Agent Mediated Grid Services in e-Learning

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Abstract

This paper presents an agent-mediated e-learning grid services in a layered architecture. A prototype system was developed based on the architecture. It has shown that our method is not only promising but also practical.

1. Introduction

Recently e-learning increasingly addresses learning resources sharing and reuse, interoperability and various modes of interactions. By sharing and reusing the available teaching resources, learners can benefit from very personalized learning paths to fit for individual requirements. Grid computing provides a solution for resource and service sharing. In this paper, we propose a layered architecture in a grid environment for the learning resources sharing and reuse. A multi-agent system (MAS) infrastructure is proposed in the architecture for the management of the distributed and autonomous learning resources, discovery of learning services, and selection of services etc. The agents are modeled using the composite state goal model [1], a goal-oriented modeling method, to enable the agents to autonomously adapt to the dynamic environments.

2. Agent-Mediated Learning Grid Services

As showed in Figure 1, the proposed architecture consists of seven layers. Layer 1 is the Service Provider Application Layer. It indicates the learning resource servers including learning objects repository and other resources installed and executed in each grid. Layer 2 is the Grid Service Layer, which presents the services provided by each grid. They provide various learning services. Their functions are supported by the learning resource servers at Layer 1.

Figure 1 The grid service architecture

The Marketing Service Agents (MSAs) at layer 3 run on individual grid nodes. They are responsible for marketing the services provided on the grid node they are running on. Those agents should have knowledge about the grid services, the hardware performance of this computing resource, and all applications installed on it. Layer 4 is the Information Service Center (ISC) layer containing global grid information service including grid services advertisement, service yellow
pages, etc.; agent management service including agent information services, ontology services, etc.; and global learning information service including learning object meta-data database, etc. The Service Agents (SAs) at Layer 5 are running on each grid that requires services from other computing resources (grid nodes). They are in charge of finding candidate services, negotiating with the MSAs and finally selecting the most suitable services.

Layer 6 is the Consumer Applications that present and manipulate learning objects. Learners at Layers 7 will obtain the learning service through the learning applications at Layer 6.

3. Prototype System

A proof-of-concept agent-mediated grid system has been developed in the campus network to simulate grid services of an e-learning system. The client nodes are running the learning applications to serve the learners. The service nodes are running the course management systems that provide learning object services. The ISC contains the information about the grids and the courses available on the grids.

The e-learning system was developed using the grid development toolkit Globus [2] and the agent development tool Jade [3]. Two sets of learning object repositories were managed on the grids.

The MSAs for the two course servers and the SA for the learning application were modeled with the composite state goal model and implemented using the agent framework [1], which we developed for this new type of agents in our previous research, on top of the Jade.

In the experiments, when a learner requested service for learning through a client node, the learning application first assessed the learner to evaluate his current skills. Then a personalized learning path was generated for the learner based on the composite state goal model and the course information obtained through the ISC. The SA then looked for the learning services that can fulfill the requirements through the ISC. After the SA obtained the information of the learning object providers, the SA will negotiate with the MSAs on the candidate grid nodes to select the suitable service provider. The information of the selected grid service will be passed back to the learning applications through the MSA and the SA. The learning application will then setup the connection with the selected learning service provider to obtain the required learning objects.

The attribute values of learning objects and the learner’s expectations were considered during negotiation between the SA and the MSAs. For example, if a learning object has duration 10 hours and skill level 4 whereas the learning object for the same course on another node has duration 8 hours and skill level 3, the learning object selection will be decided based on the learner’s expectation. If the learner likes shorter time, the learning object with shorter duration will be selected. Otherwise, if he wants to learn more, the one with higher skill level will be selected.

Other than the course attributes, both the SAs and the MSAs consider the time and cost constraints. The SAs are able to find the service providers, and negotiate with the MSAs with a simple response-time parameter and a service cost parameter. The service provider is selected according to the two parameters that are set by individual learners. The service constraints have higher priority than the course attributes. That is, if a learner sets these parameters, the agents will first satisfy these constraints.

The experiments show that in an agent-mediated grid computing environment, tasks such as service discovery, service negotiation, and resource scheduling, can be managed by different types of mediators i.e. agents. Therefore the transparency to the environment changes in application development is increased and the system performance is improved.

4. Conclusions

In this paper, agents are proposed as mediators for enabling agent-mediated grid services. Under the layered architecture, the mediator agents are able to act on behalf of learning service providers and learning applications respectively. They communicate and negotiate with each other to reach an agreement to finally setup the connections between a learning application and a learning service provider.

References


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