

Building an information resource support system for science and technology in China: a report of the development of National Science and Technology Library

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Abstract-The NSTL was developed as an information resource infrastructure for supporting research and education in science and technology. The article sums up its development model and mechanism, the way and experience in providing networked information service, from the aspects of its establishment background, current development, construction achievement and service activity, based on literature and website survey.

Keywords-information sharing system; information resource management; NSTL

I. INTRODUCTION

Science and technology (S&T) information resource is a critical component of the research and education infrastructure in a country. After more than eight years of development, the National Science and Technology Library (NSTL) has become one of the most important S&T document and information service organizations in China. The personalized and digital services that NSTL provides characterize the information service development in the Web environment. The model of joint construction and concept of information sharing represents the development trends of current information service. The establishment of NSTL was a major event in current history of S & T document and information service development in China, and its construction and development is not only an epitome of construction of China's modern S & T document and information support system, but also an example of public service in S & T information service fields in China. It is meaningful to sum up its operational model and mechanism, as well as its way and experience in providing networked information service [1].

II. THE FOUNDATION AND MANAGEMENT OF NSTL

A. Foundation background

In the 1990s, the weak document and information management system, the reform of foreign currency exchange system in China, and the soaring prices of Western scholarly journals are among the major factors

that resulted in the substantial decrease in the subscriptions to foreign S & T information resource in China, which greatly affected the development of the scientific research, technological innovation and higher education in China. In 1998, the Ministry of Science and Technology embarked an ambitious project that would build a centralized collection of Western scholarly publications to meet the information needs of research and education. The centralized collection for S&T scholarly publications was to reform the existing S & T information management system and solve the problems that had been hindering the S & T document and information services in China. These problems included the fragmentation of resource management, duplication and low utilization of information resources. In order to establish an information sharing construction organization and a sustainable developing mechanism, NSTL was established by the Ministry of Science and Technology, on 12 June 2000, under the coordination of the Ministry of Finance, the State Economic and Trade Commission, the Ministry of Agriculture, the Ministry of Health and the Chinese Academy of Sciences, in accordance with the approval by the State Council of China [2].

B. Organization framework

NSTL consists of 9 member institutions: the Library of the Chinese Academy of Sciences, the Institute of Scientific and Technological Information of China, the Library of Chinese Academy of Agricultural Sciences, the Library of Chinese Academy of Medical Sciences, China Machinery Industry Information Institute, China Metallurgical Information & Standardization Research Institute, China National Chemical Information Center, Library of Standards of China National Institute of Standardization and Library of National Institute of Metrology of P.R. China. As a virtual S & T information institution, the director in general is responsible for the implementation of the decisions made by NSTL council which is the decision-making body. The council is composed of experts in varied S & T fields, specialists in document and information field, leaders from the member

institutions of NSTL, as well as the officers from government departments in charge. The Ministry of Science and Technology, on behalf of six ministries, works for policy guidance, supervision and management of NSTL.

This innovative management system and operation mechanism, breaking China's existing administrative model, has created advantageous conditions to effectively promote the cooperation and coordination among document and information institutions which belong to different organizations. The innovative management system and the virtual forms of establishment has become a very typical practice of the reformation of the S & T management system and the transformation of government functions, which have been promoted by the Ministry of Science and Technology. Furthermore, the establishment of NSTL has created a new model for joint construction and sharing of S & T document and information resource, which is an important achievement of the reformation of the S & T management system in China.

C. Aims and objectives

The aims of NSTL are to collect and exploit documentation and information in natural sciences, engineering and technologies, agricultural sciences, and medical sciences as required by national development, and to provide documentation and information services to the S & T community nationwide. The main objectives of NSTL are to build a domestic first-class, international advanced web-based S & T information resources service and guaranty system as follows [3].

- Collecting Chinese and foreign S & T document and information resources on various media as completely as possible;
- Facilitating shared exploitation and utilization of S & T documentation resources;
- Providing prompt services by applying all the suitable advanced information network technologies;
- Speeding up the in-depth processing of information and providing diversified services;
- Carrying out research on library and information science, providing analytical information service and consulting service oriented to decision makers;
- Training high-level professionals in information resource management;
- Promoting domestic and international cooperation and exchange.

D. Innovative management concept

Since its establishment, by implementation of concept innovation, mechanisms innovation, technological innovation and service innovation, NSTL has set up a shared system of S & T document and information service which is consistent with network information environment and the market economy mechanism, built an integrated S & T document and information service platform based on internet at the internationally advanced level. As its aim is to make full use of the favorable condition of national financial support and to persist its construction and service for public service, NSTL has made its endeavor to carry out its service purpose and work efficiency through the

provision of public document and information services, so as to ensure that the country's input and incremental funds can be effectively applied to all public information services [4].

