

# Research on Computing Resources Sharing of University Laboratories in Education Cloud Environment

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**Abstract.** In view of the common problems of computing resources sharing existing in university laboratories, and combined with the advantages of cloud computing technology in the current education cloud environment, this paper explores the computing resources sharing in colleges and universities. The integration scheme of laboratory computing resources is designed, the sharing mode and operation management mechanism of computing resources are proposed, and the application domain model of computing resources is studied, which is helpful to promote the standardized development of resource sharing, and provides a reference for resource sharing implementation in the education industry.

## 1. Introduction

In recent years, education informatization has risen to the height of national education strategy. Along with the rapid development of cloud computing technology, "Internet plus Cloud" has penetrated into various industries, and "Education Cloud" came into being[1][2]. Generally speaking, "Education Cloud" provides a new type of shared computing model, which integrates the entire IT resources to form a huge resource pool and realize the real resource sharing[3]. It is the migration application of cloud computing in the field of education. In the era of "Education Cloud", resource sharing has ushered in an unprecedented opportunity. This paper studies the problem of computing resources sharing from the perspective of diversification, designs the integration scheme of laboratory computing resources, proposes the sharing mode and operation management mechanism of computing resources, and explores the application fields of computing resources.

## 2. Analysis of the Development and Current Situation of Computing Resources

Computing resources sharing which has been included in national development strategy in the United States, Japan, South Korea and some developed countries, is a topic of global education technology[1][4]. The concept of cloud computing was originally proposed by IBM in the United States. IBM has customized the Virtual Computing Laboratory(VCL) to serve colleges and universities. Then, many well-known universities have successively carried out research on cloud resources sharing cooperation. For example, Stanford University, Massachusetts Institute of Technology and University of California at Berkeley jointly develop a cloud resources cross-university program. University of California at Berkeley, Cornell University and University of Massachusetts Amherst jointly conduct research on cloud computing resources sharing. High-quality resources among universities in developed countries can be highly shared across universities and states, creating favorable conditions for enhancing the innovation competitiveness of universities and



countries. In recent years, with the active promotion and guidance of our government's policies, cloud computing technology has developed rapidly. At present, domestic colleges and universities rely on cloud computing to actively build platforms for teaching and scientific research, however, the platform is mainly open to teachers and students in a limited range. At present, domestic universities rely on cloud computing to actively build platforms for teaching and research[3]. However, the platform is mainly open to a limited range of teachers and students. According to a statistical study in Zhejiang Province, the proportion of open laboratory resources in colleges and universities in the province is relatively low. Universities with an open rate below 10% account for 64.29%, and 10% to 30% account for 19.05%. In recent years, it was found that the following problems about the current status of resources sharing platforms are common.

### *2.1. Decentralized Management and Redundant Construction*

Many colleges affiliated to universities generally build their own computer labs for experimental teaching. In addition to computer laboratories for experimental teaching, some science and technology colleges will also build research laboratories for high-performance computing, which makes computing resources are relatively scattered. It is not conducive to unified management and construction, and there are problems of redundant construction.

### *2.2. Insufficient Depth and Scope of Resources Sharing*

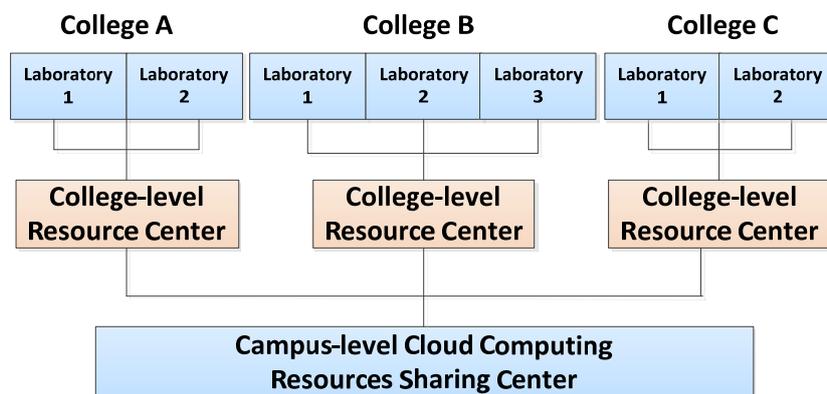
Some universities have built a resource sharing platform based on cloud computing, but it is only open to teachers and students within the campus. There are many barriers among campuses. Resource sharing should not be involved in the school alone, but also be extended to a certain region, especially the whole province and most schools across the country. In addition, the functions of the existing resources sharing platform are relatively simple, some of which are for experimental teaching and some for scientific research. We should expand the functions, integrate teaching and research, and enable resource sharing to communicate in a deeper level.

