Integrated Management System of Instrument and Equipment in University Financial Media Laboratory Based on Hybrid Cloud Architecture

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Abstract. Drawing lessons from previous research results, design an integrated management system for instruments and equipment in the university's media converged laboratory based on a hybrid cloud architecture. The device basic information management module mainly defines the basic information of the device, and registers all the information of the device or changes in all the information. The equipment scrap management module realizes early warning of scrap information and processing of scrap applications for scrap equipment. The function of the equipment maintenance management module is to realize the recording of information about the periodic quality inspection and maintenance of test equipment and other equipment in the laboratory. Equipment accessories management module is mainly to add, delete, maintain and query equipment accessories information. Register the information of Equipment Distribution Department through the equipment distribution management module. The system management module is responsible for the basic user information and other basic settings. The system uses firewall technology to isolate and protect the user network from the server. Test results show that the system function and performance are good, can be put into use.

Keywords: Hybrid cloud architecture · Financial media · Data migration service · Laboratory equipment · Information dispersion algorithm · Integrated management

1 Introduction

For the university financial media laboratory, the traditional equipment management mode can not meet the current needs because of its backward equipment management mode and slow processing speed. The demand of modern equipment management information system is particularly urgent [1]. Modern equipment management information system adopts advanced computer technology and network technology, and integrates modern management concepts and methods for equipment management. Through the equipment management information system, ensure that the equipment is always in a good state of operation, give full play to the potential of the equipment, and improve the

S. Liu and X. Ma (Eds.): ADHIP 2021, LNICST 416, pp. 587–600, 2022.
https://doi.org/10.1007/978-3-030-94551-0_46

operation efficiency and economic efficiency of the equipment [2]. With the improvement of production management informatization, the informatization modernization of equipment management needs to realize the informatization of basic information of equipment first. In daily management, the equipment information is unified planned into the management system. With the help of the real-time characteristics of the computer system, the equipment information data can be quickly and accurately counted, and the summary and analysis reports can be automatically generated. It provides an effective means for the integrated management of laboratory equipment.

After more than 20 years of development, the laboratory information management system has made great progress in both design and application technology. Especially with the development of today's network society and the acceleration of information exchange, more and more new international standards have been determined, more and more laboratory information management systems have been put on the market, some products have also appeared the development trend of "homogenization", and more and more manufacturers have turned to the competition of price and service. Users are more willing to accept suppliers with good service and strong company strength. More and more manufacturers begin to pay attention to the development of products from the perspective of customer needs, based on cost saving, and from the details to improve the user experience. The development of laboratory information management system is a special management system developed with the development of computer information technology. In the aspect of system architecture, it has experienced different stages from C/S architecture to B/S architecture. C/S architecture is mainly used in the developed regions of local area network. With the development of Internet technology, the B/S architecture model based on Web server has become popular. Through web application, the cost of client application is reduced, and the number of user groups is expanded, and the user area is no longer restricted. With the contact of customers to computer information technology, more and more customers no longer focus on the function, and the requirements for user experience are also higher and higher. Many LIMS system suppliers also value the R & D investment of related technologies. The laboratory information management system based on C/S architecture has experienced the development and evolution mode from two-tier architecture, three-tier architecture to multi-layer architecture. Traditional C/S architecture system, fat client software is not easy to deploy, thin client has complex development, need to use the network, users lack of good experience. But with the development of C/S architecture technology, the problems such as data synchronization and deployment are gradually eliminated or become non main contradictions. Based on these two architectures, an integrated management system of instrument and equipment in university financial media laboratory is designed based on hybrid Cloud Architecture.

2 Design of Instrument and Equipment Integrated Management System of University Financial Media Laboratory Based on Hybrid Cloud Architecture

2.1 System Architecture Design

Based on the hybrid Cloud Architecture, this paper designs the instrument and equipment integrated management system architecture of university financial media laboratory. The

core of the architecture mainly includes five parts: main service, data storage service, data restoration service, data migration service and access statistics service, and cloud storage access component [3].