With various modern technologies, the construction, development and the reliable utilization of information and web-based service of NSTL have been performed smoothly. Under the principles of public service and socialization, as for some special types of document, market operation mechanism has been applied. It should be pointed out that NSTL has adhered to the principle of the cooperation, collaboration, openness and sharing in order to vigorously promote the joint construction and sharing of document and information resource among its member libraries, to avoid duplicate subscription and boost healthy development, from the aspects of organizational planning, administrative model, operational mechanism, technical means, service means and so forth. Meanwhile, NSTL has actively promoted the joint construction and sharing of information among major S & T document and information organizations nationwide.

III. INFORMATION RESOURCE CONSTRUCTION AND NETWORKED INFORMATION SERVICES

Enhancement of information resource support capability

In accordance with the operational mechanism of "Unified programming, Standard processing, Associated constructing and Resource sharing", the construction of document and information resource of NSTL has been established in the country's development strategy, depended on the overall planning and coordination of subscription, to overcome the fragmentation among information service organizations and the drawbacks of duplication ordering for information resources in the past, and to promote the optimal distribution of resources and improve the usage of the limited funds for the subscription of document and information resources. As a comprehensive S & T document and information support institution in China, NSTL has subscribed four areas of documents covering natural science, engineering, agricultural science and technology, medicine and health care, involving more than 100 disciplines or research fields. Having been profited from the advantage of the increase of country's funding, the number of foreign document and information resource has kept growing. After several years of development, NSTL has become one of the largest virtual information service organizations, which is on network environment and promotes the joint construction and sharing of S & T document and information resource [5].

By the end of 2007, the subscription number of the foreign S & T journals in hardcopy had reached more than 15,900 titles, which is 4.5 times larger than that before joint construction, while more than 5,000 titles of foreign conference proceedings had been subscribed, which was nearly two times of the number of pre-joint construction. According to statistical data, the number of S & T journals and conference proceedings ordered by NSTL has accounted for more than 60 percent of the whole country's subscription number of the relevant resource. NSTL subscribed more than 300 titles of online foreign full-text journals on the basis of national site license. NSTL is the

only one that orders online journals to serve S & T users all over the country (see Fig. 1). Relied on the foreign hardcopy periodicals ordered by NSTL, through concession order, the member institutions have subscribed more than 7,000 titles of foreign online journals.

By the end of 2007, the number of the online foreign full-text journals joint ordered by NSTL and other information institutions had reached 55 titles, which can be accessed by 182 institutions under IP address control.

Moreover, NSTL had purchased more than 200,000 eBooks in Chinese from Apabi Technology Co., Ltd., for internet access. Additionally, with the support of the country's strongly incremental funds, the large stock of document and information resources accumulated for several decades by all NSTL member institutions has been effectively activated, which has greatly enhanced China's support capability of S & T document and information resource.

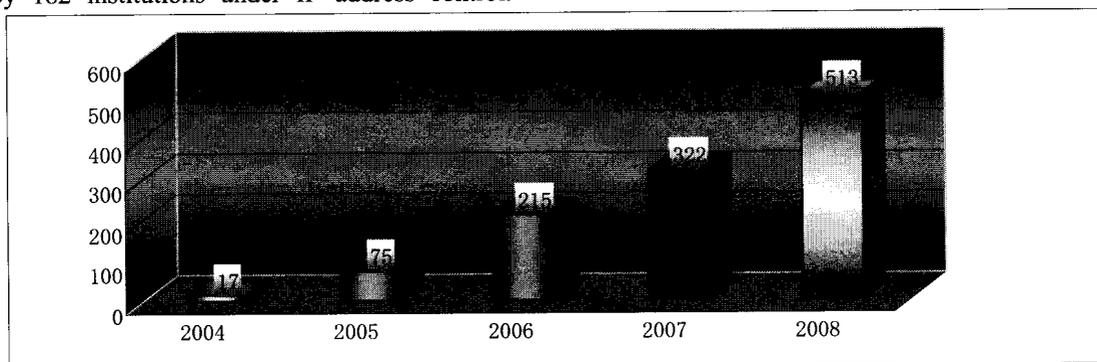


Fig. 1 Number of Full-text Journals Databases Subscribed by NSTL from 2004 to 2008

A Web-based document and information service system

With the increase of the coverage of its document and information resources, NSTL developed an online information service system that possessed the richest types and the largest scale of foreign S & T document and information resource in China. The online service system of NSTL, initially providing service on December 26, 2000, which is now one of the largest S & T document and information service systems in China, is a gigabit broadband MAN connecting all the member institutions, and has connected with National Library of China, the China Education Research Network (CERNET), China Science and Technology Network (CSTNET) and the General Armament Department Science and Technology Information Research Center via 100M fiber. As it provides the S & T institutions all over the country with various document and information services via internet, users from scientific research institutes, educational institutions, government departments, companies, and other groups or individual users, as long as they can access to the internet, can enjoy the equal treatment of document and information services. Undoubtedly, the networked

document and information service, full of feature-richness, jointly provided by NSTL member institutions has pioneered a very convenient way for Chinese S & T communities[6].

