# Design of a Cloud-Based University Sports Information Management and Big Data Service Platform

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**Abstract.** This research aims to design and implement a cloud-based university sports information management and big data service platform to enhance the efficiency and quality of sports information management in higher education institutions. Traditional sports information management relies heavily on manual processes, leading to issues such as low efficiency and data isolation. This platform integrates cloud computing and big data technologies to achieve efficient data processing, secure information storage, and convenient data sharing. The platform's processing capacity has been increased from manually handling a few hundred megabytes of data to automatically processing over 5 gigabytes per day, significantly improving the efficiency of sports information management. Additionally, the introduction of encryption and access control mechanisms effectively ensures data security and privacy protection. Through the application of this platform, not only has the quality of sports teaching and research been improved, but it also provides a digital solution for sports facility management. This platform offers a new perspective and approach to the informatization of sports in higher education institutions, demonstrating the potential of modern technology in sports information management.

**Keywords:** cloud computing; higher education sports; sports information management; big data service platform.

## 1 Introduction

This paper aims to explore the design and implementation of a cloud-based university sports information management and big data service platform to address the current issues of low efficiency and data isolation in higher education sports information management [1]. By integrating cloud computing and big data technology, this research proposes an efficient, secure, and easily shareable information management platform designed to optimize support systems for sports teaching, training, and research work. The paper first analyzes the limitations of existing management methods, and then elaborates on the platform's architecture design, functional modules, interface design,


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and data model [2]. Through specific cases, the paper demonstrates the platform's effectiveness in practical applications and discusses its potential impact on the development of sports informationization in higher education institutions.

## 2 Current Status and Problems in University Sports Information Management

Currently, university sports information management primarily relies on Excel spreadsheets created by various specialized teachers. These spreadsheets contain information such as exam results, student health data, sports training logs, etc., but they suffer from issues of data isolation and inconvenience in sharing [3]. Surveys show that 82% of sports teachers need to manually integrate information from different spreadsheets to generate data reports. At the same time, there is a lack of effective integration between the sports system and campus smart card systems and educational administration systems, which leads to sports management departments being unable to obtain comprehensive data on student exams, grades, etc., in a timely and accurate manner. This directly hinders the efficiency of data-assisted decision-making. Current research conditions and athlete training conditions in universities need improvement. Only 23% of universities have standardized testing laboratories, and most research work remains at the theoretical research stage, primarily due to obstacles such as a lack of funding and facilities [4]. In terms of training conditions, many university sports facilities are aging, with 70% of sports fields lacking shower facilities, making it difficult for athletes to meet their post-competition recovery needs. The informatization of sports in higher education institutions lags significantly behind and urgently requires the introduction of new technologies to achieve digitization and intelligent management.

## 3 Cloud-Based Sports Information Management Platform

### 3.1 Overall Platform Architecture Design

The cloud-based university sports information management platform designed in this paper adopts a multi-tier architecture, consisting of the presentation layer, business layer, and data layer [5]. The presentation layer primarily includes browsers and mobile apps, supporting students and teachers to access and interact with information through web pages or apps, thus ensuring multi-terminal support. The business layer is built on cloud servers and utilizes the Spring Cloud microservices framework to modularize sports-related functionalities, such as body data statistics, training management, resource reservations, etc., and enables rapid horizontal scaling of service modules. The data layer utilizes a MySQL database for storing structured data while incorporating big data technologies like Hadoop and Spark to store and analyze massive amounts of unstructured data, such as sports movement trajectories and videos. The system employs REST APIs for cross-platform data exchange [6]. In terms of security controls, in addition to access permission control, encryption mechanisms are introduced in data

transmission and storage to ensure the security of sensitive information. This design, based on cloud computing and employing modular and distributed thinking, facilitates the creation of a flexible and scalable platform, as illustrated in Figure 1.