The main service provides a friendly, easy-to-use and flexible user interface for applications and clients to complete the functions of data file access and resource management. The main service forwards the specific data processing request to other services for completion. The data control module responds to the user's request for file storage and acquisition, and forwards the request to the data storage service or data restore service to complete the operation. In addition, the data migration service can be called by the data control module to complete the migration of data files. The cloud storage management module interacts with private cloud or public cloud storage service providers based on cloud storage access components, manages the joining and exiting of cloud storage resources, configures the parameters of cloud storage service providers, monitors the load status and connection status of storage resources, and feeds back to other modules in time. The data management module is used to manage the information of system data files. The functions between the main service and other services are fully integrated. According to the scale of the hybrid cloud storage system, different ways such as program interface, WEB service or message queue can be used for communication coordination.

Data storage service: the data splitting module uses IDA algorithm to block the data, and records the metadata of the data block for data query and recovery. The data security module can be used to encrypt and sign the data symmetrically to ensure the confidentiality and integrity of the data [4]. The storage scheduling module determines the data storage strategy and calls the cloud storage access component to complete the storage function.

Data acquisition service: it is used to obtain data from private cloud or public cloud. Data security module is responsible for data decryption and integrity verification, restore scheduling module queries data block meta information, determines data file acquisition scheme, and data recovery module restores original data according to IDA algorithm.

Data migration service and access statistics service: the implementation of data migration service is to solve the problem that the cloud service provider replacement and data storage solution are not optimal, and run automatically according to a certain cycle or directly called by the main service. Access statistics service makes statistics on the access of data files in cloud service providers, providing assistance for data storage and migration.

Cloud storage access component: it is called by other services in the form of component. The private cloud access module encapsulates the interface of the private cloud, and the public cloud access module provides a unified access interface for all cloud service providers in the system to complete identity authentication, access, storage management and other operations [5].

Data processing in hybrid cloud architecture is completed by data storage, data acquisition, data migration and access statistics services. Data storage: the user uploads the data to the main service through the service interface. After the latter is delivered to the data storage service, the data storage service first determines whether the storage space occupied by the private cloud has reached the threshold set by the system. If not,

it indicates that the private cloud has enough space to store the user's data. At this time, the system directly stores the data file and generates metadata to write to the server database, otherwise it indicates that the data needs to be uploaded to the public cloud space. If the user sets the encryption mechanism for the data stored in the public cloud, the data encryption is completed first. Then the system uses the cloud service provider selection algorithm to determine the storage scheme, calls the information dispersion algorithm to divide the data into blocks, and generates data files and metadata of data blocks, including file size, storage location and other information. After the metadata is written to the database, the system puts the data block into the upload queue to wait for uploading to the public cloud storage space.

When the data acquisition service responds to the user's data download request, it first obtains the metadata of the requested data file from the database, so as to know where the data file is stored: if it is stored in the private cloud, the system directly accesses the private cloud to obtain the data and returns it to the user; When the data needs to be obtained from the public cloud, in order to improve the access performance, the system sets a certain size of cache space in the server hard disk. If the data file is in the cache space, it can be directly obtained and returned to the user. Otherwise, the system calculates the current best data block download scheme and accesses the public cloud to obtain the corresponding data block. Finally, the merged complete data file will be cached to the local cache and returned to the user. The existence of public cloud cache space enables some frequently accessed data to be obtained directly without acquiring data blocks from the cloud and then merging them, which improves the performance of data acquisition to a certain extent [6].

