The Construction and Development of Automation, Networking and Digitalization in XJTU Library

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Abstract—**This paper describes the construction and development of Xi'an Jiaotong University Library in automation, networking and digitalization in the past decade, including management system, network and hardware, computer room construction and digitalization of special resources.**

Index Terms **— Automation, Networking, Digitalization, XJTU Library**

I. INTRODUCTION

Xi'an Jiaotong University Library built its own 100M Fast Ethernet LAN in 1998, introduced INNOPAC management system from USA and realized the library automation. Demands of information resources and information services are constantly changing following the development of technology. The network is upgraded in order to satisfy the information needs of readers. Many new features were introduced with INNOPAC, more information service system were built. The space of library network control room was extended and re-constructed to ensure the high quality information services of the library. In this paper, we will introduce the automation, networking and digitalization development of Xi'an Jiaotong University Library in the four parts, which are management system, digitalization, hardware configuration and the construction of network control room.

II. AUTOMATION, NETWORKING AND DIGITALIZATION CONSTRUCTION IN XJTU LIBRARY

1 . MANAGEMENT SYSTEMS

With the development of library, more and more focuses are placed on the automation management of library. In order to respond with this requirement, XJTU library sequentially developed and introduced a number of management subsystems.

Integrated library automation system

Before the introduction of INNOPAC, XJTU Library has its own library management system, but its function and automation is incomplete, only cataloguing and circulation modules are available. In 1988, XJTU library introduced INNOPAC system from INNOVATIVE INTERFACE INC USA, five modules are included as acquisition, catalogs, serials, circulation and OPAC, and for 64 staff users. This improved greatly the automation management of XJTU Library. Due to the increasing user number and more management requirement, in 2002, the number of user license of INNOPAC were increased again, that is 90 staff users and unlimited OPAC. And users and new feature like E-mail circulation were added. INNOPAC also was upgraded to Millennium and the character terminal mode was upgraded to client mode.

Homepage Management System

Library home page is an open window of the library, which reveals all the library collection. The home page has direct impact on readers. Formerly the home page was maintained by one librarian, which led to some problems like not up-to-date information in time, ambiguous work dividing, deficient topic and backward management. Following the establishment of home page management system, the management mode has been changed from static to dynamic, the maintainers are classified and the responsibility is explicit. The information can be updated timely according to different user authority and duty. The information topic can be modified, added and deleted according to actual requirement. The manageability of XJTU library home page is enhanced.

Access Control System

Formerly the Library door was open to all the users. Anybody has access to library without any certificate. Therefore librarian was needed in each reading room to verify the legit reader identity. Since this work was done manually, it's impossible to gather statistics exactly and detailed of readers' number and identity, and many librarians are needed in this case

With the establishment of Access Control System, the laser scanner can record the reads' Barcode while readers are entering the library. Then it can count readers' number, record readers' identity and this makes it easy for statistics management, reduces the librarians on duty for reading room and improves the working efficiency and management level.

Electronic Reading Room Management System

In 1998 XJTU Library built an electronic reading room for readers' access to electronic resources, web browsing, thesis writing and user training. With the increasingly users' demand, the PC number was increased from 40 to 300. Therefore, Electronic Reading Room Management System has built, which can make statistics of user number, identity and requirement in order to meet the readers need better.

Virtual Reference System

Reference librarian provides real time service by network to help users solve the problems in collection exploitation and resources searching.

Combined Virtual Reference System, abbreviated to CVRS, is a platform, which is a bridge between reference librarian and readers. Just registering before the first time use, users can enjoy the virtual reference service. CVRS has many functions like synchronized browsing, desktop sharing, whiteboard world, audio screen exchanges, knowledge database management and Web functions Form question.

E-journals Navigation System

E-journals amount in XJTU library is growing day by day. About 10,000 foreign e-journals and 5000 Chinese e-journals are collected. Huge numbers of electronic journals provide the readers with a reference of information resources, but it is also inconvenient for using.

E-journals Navigation System of XJTU Library provides index and browse function. Access points include journal name, ISSN number and key words of journal name. The search results contain journal name, ISSN, Databases and other information. Journals can be ordered by journal name, database name, or subject. Especially navigation system includes a subscription of the latest annual edition print journals and periodicals, free and non-free electronic and periodicals. In the system, each title has a directly link , for the print version ,from which users can reach to OPAC records to check its collection, for e-version, from which users can access to full text.

Key Disciplines of Network Resources Navigation System

Lately Key Disciplines of Network Resources Navigation System has been developed. XJTU Library is responsible for organizing and harmonious or united action, and other libraries participate in developing the system..