### *2.3. Lack of Standardized Resources Sharing Architecture*

In terms of the current situation of laboratory resources sharing in colleges and universities, most of them do not have a perfect sharing architecture and mechanism, and there are no overall sharing plans. The content and sharing mode of shared resources show great randomness.

## **3. Integration Scheme of Computing Resources in University Laboratories**

The resource integration and sharing in university laboratories are not isolated, but interactive and mutually promoting. With the continuous fusion development of modern disciplines, we should continue to improve and optimize the laboratory's own functions, expand the scope of laboratory's computing resources to meet the needs of the development of teaching and research[5]. It is necessary to implement the scientific integration program of computing resources, to achieve the mutual openness, mutual cooperation, resources sharing and collaborative innovation among laboratories, colleges, schools, regions, and school enterprises, so that the laboratories mainly based on computing resources can transform into the integrated service of teaching, scientific research and management. The integration scheme of computing resources in colleges and universities is carried out according to different types and levels, as shown in Figure 1.



**Figure 1.** Integration scheme of computing resources in university laboratories

### 3.1. Integration of Computing Resources in Different Functional Laboratories within College

In the early stage of laboratories development, the traditional laboratories mode were decentralized, closed and inefficient[6]. Most laboratories were set up according to the curriculum, and belonged to the teaching and research sections. For example, in our university, three departments affiliated to Information Science and Technology college have their own image processing laboratory, computer application laboratory, data structure laboratory, information security laboratory, etc. From the actual situation, it is possible to centrally integrate and manage large-scale computing resources which contain mainly computers and servers, to establish a college-level data resources experiment center, and to carry out comprehensive and innovative interdisciplinary experimental projects and scientific research[7]. It will fully reflect the continuity and integrity of the entire laboratories of college.

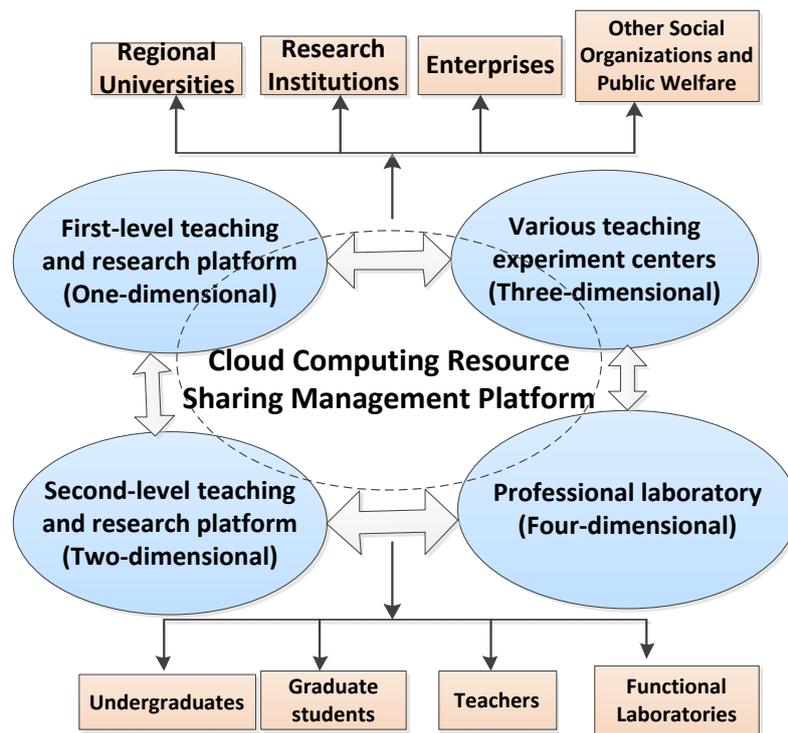
### 3.2. Integration of Computing Resources of in Same Functional Laboratories Across Colleges

After adjusting the computing resources of each college laboratories, due to the basic supporting role of computing resources[8], there are still computer laboratories with similar functions in different colleges. It is necessary to integrate the computing resources across colleges, establish a campus-level cloud computing resources sharing center, and provide computing resource data services for the whole campus. The resources integration work of the laboratories has fully utilized the cross-disciplinary advantages of computers and achieved the optimization of resource sharing.