Data migration and data access statistics: in a reasonable storage architecture, the access history of data files should be established, which can be queried by users and system administrators. Based on this, the data access statistics service classifies and statistics the data file access, and provides support for cloud service provider selection and data migration implementation in public cloud data storage. The binary relation of file type and file size only identifies a kind of access statistics data. When the file type is the same and the integer value after rounding is the same, the two files are considered to be the same classification. The access statistics service maintains the statistics in the following ways: when the user stores the data files to the system, the total cumulative quantity of the matched classification statistics increases accordingly; Access statistics service regularly scans metadata information of data files in the system, and updates the total storage time and total number of visits in the statistics. Based on the access statistics, the system can make a simple prediction of the data file storage when the data is stored. The predicted storage time and the number of downloads in the storage time can be set as the average storage time and the average number of visits. The more data in the system, the closer the access statistics are to the actual storage situation, which makes the selection strategy of cloud service providers more reasonable when the system is storing data. After the system uploads data to the public cloud, the storage scheme composed of cloud service providers may not be optimal in actual situation, or there is a certain difference from the expectation, and the data migration service will be adjusted automatically. Migration service scans the data files stored in public cloud periodically according to the cycle, recalculate the storage scheme for the data files that have reached

the predicted storage time, and when the migration cost is relatively small, the cloud service provider can be replaced for data migration.

In the system architecture, the Vandermonde matrix in the information dispersion algorithm is as follows:

$$P = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ 1 & 2 & \cdots & n \\ 1 & 4 & \cdots & n^2 \\ \vdots & \vdots & \vdots & \vdots \\ 1 & 2^{m-1} & \cdots & n^{m-1} \end{bmatrix} \tag{1}$$

In formula (1), n and m represent natural numbers.

The identity matrix in the information dispersion algorithm is as follows:

$$R = \begin{bmatrix} 1 & 0 & 0\cdots & 0 \\ 0 & 1 & 0\cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0\cdots & 1 \\ 1 & 1 & 1\cdots & 1 \\ 1 & 2 & 3\cdots & n \\ \vdots & \vdots & \vdots & \vdots \\ 1 & 2^{m-1} & 3^{m-1} & n^{m-1} \end{bmatrix} \tag{2}$$

2.2 Design Equipment Basic Information Management Module

Equipment basic information management module mainly defines the basic information of the equipment, and registers all the information of the equipment or the changes of all the information. It mainly manages the classification and abstract properties of the device definition, and the main design operations include adding, deleting and modifying. This module is part of the daily management of the most commonly used devices. The requirement of equipment information management is to record the information of the whole process from adding equipment to abandoning equipment. Specifically, management involves the steps of registering storage devices, establishing and maintaining device card information. Warehousing registration is the storage of registration information of warehousing equipment or materials, the storage of equipment information and equipment log, and the establishment of equipment account information. Device information modification is to modify the error information, which is generally the error in the process of device input registration and distribution, in order to ensure the correctness of data information. The query module can be used to query system data and generate business reports [8]. It mainly includes equipment inventory statistics, equipment usage statistics, equipment storage statistics, equipment scrap statistics and equipment maintenance statistics.

Design and implement the equipment basic information management module to realize the management of fixed assets of the laboratory. Through the construction of equipment information files and use logs, it is convenient for the equipment management personnel to allocate the equipment. At the same time, the management personnel can understand the risk of equipment management in time, and achieve risk early warning and control in time. In the process of equipment information query statistics, we can query according to different conditions, and set the priority of the query, so as to filter the equipment information.

The activity diagram design is shown in Fig. 1.

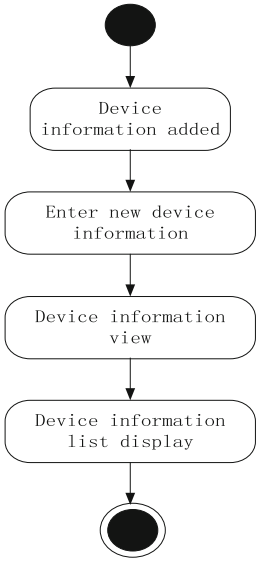

Fig. 1. Activity diagram of equipment basic information management

2.3 Design Equipment Scrap Management Module

The equipment scrapping management module realizes the early warning of scrapping information and the processing of scrapping application of scrapped equipment. Scrap management realizes the creation, maintenance and approval of scrap application information. After the approval of scrap application, scrap information is recorded, including time, reason and operator. Database to save the corresponding data [9]. In the system design, the scrapped database is designed and implemented to mark the scrapped equipment. It is convenient to query scrap information.