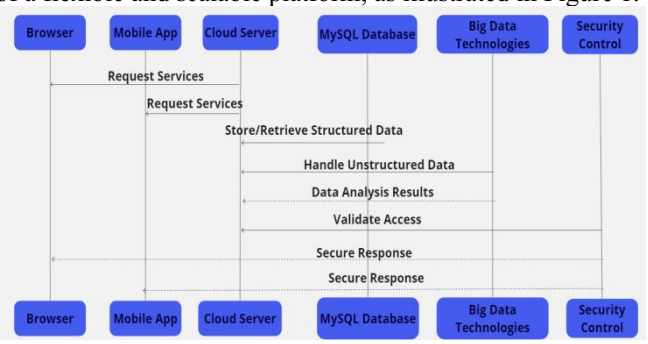


**Fig. 1.** Overall Platform Architecture Design

### 3.2 Platform Functional Module Design

In this design, the platform is divided into subsystems following a "sub-modular, loosely coupled" approach, including the Body Data Management subsystem, Sports Training subsystem, Venue Equipment Management subsystem, Event Management subsystem, Research Project subsystem, etc. [7]. For example, the Body Data Management subsystem incorporates various functional modules that can input student height, weight, and other information, and generate body measurement reports. It also integrates subjective feedback through health questionnaires to assess physical fitness and disease risk, providing personalized recommendations. Subsystems interact with each other through REST APIs and provide development interfaces for secondary development of apps or mini-programs, enabling mobile data entry and query analysis. The platform records students' data throughout their entire academic lifecycle, supports multidimensional statistics, and serves as the basis for the formulation of university sports policies. Each subsystem module has access control to ensure data security [8]. This modular design facilitates flexible expansion of platform functions and makes maintenance and upgrades more convenient.

### 3.3 Platform Interface Design

The platform in this design provides RESTful-style API interfaces for easy access and data integration across multiple platforms. The interfaces use the JWT mechanism for user authentication, and upon successful verification, return a Token token [9]. Subsequent client requests access authorized interfaces with the Token token for authentication. Interface documentation is automatically generated through Swagger for ease of development and debugging. The data exchange format uniformly adopts JSON, as shown below:

```
// Request example
POST /api/login
```

```
{
"username": "zhangsan",
 "password": "123456"
}
// Response example
{
"code": 200,
 "message": "Login successful",
"token": "xxxxx.yyyy.zzzz"
 }
```

The platform also provides open interfaces for third-party integration, allowing campus card payment systems, educational administration systems, and others to access sports data and achieve multi-system linkage applications. Additionally, some interfaces and modules are open to external use. By establishing strict usage guidelines, they can be used by teachers and students to develop mini-programs or mobile applications, expanding the platform's application scenarios.

### 3.4 Platform Data Model

In this design, the platform constructs an object-oriented data model, primarily encompassing over twenty core business tables, including student information table, teacher information table, course table, grade table, physical fitness data table, and more [10]. These tables are linked through primary and foreign keys to support complex relational queries. Additionally, the platform models multimedia data such as sports trajectories and images, organizing them as object storage and utilizing big data technologies for relevant analysis. Data quantities can be measured in the following units:

$$N_{record} = N_{student} * D_{train} \tag{1}$$

$N_{record}$: Represents the total number of sports achievement records; $N_{student}$: Represents the total number of students; $D_{train}$: Represents the number of days a student participates in year-round training.

The capacity of health and physical fitness data (TB) = Number of students x Data volume per student x Time spent in school.

$$S_{data} = N_{student} * S_{single} * T_{inschool} \tag{2}$$

$S_{data}$: Represents the total capacity of health and physical fitness data, measured in TB (terabytes); $N_{student}$: Also represents the total number of students; $S_{single}$: Represents the data volume for an individual student; $T_{inschool}$: Represents the time a student spends in school.

# 4 Key Technology Implementation of the Platform

## 4.1 Cloud Computing Platform Deployment

The sports management platform designed in this project is deployed on Alibaba Cloud, utilizing Kubernetes as the container management platform to achieve rapid and elastic scaling. Microservice applications are packaged in Docker containers and deployed on-demand. In terms of data storage, structured data is deployed in the cloud database RDS MySQL, while files and unstructured data are stored in cloud object storage OSS, offering cost-effectiveness. The platform enables automatic scaling based on monitoring data of server CPU and memory usage, allowing virtual machines and containers to automatically scale up or down to optimize resource allocation and ensure service stability and reliability. Simultaneously, features like log monitoring and anomaly alerts are enabled, collaborating with technical personnel for daily operations and maintenance. This deployment architecture realizes a high-availability, high-reliability, and scalable operation on the cloud, as illustrated in Figure 2.

