

Cloud service model for the management and sharing of massive amounts of digital education resources

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ABSTRACT: Current digital education resources are abundant, heterogeneous, region-oriented and changing constantly. The ability to provide a superior digital education resource and improve the efficiency of on-line use and its effectiveness has become an extremely challenging objective. This is especially so, given the massive amount of digital education resources to be managed and shared. Cloud computing is suitable for process-oriented, data-intensive applications, and has obvious advantages for large-scale computing and data processing. In this article is introduced cloud computing for the management and sharing of massive amounts of digital education resources. The work determined an integration and sharing cloud service model for massive amounts of digital education resources. This improves education resource management and sharing, and also improves digital education resource utilisation and effectiveness. Finally, this provides digital education resource users with needed, efficient, dependable and satisfying access to these resources via cloud services.

INTRODUCTION

The Chinese national medium- to long-term programme for scientific and technological development (2006-2020) makes modern education services supported by information technology a focused objective and network education one of the five service applications [1].

The education informatisation development plan for 10 years states: …*Educational modernisation driven by information for the purpose of educational interchange development has become the strategic choice in China's educational development; building of China's education informatisation public service system; the construction of learning society support service system* [2].

Modern education technology is based on the computer and information technology applied to education and teaching. Development of information technology for education will completely change the education support superstructure.

The amount, richness and sharing of information resources in a digital learning environment fundamentally changes the learning process [3][4]. It is important to address how to learn on-line, how to learn by independent discovery, how to use network tools to learn by collaboration and discussion, and even how to learn by creating systems using information processing tools and platforms.

How to deal with plentiful data and services and provide users with a convenient and efficient network service needs to be addressed. Network learning faces the challenges that learners continuously require services and access, including from mobile devices. Ubiquitous learning has higher data and service requirements. At the same time, software, hardware and maintenance costs of the school education technology and network centres keep rising. It is important to find a cost-effective way to provide for the plentiful data and service needs of network learning.

DIGITAL EDUCATION MASSIVE RESOURCE INTEGRATION AND SHARING ON THE CLOUD

A cloud teaching environment represents a new technology by which to support the development of education in the information age [5]. Resources from teachers and students are stored on a cloud platform for the convenience of information sharing [6]. In this study is introduced a cloud computing model supporting massive amounts of digital education resources, their management and sharing.

The model supports cloud registration, organisation and classification management, and a cloud security system. It provides integration and sharing of massive education resources on a unified platform, which is transparent with an efficient access interface. The architecture of the model is shown in Figure 1.