The activity diagram of equipment scrap management is shown in Fig. 2.

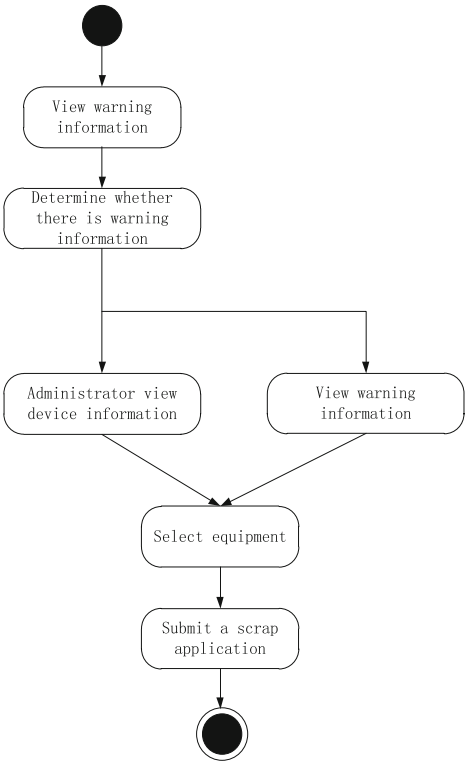

Fig. 2. Equipment scrap management activity chart

The function of this module is to manage the equipment scrap information. The process flow is as follows: the system will make an early warning for equipment scrapping, the equipment administrator will put forward an application for equipment scrapping, the authorized personnel will approve it, and the financial personnel can view the scrapping information for corresponding financial processing.

2.4 Design Equipment Maintenance Management Module

The function of equipment maintenance management module is to record the regular quality inspection and maintenance information of test equipment and other equipment in the laboratory. The main record information includes the setting of maintenance period and the basic management of maintenance date. During equipment maintenance, change the equipment status, create and modify equipment maintenance records, and delete equipment maintenance records. In this module, it also supports the view of equipment maintenance record information, and allows the view of equipment maintenance record information in the way of log view.

2.5 Design Equipment Accessories Management Module

Equipment accessories are the parts information needed in the maintenance or use of the equipment. The equipment accessories management module is mainly used to add, delete, maintain and query the information of equipment accessories. For the purchased accessories, the information can be added and modified according to the specifications and models, and the quantity of used accessories can be maintained. Provide the corresponding query conditions to query the information of equipment accessories. Equipment accessories management is similar to the design of equipment basic information management module, which will not be repeated here.

2.6 Design Equipment Allocation Management Module

The equipment purchased from the laboratory is used by special departments or personnel or departments, which needs to be realized through the equipment allocation management module in the system. When the equipment is allocated, the equipment allocation department, person in charge, equipment number, operator, equipment use function and other information are registered through the equipment allocation management module. For equipment such as consumables, record the number of users and the name of consumables. The function of equipment allocation management module includes the registration of equipment allocation information and the management of equipment allocation application [10]. The system approval user can process the equipment allocation application, and the applicant can view the application status.

2.7 Design System Management Module

As the basic management function of the whole laboratory equipment management system, system management is operated by the system administrator to complete the basic settings of basic user information, role authority matching and organization allocation. It is mainly used for system user data, system security, organization management and user authority control. User management registers the users of the system, and combines with the authority control subsystem to determine the user's operation authority and department ownership. It includes: user basic information management; User account: the account and password of the person logging in to the system; User role: determine the role permissions of personnel. In the process of business authorization, users can be grouped. A user can belong to multiple groups at the same time. By authorizing to groups, business function permissions can be authorized to users at the same time. The main task of department management is to set up and maintain the organization of the company. The goal of the system's authority management is to complete the authority assignment of the user role, and the purpose is to enable the personnel with the corresponding role to have the corresponding business operation authority according to the established user needs. In the design of the system, the business operation is realized through the business operation module, that is to say, the assignment of permissions is the operation control of the business module, that is, users with corresponding user roles are required to be able to modify, add, delete and query the module. Users without

