CHINA'S INFORMATION SUPER HIGHWAY: ITS GOAL, ARCHITECTURE AND PROBLEMS

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ABSTRACT

In this paper, a status report on China's national information infrastructure (CNII) and its development progress is introduced. The main goal of the CNII is to accelerate the economic development by means of information technology (IT). Based upon the modern information technologies, the CNII is designed as the nationwide three dimensional information communication network to streamline information transmission processes and overcome tremendous information traffic problems stemmed from the high speed economic development. The problems related to the CNII are outlined.

INTRODUCTION

The multimedia technology triggers a new competition in information technology (IT) and its relevant market. To take this challenge, China's government declared the plan about China's National Information Infrastructure (CNII) in 1993. The pilot projects of the CNII have been launched, known as the "Golden Projects" (GPs). These projects have achieved certain immediate results, which demonstrate that the CNII has a strong impact on the economic development, which leads to optimized industrial structures, increased economic efficiency and effectiveness, and put forward the international marketing strategy.

The strategic goal of the CNII is to promote the economic development more quickly, qualitatively, and successfully by means of IT. One views the construction of the CNII as a very important long-term strategy to increase and enhance the national strength and competitive capabilities in the worldwide market.

Since the beginning of the economic reform at the end of 1970s, the high growth rates of the national economy (double-digit growth rate) and increasing foreign investments (e.g., the foreign direct investment in 1996 was about $42.35 billion, growth rate 12.23%) have generated a great deal of information traffic. It is, therefore, an imperative to modify the information and communication infrastructure to support the economic development. On the other hand, it is estimated that one unit investment in telecommunication systems yields about 18 units' benefits to the other industries. This indicates the large potential in the information and communication industry.

The rest of this paper is organized as follows. The existing base of the CNII is introduced in section 1. The pilot projects of the CNII - the GPs are described in section 2. The problems of CNII are presented in section 3. Finally, some conclusions are proposed in section 4.

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THE EXISTING BASE OF THE CNII

The CNII consists of three levels: telecommunications infrastructure, transport services, and information services. The telecommunication infrastructure is constituted by the public packet-switched data network (CHINAPAC), the public digital data network (CHINADDN), the GP networks, and the other dedicated networks. The transport services are provided by various organizations such as the Ministry of Post and Telecommunication (MPT), the Ministry of Railways (MOR), the Ministry of Electronic Industry (MEI), and large state companies, etc. The information services are provided by governmental administrations, state and private firms, and public institutions as well as foreign firms and organizations.

In fact, since the end of 1970s, China has begun to build 12 large computer network systems, which include the railway, banks, public security, and economic administrations. Up to the end of the 1980s, the networks were in a quite large scale. Because of various reasons, the 12 large networks are almost vertical systems, i.e., the dedicated networks owned by the ministries link with their relevant industries.

At the end of 1994, the number of installed computers was over 2 million (Li 1995). There were over 800 large data bases in operation. The length of the optical-fiber trunks was about 60,000 km, digital microwave trunk 45,000 km, the number of broadcast and television stations were about 2,500. Up to May 1995, China had 0.72 million long-distance telecommunication lines and 26.8 million terminals. Total capacities of installed telephones were 69.34 million. The CHINAPAC and CHINADDN terminal capacities were over 110,000 terminals, covering over 700 cities, and became the main communication platform of the GPs. In the same time, automatic switching technology has been adopted in the whole country. The rate of

remote digital transmissions was about 80% out of the total service. The rate of program-controlled telephone switching was 97% of total telephone switching services. Certain advanced telecommunication technologies have been applied, such as GSM, ATM, and SDH (2.4Gbs). The high speed computers with an operation rate over 10 Bips have been developed in 1997.

The architecture of China's telecommunication network shows a higher density in Southeast China than in Northwest China. This is consistent with the level of economic development. In fact, the telecommunication networks have been built not only by the central administration but also by provinces and cities in local regions. Some ministries and commissions as well as public institutions have developed their own dedicated satellite telecommunication systems.

