Integrating E-Learning System Based on Cloud Computing

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Abstract—Integrating resources in e-learning systems and providing smoothly cross-system access can highly extend the learning range and improve learning efficiency. In this paper we made an attempt to establish an e-learning cloud. By reviewing the architecture of traditional e-learning system and concept of cloud computing, we proposed the idea of constructing e-learning cloud to enable e-learning resource sharing without the limitations of cross-system access. By using critical technologies, Self-Organizing network, Intelligence Resource Access Control Policy Various, cloud computing services and Negotiation-based Content Provider, e-learning cloud implements an integration of different pedagogical approaches to learning cross-system.

Keywords- e-learning; cloud computing

I. INTRODUCTION

E-learning system normally provides services in Intranet or Internet for a specified range of users. It is constructed by data center and one or some servers. As shown in Figure.1, There are mainly four modules in traditional e-learning system. Content author module has two functions: the production of video courses and the production of e-learning. Production of video programs can collect image acquisition in real-time, and the object captured in real-time can be produced or broadcasted or controlled or stored by IP-based television production class system. This content can become directly into the object of a further production of those materials. E-learning production can create text-based learning programs and multimedia educational content.

Recently, cloud computing is changing the nature of internet from static environment to a highly dynamic environment, which allows users to run software applications collaborate, share information and create services online [4].

In this paper, we propose an e-learning cloud based on cloud computing. In the rest part of the paper, we give a brief review on traditional e-learning architecture and the concept of cloud computing. Then we introduce the architecture of e-learning cloud. Based on the architecture, we describe the key problem in implantation and give our solution. After that, we summarize the paper.

II. BACKGROUND KNOWLEDGE

A. Traditional E-learning System

E-learning system normally provides services in Intranet or Internet for a specified range of users. It is constructed by data center and one or some servers. As shown in Figure.1. There are mainly four modules in traditional e-learning system.

Content author module has two functions: the production of video courses and the production of e-learning. Production of video programs can collect image acquisition in real-time, and the object captured in real-time can be produced or broadcasted or controlled or stored by IP-based television production class system. This content can become directly into the object of a further production of those materials. E-learning production can create text-based learning programs and multimedia educational content.

![Figure 1. modules in Traditional e-learning system](image-url)
Content management module also composed of two parts: e-learning content management server and content distribution. E-learning content server uses the advanced Internet learning concepts, focusing on the transmission of multimedia, hypertext learning content, focusing on the intercommunication among learners, focusing on learning effect of the inspection and management, focusing on international standards, which is a comprehensive and overall learning management system. Content distribution system is available on centralized management for a large number of large files and multimedia streams, coupled with the contents of the engine in access points, so users in access points can break the bandwidth bottleneck in wide-area network, learn and study improved. Content broadcast station in access points uses content engine technology, which is new terminal content equipment with content delivery network ideas. When users in access points need to do e-learning, they can access to rich multimedia content by visiting the center e-learning website including large files and multimedia streaming accessed from the content network in local network engine, breaking low frequency bandwidth bottlenecks on wide area networks, and achieving true multimedia.

User management module includes three functions: managing user’s basic information, tracing user’s learning schedule and evaluating user’s learning effect. Object effect of learning can be evaluated to help users to make improvement. Thus evaluating the learning effect is the core of the module.

Access control module is mainly used to protect the copyright of the content inside e-learning system. It can prevent illegal trial of accessing without being authorized.

B. Cloud Computing

Cloud computing[5][6] is a model for enabling convenient, “on-demand” network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Cloud computing technologies allow the academic institutions to get access to computing on demand, especially those that do not have the technical expertise to support their own infrastructure. To the end users, the cloud is invisible so the technology that supports the applications does not matter to them. For many institutions, cloud computing offers a cost-effective solution to the problem of how to provide services, data storage, and computing power to a growing number of Internet users without investing capital in physical machines that need to be maintained and upgraded on-site on regular basis by the it support staff.

An important basis technology for cloud computing architecture is virtualization. Based on the different virtual levels, cloud computing is typically divided into three types according to the Packaging of computing resources in different abstraction layers: infrastructure as a service (IaaS), platform as a service (PaaS) and Software as a Service (SaaS) [7].

- IaaS refers to taking the servers, storage systems, network communications equipment and other computing resources as a standardized service via network.
- PaaS, also known as the middle of clouds service, provides a mapping that contains Linux distribution, Web server and programming environment, can be used for various stages of software development, testing, and deployment.
- SaaS is the highest-level of cloud computing applications, and also the layer end-user-oriented. It usually refers to the development of software examples and applications processes based on the specific infrastructure.

In addition, according to the different cloud computing service providers, cloud computing services can also be divided into public cloud, private clouds and mixed clouds.

III. ARCHITECTURE OF E-LEARNING CLOUD

The goal of building the e-learning cloud is to distribute and share resources cross-systems, which is enable users of e-learning cloud use all distributed resources without conscious of the location, format, view tools and access account of resource. To build such an e-learning cloud based on multiple heterogeneous e-learning systems, there are some problems described below:

- Considering the stability and flexibility of e-learning cloud, they are connected by peer-to-peer network. Without a center, how can one system join the cloud and know other systems in the cloud?
- To enable users to access resources flexible as while as protecting the copyright of the resource, how can we design the access policy?
- Media diversity of resources is the feature of e-learning cloud. To make the resources accessible cross-system, what would be implemented?
- Since e-learning cloud provides services towards different termination equipment, differences of the computing capability and communication protocol among equipment should be a consideration aspect.