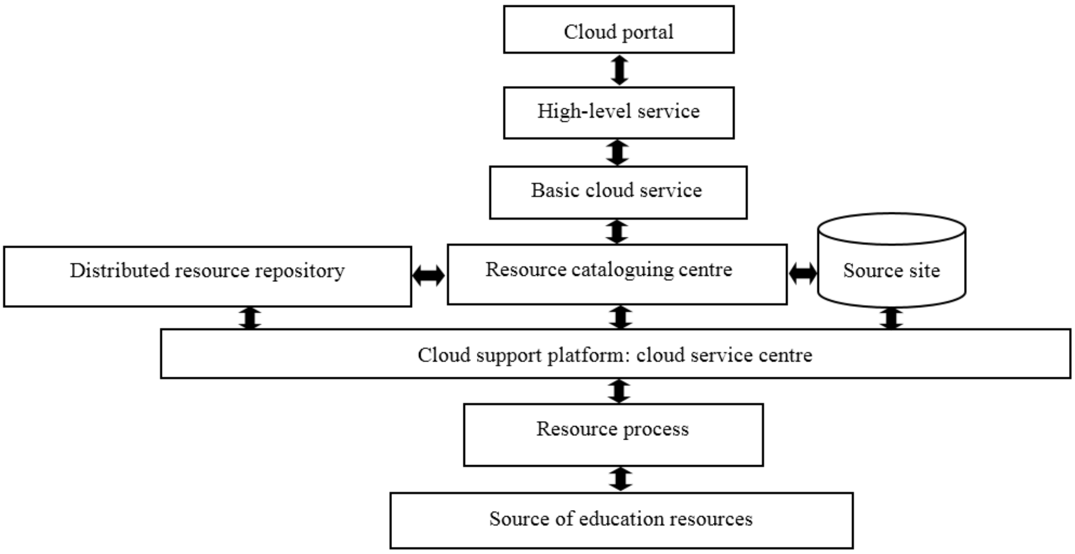


Figure 1: Architecture of a cloud services model for a digital education resource management system.

Cloud Service Centre

The cloud service centre provides support for education and scientific research through virtual cloud computing services. The service centre runs under the distributed computing resources environment of the Hainan Vocational College of Political Science and Law, Hainan, China. Hardware is Sugon Company's high performance server, and the software is mainly Microsoft Corporation's Hyper-V Server (SQL Server). The deployment structure is shown in Figure 2. Some details of the various components follow.

- Cloud service centre front end is the access point for the whole service centre, receiving virtual machine operation requests from users.
- Local virtual management system runs as a back end to the cloud service centre and is transparent to normal users. It manages and configures physical and virtual computing resources of the cloud service centre through Windows PowerShell.
- Virtual machine image and application management pool provide access to the cloud service centre front end via HTTP/HTTPS, so as to manage and distribute users' demands for virtual machine resources.

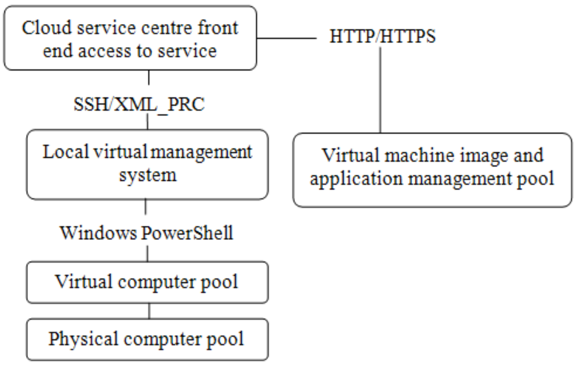


Figure 2: Cloud service centre deployment structure.

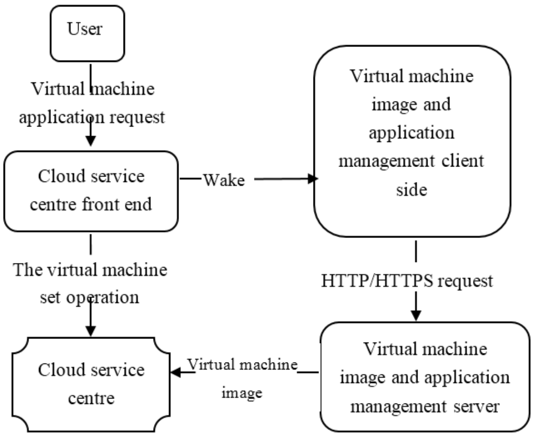


Figure 3: Operation of the virtual machine image and application management pool.

The operation of the virtual machine image and application management pool is shown in Figure 3. Virtual machine image and application management client side is embedded into the cloud services centre front end to generate a virtual machine image. When users submit requests to use virtual machine resources to the cloud service centre front end access, the front end access will wake up the virtual machine images and applications management client side, which sends requests to the virtual machine images and application management server via HTTP/HTTPS. Then, virtual machine storage generates the virtual machine image. The local virtual management starts the virtual machine, which users can now access. The detailed process follows:

- Virtual machine images and application management client access service front end gets the virtual machine parameter set: (Virtual machine name, transport protocol, virtual machine class name, virtual machine system structure, virtual machine image text format);

- and, then, the client side creates an HTTP / HTTPS request to send to the server;
- and lastly, the client side obtains the virtual machine image from the server and places it in virtual machine storage.