Key Disciplines of Network Resources Navigation System is constructed based on the principle of "unified platform, uniform standards, cooperative constructions, distributed maintenance, centralized management, sharing of the country," The System adopts model of distributed data collection and centralized service. The whole system is a 2-tier structure of Central Systems and Local Systems, Central System is responsible for publishing and management of data, and harvests metadata from its partner libraries through OAI. The partner libraries use the Local Systems to collect and catalogue metadata of network resources in their specific partnered disciplines, and to provide OAI metadata harvesting and to submit the metadata to the Central System. The Local Systems also provide the functionality of direct data transmission between the Central System and themselves.

The Central System consists of five subsystems which are website basic service system, metadata management subsystem, metadata publishing and retrieving subsystem, system management module and interface.

The metadata storage of central system contains a temporary database and final database.

The central system stores the metadata harvested from different local systems into the central temporary metadata database. Data managers of the central system make duplication checks and examinations of these metadata, and then store the data into the central final metadata database. The data mangers decide and set up metadata release guidelines for the central final metadata database. They, then, officially release those data which meet the requirements. Users can now browse and search those released metadata.

The local systems consists of four subsystems which are web search system, cataloging system, system management module and interface

The data of the local systems consists of local website database, local temporary metadata database, and local final metadata database.

The operators use the web search subsystem to retrieve web page information, and store it into the website database. Catalogers go through the website database to choose needed web page information, and catalogue metadata for these network resources using the cataloging subsystem. The metadata are stored in the local temporary metadata database. After approved examination, these metadata will be stored to the local final metadata database. Then the metadata in the local final metadata database can be harvested by the central system in OAI standard.

The Remote Dissertations Submit System

More than 4,000 graduate students (both Masters and PhDs) graduate from the Xi'an JiaoTong University each year. The library needs to store their dissertations in electronic edition. Students are used to submit their dissertations in electronic edition to the library by using floppy disks before their graduations. This whole process required a great deal of laboring, and it was mistake-prone, with no proofreading on the spot, and with the danger of

infecting computer virus.

Now the Remote Dissertations Submit System allows students to submit their dissertations to library's server in required format through network. The server proofreads dissertations automatically; decline those which are not in accordance with the required format. Dissertations which meet the requirements are submitted into the library database right away, and can be immediately searched and browsed. This system greatly improved working efficiency.

ILL and Document Delivery System

Inter library loan and document delivery is important ways in sharing literature resources. The traditional ILL is mainly to inter-loan original materials by post. With the development of copy technology and computer network technology, the way of the interlibrary loan is no longer limited to by post only, but mainly in the way that original texts are copied and scanned, and then delivered by post, fax, E-mail, Ariel, etc. Therefore, the delivery of original documents has become one of the important parts of the modern Interlibrary Loan working process, and plays an important role in library reference and consulting work..

Readers register an account in the ILL and Document Delivery System first. As soon as the registration succeeds, the system will send a registration email to the readers automatically. In one week after the registration, readers should produce valid certificate to the Interlibrary Loan Department and confirm the registration with their user name and password. After confirmation, readers can request documents by submitting an application.

2. DIGITIZATION

In 1994, XJTU Library had started the planned digitization work on the dissertations and other special collections. Because there were no corresponding standards and image scanning equipments at that time, librarian could not digitize full texts, but index and abstracts only.

In the 21st century, with the development of digital technologies and the issue of the corresponding domestic standards, XJTU Library set up a special digitization department. The department has eight high-quality scanners, 12 PCs, digital cameras and other equipments; and works on the digitization of special collections, including digitizing the full texts in our library. So far, full texts of 11,000 dissertations (including Masters and Ph.D.), 7,600 volumes of bookshave before 1949 and 2,500 copies of rare books have digitized with 2.5Tb storage space.

3. NETWORK AND ITS HARDWARE LIBRARY LAN NETWORK

In 1992, XJTU Library set up their own Novell Network, achieving a cataloguing, circulation network-management. In 1998, XJTU Library established a 100M fast fiber Ethernet, with IBM 8274 as the host switch and 100M fiber linked with campus local internet. The network was connected to 19 IBM desktop through UTP Hub will, with 10M share.

In 2000, the LAN (local area network) of XJTU Library was upgraded to Gigabit Ethernet and the host switch IBM 8274 was replaced with Cisco 4006. Through gigabit optical fiber, the LAN of the Library was connected with all floors, which is connected with the campus network.. The floor switch was Cisco 3524, which was connected to desktop switches, Cisco 2924, through five UTP, reached 100M and was exchanged to desktops.