As NSTL had paid great attention to the construction of digital information resource, its network service system, of which types of document and information databases and scales of each database had kept increasing, became a large-scale integrated document and information service system that had pooled a lot of S & T resource types, such as S & T journals, monographs, conference papers, Chinese dissertations, S & T reports, patents, standards and metrology norms. By the end of 2007, the number of databases that can be accessed to via the network service system had been over 40, which was more than 7 times larger than that at the launch of the system. The number of records including abstracts, titles and citations that had been accumulated by the system got over 60 million, which had increased by more than 30 times compared with the commencement of the system service. Up to December 2007, main types of databases and amount of data are shown as table 1.

Table 1. Databases Offered By NSTL Network Service System

Type of Database	Amount of Data (item)	Percentage
Foreign Patents	14,230,000	22.29%
Chinese Journals	17,190,000	26.92%
Foreign Periodicals	11,740,000	18.39%
Science Citations	10,850,000	16.99%
Foreign Languages Conference Papers	3,690,000	5.78%
Chinese Patents	2,170,000	3.40%
Chinese Dissertations	1,070,000	1.68%
Foreign S & T Reports	850,000	1.33%
Chinese Conference Papers	830,000	1.30%

China's S & T Achievements	500,000	0.78%
Chinese Enterprises and Products Companies	190,000	0.30%
Foreign Dissertations	140,000	0.22%
Foreign Standards	130,000	0.20%
Chinese Standards	20,000	0.03%
Others	250,000	0.39%
Total	63,850,000	100.00%

In addition to gradually improving its online document delivery service and a variety of personalized services oriented to users' information needs, since 2004, NSTL has successively established 8 mirror sites and 10 service stations throughout the country, which has further enhanced the level of the network services. Certainly, diversified means of services and the rich contents of databases have facilitated convenient access approaches and ensured that users can fully utilize all types of document and information resources of NSTL. It is out of question that this document and information service system that is unprecedented, public-oriented, web-based and easy-accessed has already strengthened Chinese support capability of S & T document and information system substantially.

B Variety of information service

NSTL has adhered to the "User-oriented, Honest services" as its service principle, continuously investigating the ever-changing information needs of users, developing new types of services and exploring specialized, personalized and knowledgeable information services, so it has achieved remarkable success in document and information services. Based on Internet, the service system for information browsing, information retrieval and full-text delivery to user's online request has been constantly improved. Through various ways of professional training, improving the operational personnel's qualities and skills of service, establishing and enhancing service evaluation and supervision mechanism, NSTL has constantly explored and richened the service means and connotations. Among the various information services, NSTL has also focused on strengthening user research, analyzing the demand characteristics of users of different units and different levels.

At the launch of the network service system, its services mainly covered free document abstracts retrieval and full-text delivery services. In order to meet the multi-level of information needs, in recent years, NSTL has continuously enriched its services, expanded the way of service, strengthened the content of service, and launched new service programs, etc. For example, journal current contents browsing, document title retrieval, online searching of public catalog, subject information service, real-time online and offline reference service, internet information navigation, Chinese preprints database, preprints portals abroad and S & T hot subject portals have successively been initiated by NSTL. In December 2007, the Database of International Scientific Citation pilot system, created by NSTL, was launched on the web, which has brought another bright spot to current document and information services in China.

For the purpose of offering better service to the users, since 2005, NSTL began to offer inter-library loan service.

Since 2006, under the joint efforts of all member institutions, the responding time of full-text delivery request has been shortened from 48 hours to 24 hours and the full-text delivery service has kept uninterrupted during weekends, which rarely exists even in the major document and information service organizations in advanced countries. The time of online real-time reference service has been prolonged from 4 hours to 6 hours per working day, while the responding time for offline reference service has been cut from 3 working days to 2 working days. With the substantial increase in total amount of resources of S & T document and information, as well as the continual strength of service function, the services provided by NSTL have been known and used by more and more users.