corresponding permissions can only operate some modules in the system. In the permission design of this system, in order to facilitate the management, the permission group management is set. The modification and addition and deletion of design basis are the basic permissions, and then the approval and query are set as permission groups. Each group is defined as a permission when the administrator sets it. Role management is mainly designed for the user role in the second chapter of the system. The role of the user in this system is horizontal management. Through the definition and management of the role, the effective allocation of the role corresponding to the authority is realized, which greatly reduces the workload of the system administrator. It is also convenient for the control of authority.

2.8 Design System Network Topology

In order to improve the robustness and security of the system, the system uses firewall technology to isolate and protect the user network and the server, so as to ensure the information security. And the use of dual database to ensure the reliability and stability of the system, the backup database will use hot backup method for synchronous backup, considering that the data transmission volume of the system will not be large, so the hot backup method will not have a significant impact on the efficiency. In addition, in order to improve the system performance, the application server and database server are combined to separate the data management and processing from the client. The use of database server can reduce the amount of programming, it provides a standard interface API for data manipulation, and can better ensure the security of the database. It provides monitoring performance, concurrency control and other tools for the database server. The system uses J2EE platform for development, uses web logic as the application server, considers the dynamic function of Java in network development and deployment, and introduces the standard of Java enterprise. Through the combination of these methods, the network security is greatly improved.

2.9 System Hardware Design

The basic configuration of the system is as follows:

CPU: Intel(R) Pentium(R) M 786 MHz 2.13 Gz;
Hard disk space: 200 GB;
Memory: 2 GB.

3 System Test

After the completion of the system design, through professional testing methods and tools, the completion of the test system design is consistent with the expected requirements. This chapter describes the purpose, scope, tools, process and results of the system.

3.1 Test Overview

The system test is to test the function and performance of the equipment management system. Through the system test, we can obtain the throughput, load capacity, response capacity, stability, reliability, security and scalability of the system, verify whether the system function meets the design requirements, and optimize the system design and improve according to the problems in the test process. Test the accuracy, tolerance and recovery ability of the database operation of the system. First of all, the test of the system is not simply because of looking for errors, but to analyze the error of the system, find the defects of the system, improve the software, and error analysis can improve the efficiency of the test. In addition, when there is no error in the test, it is also very important to test the quality of the system. The object of system testing needs to cover the hardware and software of the whole system, including the software and its dependent hardware, peripherals and so on.

The flow chart of the system test is shown in Fig. 3. The final purpose of the test is to verify whether the system meets the requirements and specifications and achieves the system indicators.

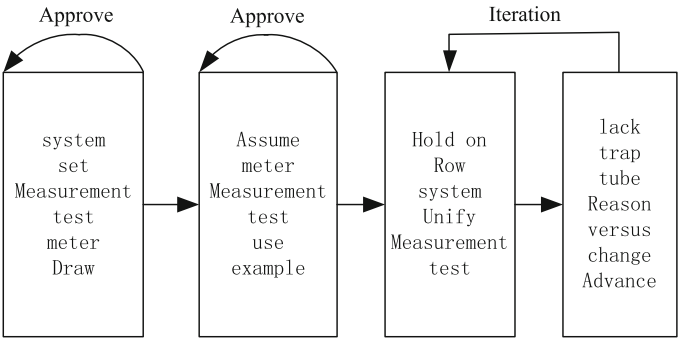

Fig. 3. Flow chart of system test

3.2 Test Purpose

The purpose of this test is to verify the functions and system performance of the laboratory equipment management system, mainly to obtain the following test indicators. Correctness: the system should be able to ensure 100% accuracy of data input, output and data transmission. Robustness: robustness requires the system to have a certain degree of fault tolerance. It requires the system to be able to remind rather than crash when illegal data is input. It requires the software to prompt in time when there is a problem. When the hardware is abnormal, it is required to be able to save the data at the first time, and the fault recovery can continue to work. Reliability: the system is required to have good reliability, and the operation failure rate caused by the system is required to be less than 0.5%; It is required that the average repair time of the system should be less than 5 h, and the number of unexpected downtime should be less than 2 times/year.

