1 will describe how these components can be usefully exploited to create a particular type of e-learning virtual community.

4 4. Requirements and trends of e-learning communities that the software solutions address

The technological solutions introduced in the previous section allow overcoming some of the current barriers related to the creation and management of e-learning communities.

In the e-learning environment collaboration activities and the management of a virtual community lifecycle currently occur using mostly Web 2.0 tools: social networks can be employed for identification, while blogs and wikis are widely used for the operational phase in order to make the members interact.

To create and manage Virtual Learning Communities it is necessary, however, to take into consideration some problems, currently still open, that have already been addressed in other domains (like e-Business).

In (Gannon-Leary e Fontainha, 2007) several barriers and Critical Success Factors of e-learning communities are identified, like Trust and Identity management, Quality of Service and technological provision.

In the context of learning, trust is essential at many levels: all the participants need to confide in both the e-learning system and the people involved in it in order to be encouraged to contribute to the discussion, without fear of exposing themselves to strangers. Institutions might be concerned with legal issues, e.g. data protection, intellectual property. Students must be able to rely on the accuracy of the content and the expertise of the teachers they are dealing with. In general, they tend to trust more a personalized learning environment rather than information found searching in huge catalogues. It is really difficult to create trust in online communities, because there is not opportunity for face-to face interaction and socialising, which can consolidate group membership. It is mainly for this reason that it takes a lot of time to build up a Virtual Learning Community. Another demand is the Quality of Service (QoS), which becomes a key issue when teachers and students participate in complex group experiments online and the system must guarantee availability and support for intense workloads. The system must also be able to quickly adapt to requests, creating a VLC dynamically every time a new learning need surfaces and offering all the required resources. Nowadays, instead, everything has to be pre-configured and installed in a specific physical space and every need must be foreseen.

In a research detailed in (Albano *et al*, 2006; Capuano *et al*, 2008; Gaeta M. *et al*, op. cit.), a series of e-learning scenarios were analyzed and some new trends emerged, such as the extensive use of collaboration and cooperation among peers, the supporting of different pedagogies, the central and

active role of the learner in the learning processes aimed at facilitating the construction of learner's knowledge and skills, instead of the simple memorisation of information. These new trends demand challenging requirements such as: coordinate geographically distributed students and tutors who belong to different institutions; interface with multiple administrations from different organisations with specific educational policies; allow access from anywhere, on any learner's computer platform and any software; support a growing load of learning resources, services and users who access resources and services; provide transparent access and sharing of software, resources and services in dynamic environments; guarantee enough flexibility to allow reuse of pieces of learning resources and services of different granularity according to specific needs; support the autonomous and dynamic creation of communities.

Most of the above requirements are very similar to the ones that the VO Set Up and Application Virtualisation are able to address. For example, the problems regarding geographical distribution, interfacing with different administrations and dynamic creation of communities can be addressed by the VO Set Up while intense workloads, flexibility and transparent access to resources can be dealt with the Application Virtualisation component.

To allow a better understanding of how the VO Set Up and the Application Virtualisation can be adopted to create and manage a collaborative learning environment, the next section presents a scenario based on the concept of the Virtual Learning Community investigated in the ELeGI project.

4.1 The implementation of the Virtual Learning Community

In the ELeGI project, a Virtual Learning Community (VLC) refers to a set of people and institutions who communicate, collaborate and cooperate in order to achieve a common educational goal by sharing a set of high level learning abstractions (e.g. models, ontologies, educational languages), processes and services as well as infrastructural resources. The implementation of the VLC requires to identify the learning capabilities and resources provided by several Learning Content and Service Providers and a mechanism to federate and expose them in a secure way to an end-user, i.e. a learner, in such a way to allow automatic and transparent management of the underlying Service Oriented Infrastructure.

Consider the following application scenario related to continuous education in medicine. A community of medical professionals has to learn new medical techniques based on innovative research results. The community must be composed by medical professionals, a reduced number of professors involved in finding new knowledge the medical professionals should learn and, finally, an interactive simulation developed by a specialized research centre, which must

be available to the medical professionals to simulate the new techniques.

To implement this scenario, the software solutions described in Section 3 can be exploited to create a VLC. The VO Set Up component can be used to identify potential community members according to the capabilities and resources they can offer and the QoS they can ensure. The Set Up component invites the identified potential members to join the VLC and the federation process starts, in order to permit single sign-on on community resources distributed through the VLC. The medical professionals must be able to apply the new techniques using the simulation service.

It is worth mentioning that one of the key differentiators of the VO Set Up components with respect to other solutions supporting the VO lifecycle management is that it provides an implementation of the Security Assertion Markup Language that is implemented also in the most adopted software solution used to federate universities, i.e. Shibolleth[4]. The VO Set Up thus can also be used to support activities such as accessing digital library resources from off-campus, accessing a research web site at another university or managing a shared instrument[5].

Then when the VLC is formed, the capabilities and resources required to execute the interactive simulation have to be selected and created and, at the same time, the infrastructural services to allow a secure, manageable and accountable execution of the training service have to be configured. For this purpose the Application Virtualisation can be used.

5 Conclusion and future work

The VO Set Up and the Application Virtualisation components have been evaluated and validated in the context of a business case relating to the creation of a VO for the execution and provision of massive multiplayer online gaming applications. The above mentioned business case presents requirements very similar to the ones of some collaborative learning scenarios identified in the ELeGI project requiring the creation and management of VLC. The contribution that the software solutions presented in this article can bring to the creation of virtual learning communities is mainly related to the opportunity of creating and managing trust relationships between community members, managing Quality of Service for experiential activities that require the execution of distributed simulations and permitting a high level of interaction between groups of users.

Current work is devoted to an in-depth analysis of the advantages and drawbacks of adopting the components, before the development of a concrete case

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[4] http://shibboleth.internet2.edu/about.html

[5] http://shibboleth.internet2.edu/uses.html

study for their assessment in the learning domain.

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