## 4. Sharing Mode and Operation Management Mechanism of Computing Resources

### 4.1. Open-sharing Mode

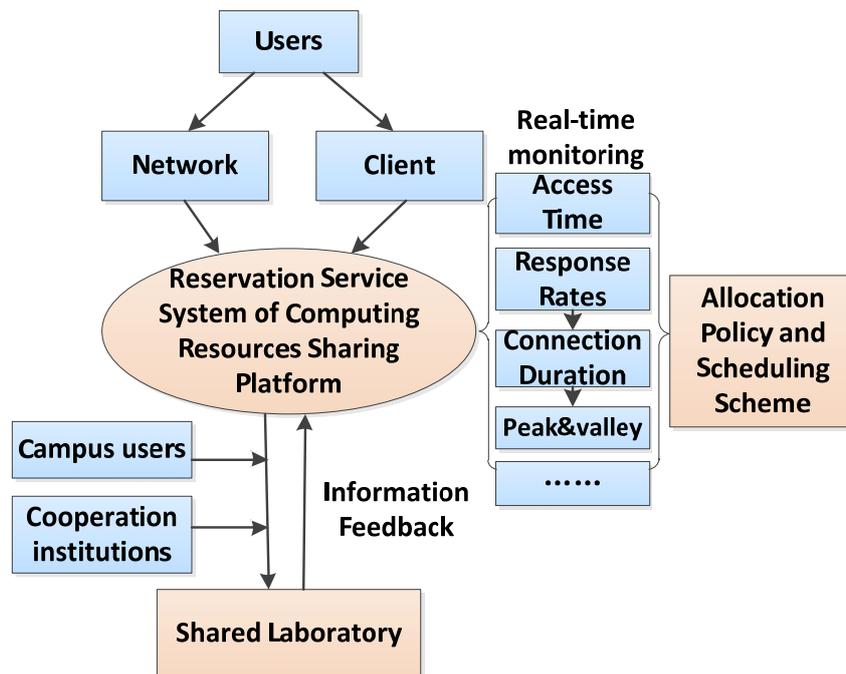
Through the integration of superior resources and teams, a multi-dimensional and integrated management and service framework of teaching and research is formed, which is based on the first level teaching and research platform, linked by the second level teaching and research platform, and centered on the third level teaching experiment centers and various laboratories. It is open for undergraduates, graduate students, teachers and functional laboratories and connects with regional universities, scientific research institutions, enterprises, other social organizations and public welfare, so that all kinds of platform resources can be organically combined and connected with each other. Laboratories resources have changed from mutual non-communication to information resources sharing and complementary advantages. The resources open-sharing mode based on cloud computing is designed, which proposes an open-sharing service mode of four-dimensional linkage, complementary advantages and various levels, as shown in Figure 2.