Performance, efficiency: the average page response time is less than 5 s. Security: the system is required to have good design in data backup, security prevention and security control. Scalability: the system can allow technology updates and new business modules to be added in the next 2–3 years.

3.3 Test Tools and Test Environment

Test Tools
The system is divided into two parts: function test and performance test. Among them, the function test is completed by making test cases and then executing them manually, while the performance test needs to be implemented with the help of tools. The performance testing tool is LoadRunner developed by mercury company, which is used to test the performance of the system.

Testing Environment
The test environment is shown in Table 1.

Table 1. Test environment

Environment	To configure	Operating system/software
Application server	CPU: 4*3.0 GHz Memory: 8 GB Hard disk: 500G network card: 100 Mbps/1000 Mbps	Windows Server 2003 SP3 Tomcat6.0
Database server	CPU: 2*3.0 GHz Memory: 4G Hard disk: 250G network card: 100 Mbps/1000 Mbps	Windows Server 2003 SP3 Oracle11g
Client	CPU: 2*2.8 GHz Memory: 2G Hard disk: 750G network card: 100 Mbps	Windows 7/ Windows XP SP3 Windows IE Windows Office 2007

3.4 Functional Testing

The function test of the system is used to verify whether the functions of the laboratory equipment management information system meet the needs of users. Test cases will be designed for all functions of the system, and then tested one by one.

After testing, it is found that the system functions meet the needs of users and design.

3.5 Performance Testing

This system will use LoadRunner's virtual user generator engine to build system load, through which virtual users can be generated, so as to simulate the business operation behavior of real users. The engine first records the business process, and then converts it into a test script. Considering that there will not be too many visitors to the laboratory equipment management information system at the same time, we will simulate the situation of 10 users online at the same time to test the concurrent operation pressure of the system.

The results of the performance test are shown in Table 2. Through the additional test of the system performance under the conditions of 5, 10, 50 virtual users respectively, and comparing with 100 virtual users, we can find the change rate of the system performance with the increase of the number of users.

Table 2. Test results of system concurrent operation pressure

Serial number	Number of virtual users (people)	Average response time (S)
1	5	0.86
2	10	0.98
3	15	1.19
4	20	1.46
5	30	1.83
6	50	2.17
7	60	2.69
8	70	3.17
9	80	3.82
10	90	4.35
11	100	4.71

It can be seen from the test result table that when there are 100 concurrent users operating on the system at the same time, the average response time is 4.71 s, which is in line with the expected results and meets the performance indicators of the system requirements.

3.6 Software Test

All functions of the system software are tested, and it is found that all functions of the software have been realized. Now the quality of the software is evaluated in several aspects: after three rounds of testing, the execution rate of test cases is 100%, the test execution is full, the pass rate of test cases is 99.54%, and the defect remaining rate is 1.38%. The defect rate and the number of residual defects have met the quality control

requirements of the company, so we can end the testing stage and enter the next stage. The main purpose of this test is to test the software functions. All the software functions in the requirements have been realized. In the last test, the new functions have been fully tested, and the defects have been corrected and the final verification test has been carried out.

4 Concluding Remarks

The design system has been formally put into operation. During the operation of the system, it is found that the system runs stably and the business process is easy to operate. Therefore, the further research of the next step of the system will mainly focus on solving the problem of printing functional defects, and develop functional modules more suitable for the new business of laboratory equipment management.

With the continuous increase of test instruments, the amount of in-vehicle test data will increase by at least an order of magnitude. Therefore, it is necessary to consider the big data and data visualization of test data to further improve the efficiency and readability of data.

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