Among public telecommunication networks, four service networks are important, including, (1) The nationwide automatic switching telephone network based on program-controlled switching technology, (2) The CHINAPAC, mainly used in computer communications, (3) The CHINADDN, which provides the medium or high speed data transmission channels to varieties of dedicated information systems, and (4) The network for mobile telephones and wireless calls. These networks together with the other three technical support networks will constitute China's national public communication networks, which have already cost over 100 billion Yuan[1]. Additionally, the broadcast & television network is a very large information system. The number of existing television sets is over 200 million, its penetration rate is well over that of telephones. Interactive television has also attracted certain individuals.

[1] *The current exchange rate between Deutsche Mark(DM) and Chinese Renminbi (Yuan) is approximately DM 1 = 4.85 Yuan.*

THE GOLDEN PROJECTS

The CNII will exploit the current network resources, follow the uniform standard, and constitute an independent administration and operation system to provide a standardized platform to end users. Based on the uniform standard and feasible technological alternatives, the national economic information network infrastructure will be reformed by the CHINAPAC and the CHINADDN supplied by the MPT, Golden Bridge Networks supplied by the MEI, and the other networks supplied by certain organizations, including China's Financial Satellite Network, China's Railway PAC, China's Customs Satellite Network, and so forth. The practical interconnection option is that the ground PACs connect with each other through gateways according to X.75 or X.25. Satellite networks and ground PACs are connected through gateways by connection of the satellite groundstations with the closest local PAC nodes. Therefore, the information traffics can be shared by the satellite and ground networks.

The CNII is concerned with the IT and the information industry (II). Its basic contents and constitutions are related to communications and transport media, computers and applications of information systems, information resources, IT and II, human resource, policies and laws as well as technological standards. The establishment of the CNII is a long-term procedure. It is roughly divided into three stages:

- Stage 1 (before 2000): The objectives focus on technological improvement in traditional industries, increasing the contribution rate of IT to GNP over 35%, development of national economic information systems and implementation of inter-network operations nationwide to satisfy the imperative demand for IT in the economic development. The budget is estimated over 500 billion Yuan, including construction and R&D costs.
- Stage 2 (From 2001 - 2010): The objectives are to finish the technological improvement in the traditional industries by adopting modern IT, diffusions of the value-added services widely, applications of IT network in education, scientific and technological researches, and primary economic sections, realization of a middle-level 'informatized' society in the developed economic regions and central cities.
- Stage 3 (After 2011): The main objectives are to let multi-media communication networks enter the elemental organizations and individual families in cities. IT is widely applied in social, economic, and cultural systems as well as families. The high 'informatized' society is to be realized.

To reach the objectives of the first stage, certain works are being done consecutively in the coming years, including (1) Establishment of the public communication networks in terms of optical-fiber lines and satellite groundstations, (2) Initiation of a number of imperative and critical projects for applications of information systems that are key to national economic and social developments, (3) Coordination in information resources development, exploitation, exchange, and management, (4) Development of market-oriented information services, (5) Organizing research forces for developing key ITs to provide technological provision and know-how to the CNII, (6) Revitalization of information facilities in the manufacturing industry to ensure the establishment of the CNII, (7) Setting-up of the development strategy and programs included in the Ninth Five-Year National Economic Development Program, (8) Establishment of uniformed technological standard and relevant regulation as well as law, (9) Implementation of human resource engineering to bring up information specialists and users.

The GPs are the most important projects for the 'informatized' national economy, which are initiated and supported by the government directly. The pilot GPs are the