C Satisfaction of various information needs

According to the vast number of S & T users' needs in China and the characteristics of document and information service under network environment, NSTL has actively adopted the relevant technical standards, norms and agreements at home and abroad, organized and cooperated with the relative domestic organizations and other forces to study and formulate relevant standards that had been applied to the construction, organization, processing, management and services of digital information resource. At the same time, the issues on utilization and long-term preservation of digital information resource, the intellectual property protections and so on have been attached importance by NSTL.

In accordance with the service principle of "Resources to the institutions, Services to the users", NSTL's information service has been pushed to the users' information environment. A variety of service promotion activities have been actively carried out to strengthen the training of the usage of information and special service promotions to the universities, institutes, key enterprises, military units and S & T front line scientists, in order to extend the service coverage. In addition, NSTL has actively implemented information research and strived to adequately play a role of knowledge base and thinking tanks in providing decision-making advisory services to the country's core development projects and government departments.

IV. ACHIEVEMENTS OF SERVICE AND ENHANCEMENT OF COOPERATION

A Achievements of web-based information service

Over the past few years, the document retrieval and full-text delivery services based on web-based document and information service system of NSTL, as well as information services provided by NSTL's member institutions, have increased year by year. In 2007, NSTL's web-based document and information retrieval system has

been accessed to for 60.46 million times that was 13 times more than 2001, increasing approximately by 50 percent as compared with 2006. In 2007, a total of 840,000 papers were offered by NSTL and its member institutions. Among them there were 260,000 papers offered via internet by NSTL, of which number had increased about by 70 percent as compared with the previous year and was 10 times more than 2001. It should be pointed out that most of the full-text delivery was completed within 24 hours.

In 2007, there were 180 million access times to NSTL's web-based document and information retrieval

system. There were about 3,360,000 articles downloaded via internet for all online full-text journals ordered by NSTL. With the increase of journals subscribed by NSTL, the number of download had been dramatically augmented, as shown in Fig. 2. These data has shown that, with the enhancement of NSTL service capacity, the status of a few years ago that there was seriously lack of foreign S & T document and information resource and diversification services in China has been dramatically changed, the urgent information needs of Chinese S & T community have been basically satisfied.

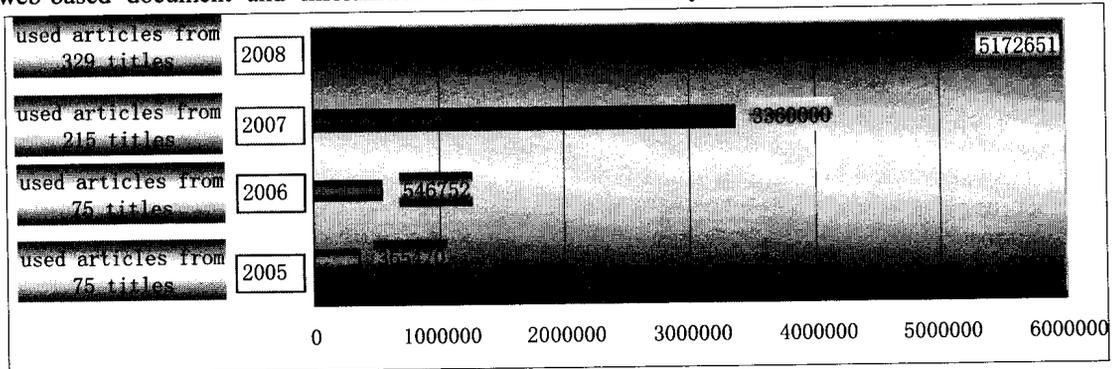


Fig.2 Download Statistic of Articles from Networked Full-text Journal Databases (2005-2008)

In some special period, the information service system of NSTL fully reflected its rapid response capability and played a role of information resource guaranty. While the respiratory disease of Severe Acute Respiratory Syndrome (SARS) existed in 2003 and after Sichuan Wenchuan Earthquake occurred in May 2008, NSTL had effectively peremptorily and swiftly organized its member institutions and relevant mirror stations, overcome difficulties, gathered and tracked comprehensive materials and data, supplied document and information service oriented special topics, in order to ensure that the retrieval of web-based document and information service system, as well as the original full-text services should not be interrupted. Consequently, document and information requirement in the front line of research can be met and the domestic scientific research personnel can obtain research literature in a timely and efficient manner.