This improves resource utilisation and strengthens the management and deployment of massive education resources through the cloud service centre's strategy and implementation. Virtual machines can be deployed and distributed on demand to the users according to application resource requirements and at an appropriate granularity. This results in ideal server load balancing of the entire cloud service centre. The cloud service centre physical server and virtual machine server are logically divided. The division of the virtual machine resources depends on the physical server's computing capacity being adequate. The stability of the entire cloud service at the College is very good.

Digital Education Resources Context Integration Using Ontology Technology

There are massive amounts of digital education resource material from multiple sources and various media. Some of the data are redundant or incomplete or inaccurate. A fusion of the data could obtain an accurate, complete, superior, compact digital education resource collection, which covers the original resource material.

In order to make massive amounts of digital education resources understandable and able to be processed by machine, it is necessary to add accurate semantic annotations. Through the observation and analysis of a large number of digital education resources, those resources from the same field are seen to have an implicit model, which could lead to a more accurate description for this field's digital education resources. The implicit model could be that a specific field's digital education resources follow a common pattern, with certain semantic properties. Ontology could be used to determine a specification of shared concepts and characteristics in one digital education field. So, it will be more conducive to develop the characteristics of digital education resource attributes, if ontology technology is introduced into the semantic annotation of digital education resources.

Finally, semantic conflict and integrative detection mechanisms are introduced, so as to obtain an accurate, complete, semantically rich and superior compact digital education resource collection covering the original data. Ontology technology was used in calculating context fusion, to get semantic annotations of the education resource collection. This could be an important basis for resource acquisition, storage and later processing.

Distributed Education Resource Cloud Gathering Mechanisms

Education resources are distributed on different sites, which form the geographical scope of the distributed education resources network. A resource cataloguing centre runs cloud agent acquisition services in multiple resource sites through the cloud. This could index and produce a superior education resources catalogue for every site. Each site retains a copy of the resource and the cloud agent collection service maintains resource consistency of the resource cataloguing centre and the resources sites. Each resource site can submit hardware, software, teacher, and learning resources to the resource cataloguing centre, using the cloud resource index. Service submission of cloud agent acquisition services and cloud resources index can operate flexibly on the basis of network resource availability at different times. The structure is shown in Figure 4.

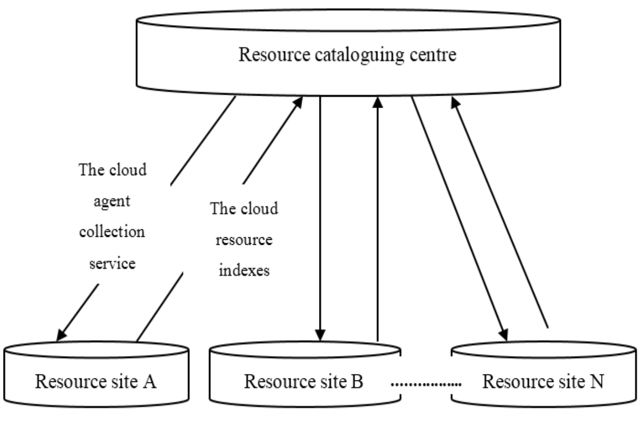


Figure 4: Distributed education resource cloud's gathering mechanism.