In 2006, this year, in order to further improve the performance of network, XJTU Library planned to use Cisco 6509 to change Cisco4006 which is currently being used.

INNOPAC Server

INNOPAC system is the core system of the XJTU Library, which requires a stable operating environment. According to the suggestion from suppliers, we used IBM server as the server system with: IBM F50, double CPU, 166MHz main frequency, 512M memory, 4.3G hard drive, 100M NIC.

In 2002, with the increment of the functions and data in INNOPAC system, we used the new servers with: IBM H85, 4 CPUs, 688MHz main frequency, 4G memory, 36G hard disk, 1000M network adapter.

KVM switches

As the quantity of servers increasing, a large amount of keyboards, mouses, monitors are required, which needs a lot of space in the computer room. Because there are a lot of services, it is necessary for maintenance staffs to enter the computer room frequently for the installation, test and maintenance of the equipments and systems, which in turn brings much dust. In addition to the increasing service in the Library, it is impossible for a system administrator to manage all servers and to be on duty 24 hours, thus when system failures happen, system administrators are often not on the scene, which leads to no maintenance in time and a break in service.

KVM system can solve the problems above. The KVM is the abbreviation of the three English words: Keyboard, Video and Mouse. KVM system is located between severs and user terminals. The signals are digital from digital KVM switches to the IP user terminals, while the signals still are analog

signals from the server to digital KVM switches. So, for digital KVM switches, with one IP address only, users will be able to manage the equipments in the computer room through the network..

Recently XJTU Library imported DKX232 KVM switches from the Raritan Company in the United States. DCIM computer adapter module can be connected with KVM switches and servers through a standard Category 5 cabling system. DKX232 is a digital KVM switch, based on IP and remote-login available. It is connected with the library network through two Category 5 unshielded twisted pair. With the configured network IP addresses, it allows two administrators to remote-log in simultaneously and to control any one of the 32 servers directly. In the same time, it allows a local administrator to control any one of the 32 servers through the local terminal server platform, T1500.

SAN Storage

Because of a large collection of electronic or digital resources, the demand for the storage space of XJTU Library increases continuously. In 2001, the library purchased a SCSI RAID system, which is equipped with 23 pieces of 73G SCSI hard disk, with a total capacity of 1.6T.

In 2004, XJTU library bought another local network storage system with a more powerful performance and greater capacity than the SCSI RAID system, i.e. IBM FastT900, including two 16-port SAN switches, 1 Midrange Disk System, 4 Storage Expansions, and 1 LTO Ultrium Scalable Tape Library which can store 32 of the 200G Tapes. This system can connect 16 application-servers to the storage area network through dual-channel fiber-optic with bandwidth of 2G, to share the space of 56 disks of 2Gb FC 146.8Gb. The storage capacity of the system reaches 8Tb and the storage capacity of Tape Library reaches 7.2Tb.

4. NETWORK COMPUTER ROOM

The automation in XJTU library has experienced a development by leaps and bounds in the recent decade. Many cases were difficult to predict, such as switches, firewalls, IDS, KVM switches, RAID, various servers, etc., which made the computer room of library fail to fulfill the demand of present equipments, such as, distribution, network cabling, and even space.. In the second half of 2004, XJTU Library carried out a large-scale transformation for the computer room and the space was extended from 90 square meters to 150 square meters.

Network Cabling

In terms of the IEEE 802.3ab standard wiring, with fiber and 6 category and 5 twisted-pair cable, network access points were increased to 150, including 50 fiber access points.

Power Supply System

XJTU library has an APC InfrastruXure UPS system. This system has a full load of 20KVA and is equipped with 32 100Av 12V backup batteries, which can delay power cut for 60 minutes when full loaded. In addition, the system can carry out maintenance and monitoring through the network and send an alarm to administrators by SMS messages.

Air-conditioning systems

Constant temperature and humidity are necessary to keep electrical equipments working properly. XJTU library provided with STULZ CCD-302A Precision Air-conditioning made in Germany, which ensures the computer room to keep 22 degrees Celsius and 45% humidity.

Standard Rack

With switches and servers installed in special cabinets, it can not only enhance the using efficiency of the space of the computer room and improve the operating environment, but also make the room look neat and orderly.

Moreover, XJTU library adopt an APC 19-inch standard rack to put eight network switches in and another nine IBM 19-inch standard rack to emplace 35 application servers.

III. PROSPECT

To summarize the development of construction in automation, network and digitalization of XJTU library, the future library is a digital and virtual library, based on developed networks, numerous servers and huge storage systems, with immense digital resources as collections. Advanced guide systems will lead readers to roam in the network of the digital library and enjoy the immense digital recourses conveniently and quickly.