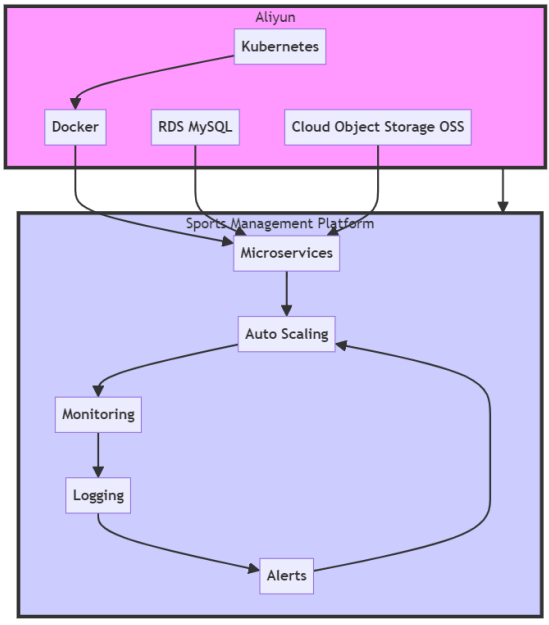


**Fig. 2.** Cloud Computing Platform Deployment

## 4.2 Big Data Processing

The university sports big data platform designed in this project employs Spark Streaming for real-time data processing. The system collects real-time data streams generated by various sports equipment, such as player movement trajectories and shooting action data from basketball court intelligent sensing systems, and video streaming data from soccer fields. These data sources have output rates of up to 1,000

records per second, representing typical high-speed streaming data. Kafka is used as the data stream input source, and Spark Streaming consumes data from Kafka. Machine learning algorithms are used to analyze player movement patterns, assess the standardization of various sports actions, and provide optimization suggestions. Additionally, the platform conducts batch processing of sports training logs and event videos in the HISTORY table. Training logs generate 200GB of data weekly, which is stored on the Hadoop HDFS of the Sports Information Center. Batch processing tasks use Spark SQL to analyze historical data, output student physical fitness growth curves, and assess the level of university sports teams. Furthermore, natural language processing techniques are employed to analyze unstructured text training summaries written by coaches and athletes, extracting information related to sports injuries, psychological states, etc., to serve as references for adjusting training intensity. This design effectively addresses the rapid processing of massive and heterogeneous sports data, truly integrating big data technology into university sports data management.

### 4.3 Data Security and Access Control

The sports big data platform has implemented stringent measures for data security and access control. AES symmetric encryption is applied to encrypt stored data, ensuring the security of data transmission and storage. For example, approximately 500GB of sports data generated daily on the platform undergo encryption. After completing big data processing tasks, including real-time data streams and processing results, the data is stored in the Hadoop HDFS file system and backed up at least once a week. Backup data typically reaches 2TB to prevent data loss in the event of a single point of failure. The platform enforces fine-grained access control to ensure the reasonability and security of data access. For instance, students can only access personal physical test result data related to themselves, while coaches are limited to accessing data for athletes under their guidance. Administrators have access to the entire dataset but must adhere to strict audit and supervision procedures. The audit module records approximately 10,000 data access activities daily and conducts real-time monitoring and alerts for any abnormal access behavior. The platform enhances protection against external threats by deploying advanced firewalls and conducting regular vulnerability scans. Monthly security scans typically detect 5 to 10 potential security vulnerabilities, which are promptly addressed to prevent data breaches, as shown in Figure 3.

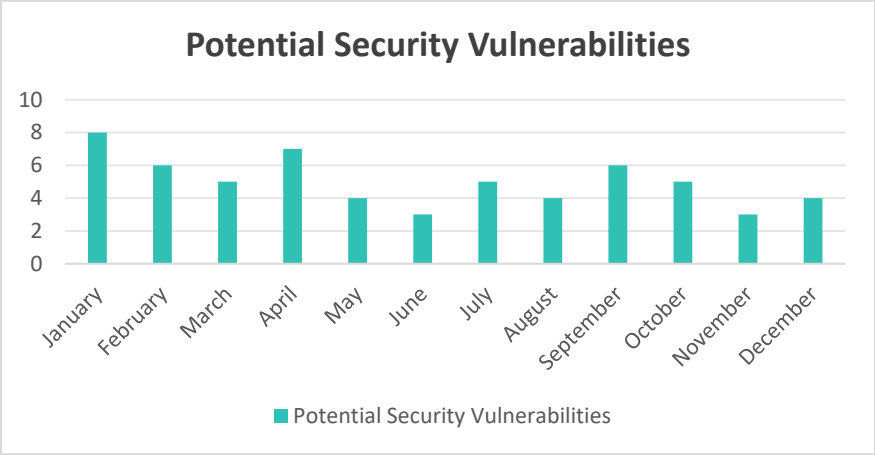


**Fig. 3.** Potential Security Vulnerabilities at Different Times

These security measures collectively ensure the integrity, privacy, and security of sports information, ensuring that data is used solely for training guidance and is not disclosed or used for other commercial purposes. The overall design strictly adheres to relevant regulations and standards for health information security.