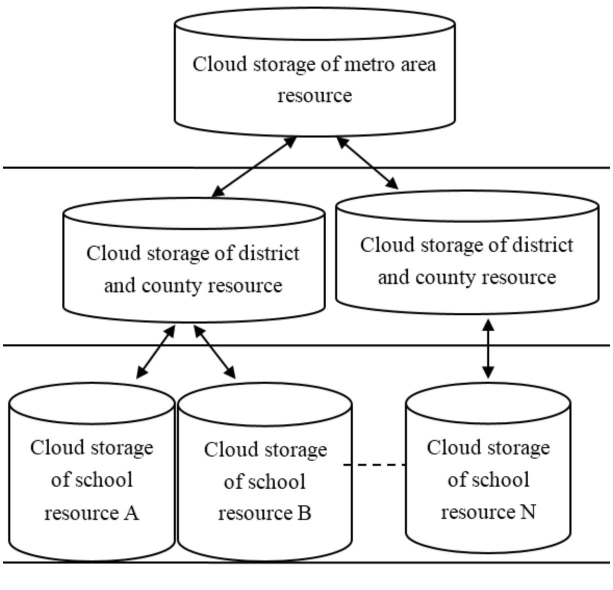


Figure 5: Stratified and hierarchical cloud storage system of education resources.

The double operation of the cloud agent collection service and cloud resource indexes service is flexible and responsive. It can reduce the resource collection network cost and service cost, because it only needs to maintain resource site cataloguing consistency.

Hierarchical Cloud Storage Mechanism for Digital Education Resources

In order to improve the fault tolerance and reliability of the use of education resources, storage areas could be stratified and a hierarchical cloud storage system of education resources could be used. Each level of resource storage makes service requests to a higher level or submits resources to a higher level to summarise. The education resource cloud storage structure is shown in Figure 5.

IMPLEMENTATION AND CASE ANALYSIS

The hardware used is the Sugon Company's 4000A high performance computer, including 32 computing nodes, an I/O node and a management node. The aggregate computing capacity is 600 billion operations per second; the storage capacity is six terabytes. One and a half terabytes of high-quality digital education resources have been accumulated.

Request Processing Implementation for the Cloud Service Centre

The cloud service centre's virtual computing nodes are divided into two types, i.e. master node and slave node. Master and slave nodes differ physically for the sake of efficiency and safety. The master node stores the metadata for the entire system, whereas the slave node stores multiple data copies. Cloud computing systems differ from client systems and do not need a central server. In order to make the cloud computing system work effectively, some nodes must maintain the metadata for the whole system. That is the resource index, the maintenance of which is the master node's main function.

In the cloud service centre, user requests are sent to the master node and, then, distributed to slave nodes for processing. The resource request processing execution framework is shown in Figure 6.

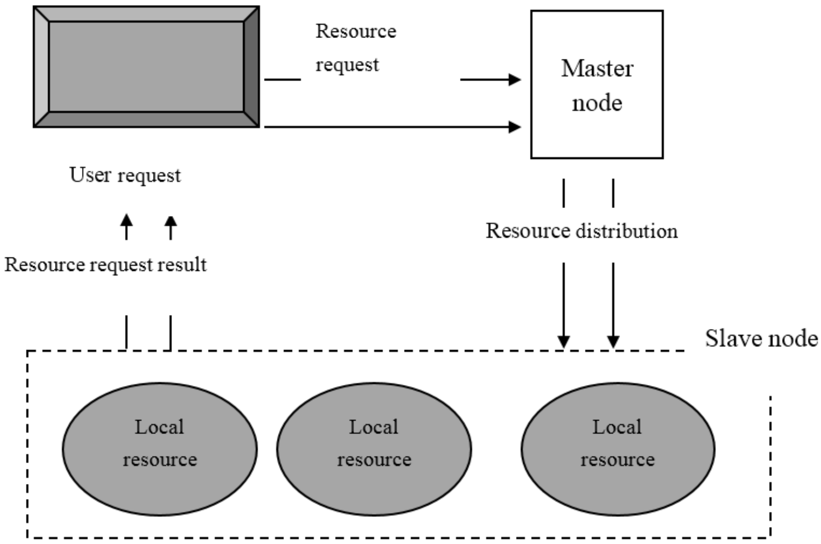


Figure 6: Request processing framework for the cloud service centre.

