A Workflow-based Architecture for e-Learning in the Grid

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Abstract

Effective e-learning distributed environments should promote high cooperation. Workflow techniques can certainly contribute to such effectiveness as the creation and delivery of learning contents are typically accomplished by groups of individuals executing specific and predefined sequences of activities. Reusable Learning Objects (RLOs or LOs) also play an important role in this context as learning content is broken into smaller parts to facilitate deployment and execution assignment. Additionally, some LOs may require high levels of computation as in the case of simulations in Hemodynamics in a Fluid Mechanics course. In order to cope with such an application, we envisioned a workflow-based Learning Management System (LMS) using web services as the communication infrastructure allied to the computational power of the Grid.

1. Introduction

In a full collaborative e-learning environment, tasks are accomplished by more than one participant and many electronic multimedia artifacts are often exchanged between students and between students and teachers. For this reason, workflow management systems (WfMSs) are being used in e-learning [1]. In addition to fostering the collaboration between humans, the WfMS may be responsible for coordinating the execution of tasks involving massive computation and/or data processing. In such a scenario, grid computing offers an adequate infrastructure to be integrated into the WfMS.

It is also important to break learning content into modules to facilitate deployment and execution assignment. For these reasons Reusable Learning Objects, or simply Learning Objects – RLO or LO – are being intensively studied and already applied. Aiming LO reuse and interoperation, LO metadata (descriptions of LOs) are in their way to standardization, as per IEEE initiative [2, 3].

We are studying an e-learning scenario requiring computational-intensive learning objects for simulation purposes; for instance, it must be possible for a student to access a learning module (a LO) capable of doing real-time computation of the path and velocity of particles in the vein system subjected to different blood pressure and viscosity conditions set by the student. In this case, computational power must be dynamically and automatically *borrowed* from other computers in the network. This project is being conducted at LNCC – *Laboratório Nacional de Computação Científica* (National Laboratory of Scientific Computing) in Rio de Janeiro, Brazil.

In this paper we present TEAM, which is an architectural model conceived to derive peer-to-peer collaborative e-learning supporting environments based on grid computing.

2. The e-learning environment

We conceived an environment in which students and teachers would execute instructional steps cooperatively, guided by a workflow management system capable of dealing transparently with distribution, autonomy and technological heterogeneity of the content repositories managed by content providers [4].

The processing unit of our environment is called a *peer*. It works as a *gateway* to the environment, providing user's authentication, user-environment interaction control and execution context management. A site is a logical collection of peers sharing a common learning purpose. Users have transparent access to resources within a site.

For cases in which the amount of data or the complexity of the model is huge and/or the services that process them consume huge amount of CPU (e.g. in modeling, simulation and visualization in scientific applications), grid computing gives us a fundamental infrastructure to manage distributed computational resources [5].

3. The TEAM architecture

We designed an architecture, called TEAM^A, based on the classic architectural pattern for heterogeneous database integration consisting of mediator(s) and wrappers. In an overall conceptual view, the architecture is composed of peers that communicate to each other using regular communication links. Peers are functionally identical but some of them run on top of a grid operating system to access resources provided by grid environment(s). There is at least one peer operating in one site.

Each peer in TEAM^A is a stack of three layers characterizing a *3-tier* architectural model.

In the first layer, a web browser or a .NET application, for example, may realize the user interface with the environment, which is a set of web services.

The second layer is the functional core of the architecture and is composed of the workflow enactment service provided by its workflow engine, which manages a convenient portion of the whole workflow instance. An enactment service is *wrapped* by a set of web services that form the interface with the first layer, and another set of web services to accept requests from enactment services of other peers in the network (interface 4 of the workflow reference model as defined by the Workflow Management Coalition). The workflow engines are also responsible for coordinating grid resources allocation. Conceptually, the workflow engine layer, besides being the WfMS, also acts as a mediator, providing to the layer above an integrated view of the distributed execution environment.

The bottom layer of TEAM^A provides persistency to the workflow enactment service layer. It is also wrapped by a set of web services that interface, via JDBC, with the possibly technologically diverse data sources.

For sites running within grid infrastructures, grid services are provided by Globus (see http://www.globus.org/). Peers add to the grid environment the functionality provided by TEAM. From a user perspective, this means that resources provided by TEAM and by the grid can be accessed transparently.

4. Future works and concluding remarks

At LNCC we are developing a grid infrastructure capable of supporting various different types of applications that can benefit from transparent access to grid resources and services. Our intention is to develop a configurable middleware system capable of integrating data and processes in conjunction with grid basic services, such as authentication, file transfer and resource allocation.

TEAM extension towards its integration with grid infrastructure is at its initial phase. We need to integrate user authentication between both environments, and develop a more refined authorization policy that will include information on user rights to access a LO. We need also to extend our current LO storage and query services. As the potential number of partners in a grid environment is considerable higher than in more conservative environments, we need to rethink how our search for LOs will be implemented. Replication is one service we are considering to include within TEAM.

References

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