## 5 Case Study

In this case study, we examine how a university significantly improved the efficiency and quality of its sports information management by implementing a cloud-based sports information management and big data service platform. The university originally relied on manual methods to manage sports data, which led to inefficiency and data isolation issues. After implementing the platform, the university expanded its sports information management to cover 3,000 students and 150 teachers. The daily processing volume of sports data increased dramatically from a few hundred megabytes to over 5 gigabytes. This transformation greatly improved data sharing and access efficiency. For example, the time required to generate physical fitness reports reduced from several hours to just a few minutes. The platform's application significantly enhanced the quality of research and teaching. The platform supported 20 research projects, including the analysis of data from more than 5,000 student physical fitness tests, leading to specific training improvement recommendations. The platform also recorded and analyzed data from over 100 campus-level sports events, providing deep insights into event organization and athlete performance. Table 1 shows the scoring of three athletes in different competitions.

**Table 1.** Scoring of Athletes in Different Competitions

| Date | Player 1 Score | Player 2 Score | Player 3 Score |
|---|---|---|---|
| 2023/1/15 | 85 | 92 | 78 |
| 2023/2/2 | 88 | 89 | 76 |
| 2023/2/20 | 90 | 91 | 77 |
| 2023/3/10 | 86 | 90 | 79 |
| 2023/4/5 | 91 | 88 | 81 |

In terms of sports facility management, the university achieved digital management of 5 sports venues and facilities through the platform. This includes tracking venue utilization, which led to a 20% increase in utilization rates, and a 30% reduction in response times for maintenance. Regarding security and privacy protection, the introduced encryption and access control mechanisms allowed the platform to successfully monitor and audit approximately 10,000 data access operations every month, effectively preventing any data leakage incidents. This case demonstrates the tremendous potential of cloud computing and big data technologies in university sports information management. It not only significantly improves the efficiency and quality of information management but also enhances data security, positively impacting teaching and research activities. Through this innovative technological application, the university successfully transformed into a more efficient and secure sports information management model.

## 6 Conclusion

By implementing a cloud-based sports information management and big data service platform, this research successfully demonstrates the potential of technology in enhancing the efficiency and quality of university sports information management. The introduction of the platform fundamentally changes traditional data management methods, increasing the daily processing volume of sports data from a few hundred megabytes to over 5 gigabytes. This significant improvement is reflected in data sharing, access efficiency, and research support, particularly in the rapid generation of physical fitness reports and in-depth research data analysis. Additionally, through security measures such as encryption and access control, the platform ensures data security and privacy protection, monitoring approximately 10,000 data access operations every month. Furthermore, the platform has a positive impact on improving the quality of sports teaching and research, supporting multiple research projects. In summary, the platform not only addresses issues in traditional management but also paves the way for university sports informationization, laying a solid foundation for future advancements.

## References

1. Huang L, Zhang C, Zeng Z. Design of a public services platform for university management based on microservice architecture[J]. Microsystem Technologies, 2021, 27(3).
2. Al C S L E. Design of Open Knowledge Platform Based On Knowledge Base Utilization Model And Service Scenario To Support Solutions Of Regional Issues[J]. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 2021, 12(6):750-754.
3. Arongna, Sulonggaowa. Application of Travel Service Recommendation Algorithm Based on Cloud Computing[J].Journal of Physics Conference Series, 2021, 1852(4):042090.
4. Shahraki A, Ohlenforst T, Krey F. When machine learning meets Network Management and Orchestration in Edge-based networking paradigms[J].Journal of Network and Computer Applications, 2023, 212:103558-.
5. Construction and Research of Digital Archives Cloud Platform Based on Big Data Management[J]. Journal of Physics: Conference Series, 2021, 1881(4):042094 (8pp).
6. Wang D, Yang X, Xu L. Design of Launch Vehicle Test Information Management System based on IETM[J].2022 International Conference on Artificial Intelligence, Information Processing and Cloud Computing (AIIPCC), 2022:207-210.
7. Hao Y, Qiu Z, Xu Q, et al. Innovation strategy design of public sports service governance based on cloud computing[J]. Journal of Cloud Computing, 2023, 12(1).
8. Sun X, Chen H, Wang Q, et al. Research and Design of Online Training Platform based on Spring Cloud Distributed System Structure and Computer Big Data[J].Journal of Physics: Conference Series, 2021, 1952(4):042087 (7pp).
9. Huang J, Li X. Research on Traditional Costume Design and Application Based on Cloud Computing[J]. Journal of Physics: Conference Series, 2021, 1881(4):042064 (6pp).
10. Luo C. Computer Data Storage and Management Platform Based on Big Data[J].Journal of Physics: Conference Series, 2021, 2066(1):012022-.