Cloud Services Education Resource Request Processing

The cloud services for a typical education resource request for resources retrieval is divided into two stages. The resources retrieval request occurs on a slave node. The cloud service retrieves the master node storage resource catalogue. The resource catalogue determines the specific retrieval resources, which, of course, may be stored on the master node. Finally, according to the load balancing of the whole system, the retrieval result will be sent back to the user by the optimal route. Retrieve resources cloud service execution time equals retrieval catalogue time, plus positioning time for the resource, plus time to determine load, plus time to return the results.

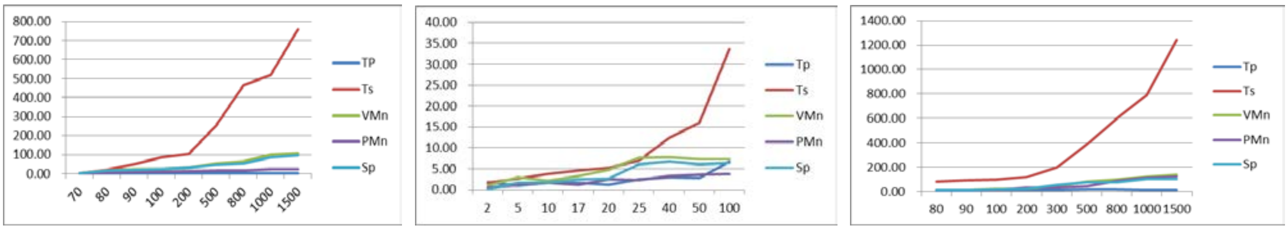
The resource insertion operation is a common service of the cloud service centre. Similar to resource retrieval, resource insertion is divided into determining and, then, operating on the related node. Resource insertion and selection of a slave node is based on the load of the whole system. Resources are inserted into slave nodes with a low load. Then, the master node's resource catalogue is modified, to maintain resource consistency. The execution time for resource insertion equals positioning time for the resource, plus determination of the load time, plus insertion time, plus time needed to maintain consistency.

Resource deletion first retrieves the master node storage resources catalogue. The resources catalogue is used to delete and invalidate the resource collection from the lightly and heavily loaded nodes. It is required that resource consistency of the master node is maintained when the load is low. Execution time of resource deletion equals retrieval catalogue time, plus positioning time for the resource, plus determination of load time, plus deletion and marking time, plus time needed to maintain consistency.

Analysis of Performance

Test results are shown in Figure 7. Retrievals are QS, in units of megabytes; insertions are IS in units of kilobytes; deletions are DS in units of megabytes. The Tp is the multi-virtual machine parallel execution time, and Ts the single virtual machine serial execution time, in units of seconds. The VMn is the number of virtual machines, and PMn is the number of corresponding physical nodes. The Sp is the virtual machine speed-up ratio, which equals the ratio of Ts and Tp.

For a single computing node, the search and insertion times increase as expected with the size of retrievals and insertions. The system had good resource processing efficiency for allocating virtual machines for retrievals, insertions and deletions. The virtual speed-up ratio reflects that the whole cloud service system was good at load balancing and scalability. Resource deletion time is longer than resource retrieval time, since resource deletion needs time to retrieve, delete, and invalidate resources, to maintain resource consistency.



QS IS DS

Figure 7: Execution performance.

CONCLUSIONS

Integration and sharing of massive amounts of digital education resources is a long-term and arduous task, especially, with the expansion of networks, education modernisation and the advent of the cloud era. More concise and effective technical means are needed to provide learners with a more pleasant experience using these resources. In this context, to improve the way massive amounts of digital education resources are managed and shared. The author used cloud computing as the basis for a digital education resource integration and sharing model for a comprehensive digital education resource integration and sharing scheme.

The implementation and case analysis verified that the model could aggregate virtual and physical computing resources on demand, as well as promote and improve the execution performance of massive education resource request processing. This was achieved, while ensuring good overall load balancing and stability. This lays a good foundation, so as to carry out large-scale construction and full implementation as the next step. The work has also provided beneficial experience in cloud computing and a new network computing model.

ACKNOWLEDGMENT

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