CODE	Objectives & Tasks	Applications
Golden Bridge	Establishment of the public, backbone and interconnect communication networks for economic and social systems. Providing value-added service, such as E-mail, EDI, multimedia, documentation exchanges.	Connection of 500 central cities, 1,000 large size firms, and 100 state important projects
Golden Customs	A platform of information communication about foreign trade. Development of application systems for managing the import/export quota license, reduced export tax, payments for import & receipts for export and balancing, import and export statistics, and so on.	Enhancement of the macro regulation ; implementation of automatic invoices processing and licenses management, and paperless trade.
Golden Cards	Establishment and improvement of the national monetary information system, implementation of the pilot project – the settlement system and its extension, issuing 200 million credit cards to cover a 300 million population in 400 cities.	Strengthening the central bank in regulating the activities of specialized banks at the macroeconomic level; implementation of automated credit card processing.
Golden Taxation	Creation of the value-added tax audit system covering the whole country, enhanced capability to manage the taxation processes, which are distributed over 3, 000 counties, including over 30, 000 basic units charging for taxation.	Guarantee of the value-added tax return by means of the most advanced, secure, and automatic measures.
Golden Agriculture	Establishment of an integrated data base about the dynamic states of the agricultural production, the farm product market, and the economic state of the countryside; development of agricultural monitoring, forecasting, prediction, warning and macro regulation and decision support systems.	Reduction in the chaos in production and distribution channels, enhanced capability to prevent disaster.
Golden Enterprises	Design of a nationwide uniformed basic measure index system about firms; creation of nationwide three-level information transmission systems based upon the central government, provinces, and central cities; creation of nationwide data base about firms and products.	Diffusion of macro economic information and dynamic state of markets, improvement of the decision making quality of enterprises.
Golden Intelligence	Facilitation for most of the teachers & students at universities as well as researchers at various institutions to share information resources nationwide/worldwide and participate in the international information exchanges as well as scientific & technical collaboration. Creation of the various data bases about scientific data, scientific and technological literature.	Facilitation of educational and scientific/technological information exchanges worldwide through computer networks.
Golden Macro-Economy	Creation of national data base about integrated statistics about industry, finance and taxation, price, investment, natural resources, assets, energy, transportation, etc. Creation of macroeconomic decision support systems.	Supply of the decision information and tools to aid the national top-level administrations in decision making.
Golden Information	Optimization and improvement of the national statistic index system; creation of various economic, scientific and technological, as well as social statistic data bases.	Real-time supply of the newest statistic information to the national decision institutions and society .
Golden Medicine	Integration of information science, computer technology, and communication technology with the medical sector. The first stage aims to connect the 500 large scale hospitals with each other through the network to share the medical information.	Improvement of the accessibility and applicability of the medical resources and information, implementation of the remote diagnosis and treatment.

Table 1 Ten Sub-projects of the "Golden Projects"

first step to build the CNII, which are shown in Table 1. Among the ten sub-projects, the Golden Bridge, Golden Customs, and Golden Cards, known as "Three Golden Projects", were publicized first in 1993, the others added to the agenda in 1995. The Golden Bridge is the cornerstone of the GPs, which is briefly introduced below.

The GB project owned by the MEI is the most important project in the GPs. The project's objectives are to open information channels, to reduce overlapped and distracted construction engineering projects, to promote the national economic and social information resource sharing, user- and market-orientation, to combine information production with its applications, to build the electronic information market and promote the modernized electronic information industry development. The ultimate goal is to exploit information resources, raise social productivity, reduce the communication "bottleneck effects" on the economic development, specially on the energy, transportation and environment, and to satisfy the public demand for entertainment, culture, education, science and technology, health and security, etc.

The GB implementation is an information system engineering, which covers the whole country. The GB network will connect with the dedicated networks owned by various ministries and commissions in the State Council, and link with the information networks owned by 30 provinces, 500 central cities, 12,000 large size companies, 100 important group corporations, and the most important state projects such as Sanxia Project, Dayawang Nuclear Power Station.