To achieve the goal of e-learning cloud, we proposed an architecture including 5 layers as shown in Figure 3.

Infrastructure layer is consisting by e-learning systems. In this layer, applications, computing power, storage capacity, programming tools, communications services and collaboration tools of each e-learning system are shared within e-learning cloud.
• Network layer: to maintain all e-learning systems inside the cloud. A self-organization agent is employed in the layer to detect new system dynamically.

• Service layer: to distribute metadata of the resources inside cloud; provide different cloud computing services based on the classification of the resources.

• Content-Provider layer: to negotiate with termination equipment and provide proper content in proper format and accepted communication protocol. An intelligent Content provider is used inside the layer.

• Access control layer: to define common-used policy to make the account in one e-learning system available in other systems in the cloud.

IV. CRITICAL TECHNOLOGIES OF E-LEARNING CLOUD

A. Self-Organizing Network

E-learning cloud is built based on existing e-learning systems. To make the cloud reliable and extensible, we neither rely on a particular server to achieve the management of entire network, nor add/update e-learning systems manually. So peer-to-peer network is used in cloud. Here let’s treat each e-learning system in cloud as a vertex in graph theory. The ideal state is that those entire vertexes create strongly connected graph as shown in Figure 4, which means every e-learning system has the detail information about other systems in cloud.

To accomplish the purpose, we introduce the self-organizing network scanning agent. The agent is the part of every e-learning system in the cloud. In each system, an information list of known systems is maintained. The agent will be executed periodical. The process is like: Agent creates a scan list according to the list of known system; Agent calls web service of each system from the scan list consequently; Agent checks the information list of target system and adds/updates new system information both in scan list and the information list. Agent also published its own information to target system.

When each agent in cloud runs periodical, strongly connective graph in cloud will be created.

The advantages of this technology are: When one or more systems fail for any reason, other parts of the cloud can work correctly; E-learning system can be added or updated into cloud automatically and dynamically.

B. Intelligence Resource Access Control Policy

To protect copyright of course content, there are multiple access grades in most of e-learning systems. When these e-learning systems become part of the cloud, we have to ensure user can access appropriate resources across-systems without break the copyright of the resource. An intelligence resource access control policy is proposed here. In the cloud, we defined 10 grades from 1 to 10 as the standard grades. Grade 1 means the lowest access right and grade 10 indicates the highest one.

![Figure 4. strongly connected graph](image-url)
When a system joined the cloud, it can define the corresponding relations between the standard grades with the grades of its own. Once a user in e-learning system A is trying to access the resources in e-learning system B in e-learning cloud, system A will convert the accessing right to standard grade and submit the standard grades to system B. system B convert the standard grade to the grade using in system B and then decide whether provide the requested resource to the user or not. Figure 5 shows the usage of standard grades.

C. Various Cloud Computing Services

Each type of e-learning system provides different types of course content. When those e-learning systems are integrated into the cloud, we should consider how to present the course content by using most suitable tool. As described above, cloud computing services can be divided into 3 types: IaaS, SaaS and PaaS. Correspondingly we can classify the resource and provide different services as shown in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Course Content</th>
<th>Cloud Computing Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>standard data, such as audio, video, data, images, text, etc</td>
<td>IaaS</td>
</tr>
<tr>
<td>2</td>
<td>Data that can be converted to standard data content of the curriculum</td>
<td>SaaS</td>
</tr>
<tr>
<td>3</td>
<td>Web-based proprietary data (ie, the player embedded in web pages)</td>
<td>SaaS</td>
</tr>
<tr>
<td>4</td>
<td>Private defined data, the player need to download manually</td>
<td>PaaS</td>
</tr>
</tbody>
</table>

D. Negotiation-based Content Provider

Nowadays, many kinds of termination equipment (mobile, PDA, PAD, netbook, pc, etc.) can be used for e-learning system. E-learning cloud should provide flexible enough services for equipment. There are big differences in display size, computing power, network bandwidth among termination equipment. Moreover learners have different demand on the quality of the course content. So it is essential to provide customized, differentiated service in the cloud.

A negotiation agent was designed to negotiate with the termination equipment on the capability. Before equipment request course content, it will send the capability set (like: supported audio and video format, bit rate, bandwidth, Qos etc.) to the agent, agent will try to find proper capability from received set. Once a proper capability is found, agent will notify the equipment and then provide the course content strictly with the chosen capability. In some case, agent will use adaptive media transformer to convert media to proper one and use adaptive protocol translator to create correct service. Figure 6 shows the architecture of the Negotiation-based Content Provider.

V. SUMMARY

In this paper we made an attempt to find the problems lies in cross-system e-learning access. By reviewing the architecture of traditional e-learning system and concept of cloud computing, we proposed the idea of constructing e-learning cloud, which included various e-learning systems, to enable e-learning resource sharing without the limitations of cross-system access. By using critical technologies, Self-Organizing network, Intelligence Resource Access Control Policy Various, cloud computing services and Negotiation-based Content Provider, e-learning cloud implements an integration of different pedagogical approaches to learning cross-system.

Initial test run of e-learning cloud provided a useful feedback from users who used the system. The feedback reveals that this approach provides a much better user experience than the traditional e-learning management systems. Flexible architecture of e-learning cloud is enabling users to utilize heterogeneous set of services that support different learning and teaching activities.

In future, we plan to expand the e-learning cloud and implement more services that are important and useful to users.

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