On December 17, 2006, earthquake in the Taiwan Strait occurred and submarine cable communication was interrupted. After that, in more than one month, domestic universities and research institutes, which have subscribed foreign online full-text database, could not access to foreign document and information resources, so that scientific research and teaching activity had been seriously hindered. At this point, NSTL' S&T Document and Information Support System played its important role in document and information service. In the month of earthquake occurrence, the amount of full-text request was 1.5 times more than the 12-month average in that year, which was highest on month's record. This showed that, nowadays, in the face of the development of digitalization and networkization of document and information, in order to deal with possible natural disasters and other emergencies, strengthening and improving the national S&T Document and Information Support System should not be weakened in the least.

B Implement of information localization solution

With the development of NSTL, it has played more and more important role in wholly improving the service level and efficiency of China's S & T document and information, promoting the transformation of S & T document and information service towards knowledge service, advancing the sustainable development of China's S & T information enterprise and driving the enhancement of China's S & T innovation capability. In any case, the construction and development of NSTL has totally embodied the construction characteristics of S & T document and information system under the web environment, as well as the direction of the modern S & T document and information service enterprise development.

In recent years, NSTL has provided support to relative units, actively explored the information service model and method for enterprise innovation, and set up a number of information platforms and databases positioning in the innovative services specifically for enterprises, which have received a positive response and cooperation from enterprises. Meanwhile, "information localization solution" based on the service programs provided by NSTL has been implemented, so as to integrate the service of NSTL into the desktop of end users. It is worth mentioning that NSTL has strived to raise the academic standards and professional qualities and skills of professionals from its member institutions through various forms of operational research, professional training and academic exchange.

C Extension the service coverage

Looking into major national S & T development projects, NSTL has organized relative institutions to accomplish and provide more than 100 research reports and subject information reports to the relevant government departments, which has been appreciated by the Ministry of Science and Technology, Ministry of Agriculture,

Ministry of Health, the Central Organization Department and the NPC Financial and Economic Committee, and other departments in China. Additionally, the member institutions of NSTL have made full use of their advantage of resource and personnel, vigorously carried out thousands of strategic studies, decision-making advices and subject reference materials for their clients.

All of the statistical data has indicated that, with the enhancement of the service capability of NSTL, the status of a few years ago that there was seriously lack of foreign S & T document and information resource and diversification services in China has been dramatically changed, the urgent information needs of Chinese S & T community have been basically satisfied, and the country's support capability for S & T document and information has been substantially upgraded. For its good performance, the sharing service system, initiated and advanced by NSTL, which has ensured that the S & T community can access to document and information service equally and conveniently, have actively been accepted by a wide range of people.

D Enlargement of cooperation among the information institutions

NSTL has continuously strengthened its resource construction and enlarged its information services. Meanwhile, relying on the network platform, towards the target to make more effective use of information resource, it has also promoted the development of joint construction and information sharing in a greater scope, to advance the construction of S & T document and information service system at national level by coordinating with China Academic Library & Information System (CALIS), National Library of China, the Shanghai Library and other information organizations and units. It has played an important role on drafting the standards for digital library construction, researching long-term preservation of digital information resource, investigating the development and utilization of information under network environment, as well as studying the issues on intellectual properties, etc.

Besides, NSTL has organized ISTIC, LCAS, National Library of China and CALIS to jointly develop the first demonstration platform for integrated description of information resource and service in China, which is based on web service protocol and has integrated certain document and information resources from NSTL, CALIS, China Science Digital Library (CSDL) and National Library of China, so as to promote the integrated retrieval and access of document and information of these libraries. Furthermore, there have been co-operations among NSTL and other major document and information organizations in China to co-sponsor international academic conferences and senior seminars. What NSTL has implemented has sped up the joint construction and sharing of S & T information in a wider range, and actively influenced the development of library and information undertaking in China.

V. CONCLUSION

Over the past years, NSTL has better fulfilled the mission set down by its constitution, timely grasped development and changes of the situation and attained certain achievements in creating the new ways of

information service under the web environment [7]. It has been proofed that the service practice of more than seven years is successful and the achievements are significant, for NSTL has set up a distributed, joint-support service system, which has effectively provided the document and information services to China's S & T users, with the features of characteristics, personalization and collaboration, and which has made contribution to the enhancement Chinese S & T innovation capability and international competitiveness. The innovative management concepts, systems and models, together with the operational mechanism of "Openness, Combination and Sharing", not only have explored the viable path and provided useful experiences to the construction of basic condition platform for the country's S & T development that has currently been carried out by the Ministry of Science and Technology, the Ministry of Finance and other departments, but also have played a role model and radiation in driving the joint construction and information sharing at local and industrial level in China. In a word, it can be said that the course of NSTL is a miniature of the development of China's S & T document and information service system in recent years, which has reflected the achievements attained by China's S & T information undertaking.

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