In the technological aspect, the GB network will be connected with the CHINAPAC, the CHINADDN, and the PSTN as well as the national financial network and the other dedicated information networks through optical-fiber lines, satellite and microwave lines in the way of program-controlled and wireless mobile communications. The GB network and the other networks will be interconnected to support each other and back up to avoid damages. The GB network is able to transmit data, voice, video, fax, and other messages. The first consideration is to connect the GB network with the financial network to satisfy the demand for modernized foreign trade, customs and banks, and to provide the information channels to various information service systems concerned with commerce, travel, weather, national security, scientific and technological information retrievals. Then, it will be connected with Ministries and Commissions, Provinces, and the large state enterprises. Considering the technical advantage, extensibility, and economy with the state of affairs in China, the GB network starts with building a "middle speed" information highway (transmission rates between 144 Kbs and 2 Mbs). E-Mail, EDI and the others serve as the platform to end users for value-added services. It will simplify information transmission processes and increase productive efficiency. The network will evolve into the Information Super Highway (ISH) (transmission rates over 1 Gbs). The GB backbone network is a central network, its users are primarily the dedicated network systems. A network control center and an exchange center for value-added service are established in the GB network. The centers perform the tasks of maintenance, administration, debugging failures, security, etc. No information processing center exists in the GB network. Information processing centers are located in headquarters of various information application systems, e.g. in the information centers of ministries and of the dedicated networks. One expects that the GB has a strong impact on increasing the capabilities and quality of macro-economic regulation and decision making and on sharing information resources as well as motivating the development in the information service industry.

The GB project began in 24 provinces and central cities. Since 1996 the built sub-networks have been in operation. Twenty-five network sub-centers, including the state economic information center, are being built. The GB network has the following characters: (1) The GB network is different from telecommunication services networks and acts as a VAN (Value-added Network). (2) The GB network integrates ground networks with satellite networks. (3) The GB network is a newly built network and adopts the open network architecture. (4) The GB network is an extended network based on AI network architecture and will be upgraded over time. (5) The GB network is a joint-ownership network. It competes with the other networks and, at the same time, co-operates in the business process.

Today, the other sub-projects of the GPs have also made a great deal of progress, specially the Golden Customs, Golden Cards, Golden Taxation and the Golden

Intelligence. Golden Cards was launched first in 12 provinces and cities, among them six provinces' and cities' where the networking operations has been realized. The network built by the Golden Customs project has been applied in certain custom services. The Golden Taxation project initiates a large application program in 1997: the network will be used in 350 cities, covering over 2,000 counties. The China's INTERNET (ref. http://www.edu.cn) involved in the Golden Intelligence project has been widely used.

THE PROBLEMS

The CNII is a large scale information engineering project related to various organizations and individuals. Many problems are waiting for solutions. The important problems are concerned with investment, technology, human resource, information resource, practical applications, regulation and law, etc. Some of the problems are discussed below.

THE INVESTMENT PROBLEM

The CNII plan needs huge capital investments in R&D, implementation and operation. The systems upgrade and generation substitutions are also expensive. It is roughly estimated that the total investment for the GPs is about 15 - 20 billion Yuan, which cannot be covered by a single investment subject alone. It is necessary to attract other investment entities to participate in the plan.

The CNII projects, such as the GPs, are planned to be joint-venture projects, which are financed by certain organizations, specially by large national and international companies. The joint ventures are organized as joint-stock companies to carry out the projects, then manage and operate the facilities after the projects have been finished. This will lead to diversified investment entities and service markets. The monopolistic market, in which the MPT is dominant, has been replaced by a competitive market, resulting in a much better demand and supply relationship (Tan 1995). Also, it is a chance for both China's firms and foreign companies to enter China's telecommunication and information market.

Based on experiences accumulated from several successful international cooperative projects in the information and communication industry, foreign companies have been permitted to invest their technologies and capital into the GPs. This has received the active response. The first step taken by the government was to liberalize entries in the non-primary telecommunication services market. In practice, 9 telecommunication services have been opened to all individuals and organizations since August 1993, which include: (1) wireless calls; (2) 800 MHz group telephone services; (3) 450 MHz mobile communication services; (4) inland VSAT communication services; (5) information services with telephones; (6) computer information services; (7) E-mail services; (8) EDI services; (9) videotex. The opening of the telecommunication market will be further extended in the future.

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THE TECHNOLOGICAL PROBLEMS

The progress of communication technology has experienced a break through in recent years. Since the original communication infrastructure in China is relatively small in size, it is more easily upgraded or replaced by the advanced technologies. This may be the benefit to later movers. One expects that as a later mover China can exploit the newest and most advanced IT to catch up with the pace of technological progress in the world.

