Design of Virtual Campus Card System Based on Micro-Service Architecture

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ABSTRACT

Based on the analysis of the application status of campus card and aiming at the design of virtual campus card system under the architecture of micro-service, taking the newly-built campus card system of New Cape as an example, this paper analyses the overall requirements, system architecture, data center, system network and system performance, etc. By vertical splitting of the monolithic application, the platform's concurrent capability is greatly improved, the complexity of the monolithic application is solved, and the business response is more agile and fast. The application of the micro-service architecture will greatly improve the service capability and security level of the virtual campus card system, which can provide important reference function for the research and construction of the new generation campus card system.

1. INTRODUCTION

It is the strategic deployment of our country to promote the education modernization with the education informationization. As an important part of education informationization, university informationization plays a leading and supporting role. As a campus card system earlier applied in the school, it is also in the process of continuous development and change while witnessing the development of university informationization. The virtual campus card system based on micro-service is a new generation of campus card system based on the new
service concept, advanced technology architecture and keeping up with the development requirements of the times. The research and analysis of it will not only contribute to the upgrading of campus card system, but also help to promote the construction of smart campus to a higher level.

2. CURRENT STATUS OF CAMPUS CARD APPLICATION

2.1 Application of Virtual Campus Card

After more than ten years of development, our campus card system has integrated financial consumption and identification. The campus card system has been widely used in canteen consumption, supermarket shopping, and dormitory water control, recharge of electricity, registration fee, network fee collection, and book lending. Self-printing, textbook purchase, dormitory access, vehicle barriers, hospital medical treatment, physical exercise and other scenes. Thus, "one card in hand, walking around the campus" have been truly realized at university.

The deficiency of traditional campus cards with cards as media are becoming more and more prominent while they bring convenience to teachers and students. It is a common phenomenon in all colleges and universities that a large number of cards are replenished, which exacerbates the strain on human resources while increasing the cost of student cards. Taking the student card of Beijing Normal University as an example, students reissued 14,000 cards in 2016, and 0.5 cards per capita per year. At the same time, teachers and students inevitably complain about the time consumption of card replacement and the inconvenience of forgetting to bring card. The emergence of mobile applications such as scanning codes has made more demand for virtual campus cards [1].

In 2016, East China Normal University launched the first Wechat Virtual Campus Card in China, which totaled 25,000 in three months [2]. Subsequently, a variety of virtual campus card products continue to emerge, such as WeChat, Alipay, cloud flash payment and other APP have launched their own campus card products[3]. The leading enterprises of traditional campus cards also launched virtual campus cards in 2017, Yunnan University and other universities have become the first experimental sites of the New Cape virtual campus card, which brought more convenient service and experience to the study and life of teachers and students [4]. Famous universities such as Beijing Normal University and Shanghai Jiao Tong University have gradually opened virtual campus cards.

2.2 Microservice Architecture Application

The micro-service architecture is not only a system but also a concept. In the construction of information technology, it is necessary to deconstruct the traditional heavyweight and tightly coupled application systems to lightweight and loosely
coupled micro-applications so as to reduce mutual dependence and transplant and standardize docking easily.

The core platform of the campus card company is also gradually transitioning to the micro-service architecture. New Cape is one of them. It uses the micro-service architecture at the access level to support an application with a series of small service development. Payment platform, Internet of Things platform, open platform and authentication platform serve as public service domains, which can serve campus cards, and also empower all the required scenarios in school.

3. DESIGN OF MICRO-SERVICE VIRTUAL CAMPUS CARD SYSTEM

3.1 Overall design requirements

3.1.1 DESIGN IDEAS

Campus informatization has entered the stage of building a smart campus. At the technical level, it covers such fields as cloud computing, Internet of Things, big data, mobile internet, intelligent sensing, business intelligence and so on. Taking multi-business scenarios profound and extensive services as the construction premise, campus informatization construction planning will provide an advanced integrated management platform of intelligent campus card for the future campus information construction.

3.1.2 DESIGN POSITIONING

Intelligent business scenarios are formed through the integration of multiple systems, multiple data, and cross-business scenarios to realize the deep integration of information application system, build a cashless payment environment of the whole school and form a one-stop comprehensive information service system for teachers and students. Big data analysis under the mode of artificial intelligence is applied to assist school management decision-making, and management informatization gradually evolves into service informatization.

3.1.3 DESIGN OBJECTIVES

People, computers and things in the whole school are interconnected and interoperable to achieve the management objectives of perceptive campus through the Internet platform and the Internet of Things platform. A people-oriented, more convenient and efficient personalized campus life service circle is created with the help of various intelligent terminals, new technologies and new applications. Real-time business monitoring and active risk early warning are realized by grasping abundant process data, and it achieve supporting and assisting smart campus management decision-making.
3.2 Design of Systematic Framework

In order to achieve the goal of “smart campus construction”, the overall development of the platform adopts the current mainstream micro-services, J2EE technology system framework and JAVA development language based on the school's autonomy and controllability, opening and sharing; and adopts micro-service architecture design to meet the need of data unified management, business decoupling processing, communication security and efficiency. While the software system is open, the rationality and advancement of the platform system architecture should be considered to ensure the high security, high reliability, redundancy, loadability, easy deployment and easy expansion of the system platform.

The system platform is divided into four layers: infrastructure layer, core framework layer, business service layer and data sensing layer. A system of "high cohesion, loose coupling" can be achieved among the four layers. The platform meets the access and expansion requirements of various application systems (management systems, service systems, monitoring systems, third-party access systems, etc.).