**Figure 2.** Resources open-sharing mode based on cloud computing

#### 4.2. Sharing Management Mechanism

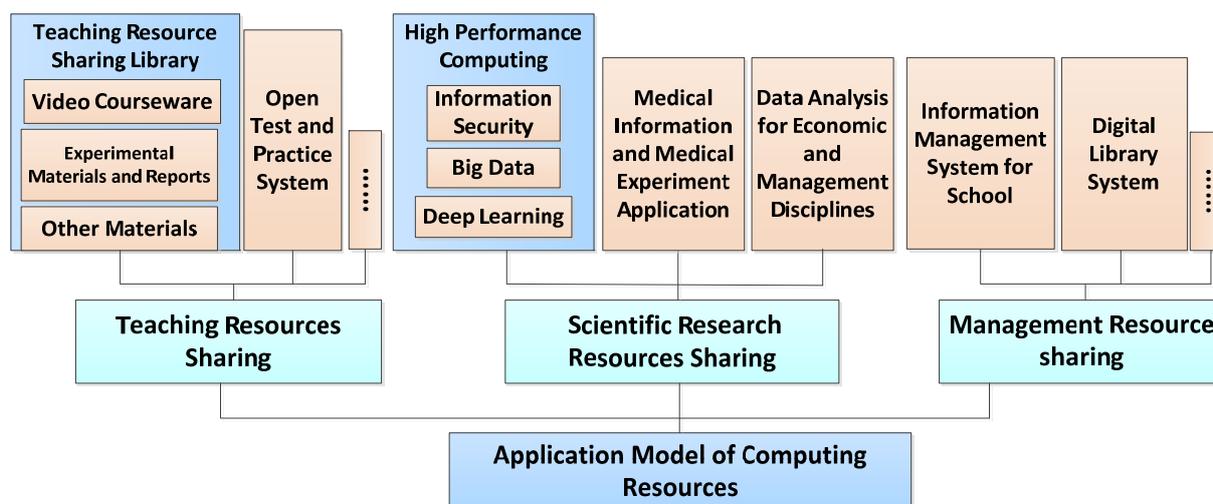
As shown in Figure 3, the shared laboratory management mechanism improves the traditional manual reservation mode in the management mode to realize the information reservation service management. Through close communication within and among universities, information feedback mechanism is established to evaluate the use efficiency of resources. At the same time, through platform real-time monitoring, data indicators are collected and data such as access time, response speed, connection time, peak valley is mined for analysis, in order to adjust the background allocation strategy and online scheduling in real time for performance optimization. Background allocation strategy and online scheduling are adjusted in real time to optimize performance. The platform has stepped onto the scientific and standardized management track, and the overall operation management mechanism has realized the virtuous circle of the closed system.



**Figure 3.** Management mechanism of shared laboratory

### 5. Application Model of Computing Resources

The sharing and management of computing resources in colleges and universities can promote the development of education in universities and provide a strong technical platform for the development of teaching, research and management[9][10]. From the perspective of the application field of computing resources, the application model is designed as shown in Figure 4. First, the teaching resources sharing can absorb advanced education concepts such as micro-curriculum and MOOC, then integrate high-quality information resources to establish a shared library of teaching resources, which is shared and exchanged among universities. At the same time, an open question bank system is established for the practical courses in need, which can provide mock examinations and online exercises, so that the experimental habits of teachers and students are not limited by time and place, and meet the diverse learning needs. Second, scientific research resource sharing can provide high-performance computing resources for colleges and universities and scientific research institutions to carry out information security such as information security, big data, deep learning, etc, as well as provide technical support for application of medical information and data analysis of economic management research[11]. In addition, it can also provide platform support for the construction of national or provincial engineering technology centers, college students' innovation practice bases and other innovative laboratories, and will actively promote the development of national, provincial and ministerial scientific research projects. Third, management resource sharing is mainly used in information management systems and digital libraries university[5], which provide unified resource allocation and management to serve teachers and students.



**Figure 4.** Application model of computing resources

## 6. Conclusion

The resources open-sharing based on cloud environment which is a major trend in the reform and development of university laboratories in China, has great significance. The Chinese government fully recognizes the importance of education informatization and resources sharing, and has successively issued a series of strategic development documents. The “National Medium and LongTerm Science and Technology Development Plan(2006-2020)” requires that the scientific and technological resources sharing be listed as an important part of the national construction for science and technology innovation system[12]. In early 2019, “Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area” advocated innovation and integration of high-quality education resources in the Guangdong-Hong Kong-Macao Greater Bay Area[13]. The development of open-sharing computing resources is conducive to optimize laboratories resources allocation in colleges and universities, greatly saving the investment in the overall laboratory construction costs. At the same time, it is conducive to improve the management efficiency of the laboratories and the experimental platforms, greatly increasing the utilization rate of laboratories resources. It is also conducive to realize the balance and fair distribution of education resources, and promote the cooperation development of the overall education level in colleges and universities. This paper first analyzes the problems existing in the current university laboratories computing resources sharing, combines computing resources sharing and cloud computing technology with its advantages in the current educational cloud environment. Then the integration scheme of computing resources between college-level and campus-level is proposed, and the sharing mode of computing resources and the operation management mechanism of shared labs are also proposed. Finally, application model of computing resources is studied. The realization of computing resources open-sharing which can break the barriers among laboratories, universities and regions, provide a reference for the co-construction and sharing of laboratories resources in higher education institutions in China, accelerate the pace of co-construction and sharing of high-quality resources in higher education institutions, and promote the development of resources sharing in higher education institutions.

## 7. Acknowledgment

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