However, China's computer and communication technologies lag largely behind the advanced countries. The problems are how to promote the development of the computer and communication industries in a feasible way. Since the beginning of the 1980s, various Chinese firms and institutions have imported thousands of expensive computer and communication systems from foreign firms. The installed facilities have relieved information transport problems to a certain extent, but also reduced the demand for the facilities provided by local firms because of non-competitive performance of local products in the market. This led to some depression periods in the electronic, telecommunication, and computer manufacturing industries. Many Chinese firms have to set up joint-venture programs with foreign firms and to assemble products, such as computers, digital and program-controlled communication equipment with imported assembly parts, according to the technological specifications provided by their foreign partners. Next, the environment for China's software industry is not advanced enough to develop its own products except for Chinese publication systems. Most of the software firms generally develop application software in small sales numbers and cannot reach economies of scale. Their products remain on a relatively backward level. Moreover, there are many different computer and communication systems with various brands used in China, which contain different standards and protocols. This results in a very difficult situation to con-

nect the systems with each other, at least in economic terms, although possible from the technological point of view. Therefore, many "information islands" exist nationwide.

The above indicated technological problems and other problems related to R&D investments, technological regulations, standards, knowledge protections and information resource sharing as well as the diffusion mechanism hinder the smooth implementation of the CNII.

THE HUMAN RESOURCE PROBLEMS

Although there are more than one thousand universities and colleges as well as research institutes in China, the experts and users skilled in modern IT are not qualified enough to develop the CNII. The problems are that many people know how to use the advanced facilities imported to a certain extent, but they are not familiar with how to repair, design, and manufacture them, and how to use them in the best way. On the other hand, the computerized information systems have just found more applications in China's firms and administrations, but few reports found that the systems are cost-effective in operation. The lack of skilled employees is the main obstacle to use the systems in the right way. Moreover, many managers have little knowledge of IT and the CNII. Some implemented information systems are acted as modern typewriters or abacuses in practice.

Manpower is dominant in the CNII. It is a critical factor for the CNII to bring up enough qualified personnel by the GPs, and to build a human resource base engaged in the CNII. For this reason a long-term educational program has been launched. The program includes the establishment of new disciplines at universities, institutes and colleges, re-education engineering, offering series of courses about IT and the CNII in TV educational channels and so on. The other measures include cooperation with international organizations, foreign firms, universities, and other academic institutions to train specialists, setting up the state examinations on IT, etc.

CONCLUDING REMARKS

The implementation and application of the CNII are challenges faced by China's electronic, communication, and information service industries. It also has a strong impact on other economic sections and individuals.

The financial limitation is an important factor influencing the growth of CNII. The information sharing mechanism is a key factor in CNII diffusion.

The government plays a central role in the CNII. It is concerned with the introduction of market mechanisms in the communication and information service industry, legislature, technological standard, coordination and regulation, etc.

The technical and economic development of China's information and communication industry shows that: (1) The operation in the industry is changing from the intense monitor and control system to a competitive market system protected by certain regulations and laws. (2) The investment form is altered from government investment alone to joint investments by various organizations. (3) The technological progress will focus on applications of new and high technologies instead on ongoing technological improvements.

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The first issue of 1998 will be dedicated to the Transactions in Electronic Markets.

We look for articles dealing with particular aspects in the agreement and settlement phases of electronic transactions. We are - for example - interested in profiles of electronic contracts and whether they include the contractual arrangement only or the exception handling, too, and how far these contracts may be standardised and regulatory issues. Furthermore we are looking for descriptions of tools that support electronic transactions, such as auction systems (e.g. Onsale), procuremen systems (e.g. GEIS). Papers welcome. Deadline for submission: January 10, 1998.

Issue 2/98, Vol. 8, No. 2, 1998:

The spring edition will focus on Electroni Commerce in Europe and the Americas We intend to continue our series commenced with last year's spring issue or Electronic Commerce in Asia.

We look for articles dealing with the current status of related projects, visions and policies on Electronic Commerce, key players and their strategies to employ EC efficiently, leading and pursuing regions range of planned investments and time schedules for implementation, regiona aspects and governmental policies to promote the diffusion of EC, technologies used and the question of open versus closed platforms, the strategy for the future, etc Deadline for submission: March 20, 1998

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