Figure 1. Microservice Virtual Campus Card Platform Technology Architecture.
3.3 Design of Data Center

The virtual campus card system, a wide-ranging system based on micro -service, includes such services as financial payment business, bank deposit business, identity identification business, self-service query system, third-party system docking business, etc. Therefore, the deployment of the system requires high density, high performance, high reliability and other aspects of the hardware server.

The design of data center should follow seven principles: practicality and advanced principle; sustainable development principle; open principle; elasticity principle; safety and reliability principle; high performance-price ratio principle; easy management and maintenance principle.

The construction of data center should not only meet the basic requirements of application system deployment, but also fully consider the development needs of the school in the next 3-5 years. The system is required to have certain expansibility, maximize the protection of existing investment, and reduce the cost of system maintenance and future development. At the same time, make full use of the advantages of virtualization technology to ensure the sustainable development of the system in terms of technology and economy.

The architecture can make sure that when one server is down, the other server can automatically take over all the services so as to ensure the stability and continuity of the system operation, and ensure the normal operation of card issuance, recharge, card replenishment, settlement and other services.

Figure 2. Microservice Virtual Campus Card System Data Center Topology Diagram.
3.4 System Network Design

The network topology of the entire campus card system is a "pyramid" structure (as shown below). The data center located at the top of the "pyramid" is the center of the whole network (core layer network). The middle layer is the convergence layer network connecting branches, third-party systems, mobile devices and all-purpose card terminal devices. The bottom layer is the access layer network distributed in the building.

![Network Topology Diagram](image)

Figure 3. Microservice Virtual Campus Card Network Topology Diagram.

All kinds of equipment in the data center are connected to the core switch in the star-like computer room. The server unit supports distributed deployment, virtualized deployment and VLAN division to ensure data isolation from other servers; As the bearer network of the virtual campus card platform, the campus network uses VLAN technology to isolate the data communication within the virtual campus card platform from other data communication (such as OA, web browsing, etc.), and uses the VPN technology to connect the LAN of the school branch with the Internet. The virtual campus card terminal is connected to LAN through wired, wireless and other means.

3.5 System Performance Design

3.5.1 SYSTEM PERFORMANCE INDICATORS

Campus card performance index parameters mainly include technical specifications, card reading distance, communication rate, memory performance, security mechanism, data encryption and so on.

Software performance indexes mainly include system work efficiency, system capacity, account structure, hardware terminal, payment capacity, database,
operating system, working mode, key system, financial system, recharge system, terminal, etc.

New Cape's Microservices-based campus card system consumption adopts online transaction mode, and also supports offline which adopts the original dual backup mechanism. The online transaction processing capacity of the system can reach 6,000-8,000 times per second, the query and concurrent data can reach 12,000 times per second, the response speed of card swiping is less than 300 milliseconds per time, and the response speed of code scanning is less than 1 second per time. The automatic startup time after service outage is less than 20 seconds, the average response time of external interfaces is less than 55 seconds, and the processing capacity of concurrent transactions is more than 5,000. The system can accommodate 1 million+ users at the same time, and the black and white list can support more than 200,000 data. Actual performance requirements can be determined based on the number of schools, the number of businesses and the scale of the application.

3.5.2 SYSTEM SECURITY

Network security. In order to ensure the consistency, confidentiality and authenticity of data transmission, the core parts of the campus card system and finance-related are deployed in the private network, and the information query class is deployed on the campus network, which is separated from the campus network through the firewall and VLAN.

Transmission security. In order to prevent illegal interception, tampering and decoding, symmetric or asymmetric cryptographic algorithms are adopted to encrypt data according to different data. The authenticity, integrity and confidentiality of data transmission are guaranteed through identity authentication, encryption and message authentication.

Key security. All the keys are loaded and exported in ciphertext mode. The key management system adopts the 3DES encryption algorithm, adopting four-level management system: root key generation system, master key generation system, master card generation system and authorization card generation system to reduce the security risk caused by key leakage.

Card security. The possibility of illegal attackers committing crimes is reduced, and the difficulty of forging POS devices and user cards is increased through the security management of campus card, PSAM card and related devices.

3.5.3 SYSTEM OPENNESS

Hardware openness. The system realizes the function of shielding hardware differentiation through the Internet of Things platform, and the hardware equipment collected by the school can be easily connected to the one-campus communication platform, which can fundamentally solve the problem in the past that the hardware used by the school must depend on the manufacturer of the campus card.
Software openness. The system realizes the independence of real software through open platform, which means that, in theory, the system can share data resources with the campus card system through the unified authorization interface of the open platform no matter what kind of software the third party uses. Thus, a service platform of multi-depth collaboration and resource sharing have been constructed.

3.5.4 SYSTEM SCALABILITY

Database independence. The platform shields the differences between different database dialects through middleware technology and realizes database independence through programming language. At present, it supports a multitude of mainstream databases including oracle, sqlserver, MySQL, etc.

Operating system independence. The platform is developed in Java. The operating system can support Linux, Windows and other operating systems. The software can realize cross-platform applications to meet the different needs of users.

4. CONCLUSIONS

The virtual campus card system based on micro-service architecture achieves vertical separation of monolithic application, which makes it easier to achieve business level expansion and the concurrency capability of the platform is so greatly improved that it can reach more than 10,000 per second. The complexity of monolithic application is solved by decomposing huge single applications into multiple micro-services, and business analysis and processing is more agile and rapid when responding. The service programs can replicate multiple copies. A same service will be started immediately to ensure the reliability of the application when any one of the services goes down. The continuous enrichment and deepening of the use of the new system in our school will surely play a great role in promoting the construction of the smart campus.

REFERENCES