Chapter 1

Evolution of National Innovation Systems in China and India: From the Perspective of the R&D Innovation Capability of ICT enterprises

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As huge developing economies, China and India have obtained significant positions in today's global economy. Especially, during the 2008 international financial crisis, the two countries maintained a rapid growth momentum, showing great potential for development. For both countries, ICT industry is of significant importance in the economic development. It is the typical sector that has represented different paths of industry development in the two countries, and attracted worldwide attentions. China's ICT industry has maintained a high growth for many years. From 2002 to 2007, the industrial scale had gained an average annual growth rate close to 30%, and the proportion of ICT industry in GDP had increased from 2.47% to 5.53%. In 2007, export of electronic information products reached 450 billion dollars, accounting for 37.6% of total exports. In India, software and information technology related service sectors have reached a compound annual growth of 28% over the past five years. For the 2004-2005 fiscal year, export from software and related service sectors had reached 17.7 billion. Revenues from ICT industry export accounted for one fifth of India's total export revenues. India exports software and services to more than 130 countries. The two countries have shown different development paths in ICT industry, and accumulated different technology innovation capabilities. Specifically, China's innovation capability relies on its strong manufacturing capability and diverse R&D innovation models of enterprises; while India relies on its strong software outsourcing capability. Differences in industrial innovation capability are firstly affected by specific characteristics of national innovation systems. Secondly, they are affected by the formation and change of endogenous capacity of enterprises in the industry. This report aims to briefly describe the characteristics and differences of national innovation systems in China and India as a basis, and analyze development paths of ICT industry in the two countries, in particular, R&D innovation characteristics and models of China's ICT enterprises at nation, industry and enterprise levels to draw instructive conclusions.

1 Introduction: the rise and modes of National Innovation Systems in China and India

When we try to look at the specific industrial innovation issues in one country, we need to first have the general pictures of so-called national innovation system of the country. Actually, industrial dynamics and the National Innovation System (NIS) approach gained ground as previous prevailing theories were challenged by the general economy developments in the 1970s and 1980s, during which period of time, the rise of the new competition from Asia; the growing importance of non-price competition on product markets; the general slowdown in productivity in the industrialized countries; and the general inability of economy policies to remedy unemployment and secure a stable economic grow. Furthermore, increased globalization and international integration induces the need to redefine patterns of specialization, trade, and economy development[1]. Nowadays, under the background of deep globalization and tendencies of innovation-based competition, when we look at the industrial development of the two emerging economies China and India, we could see both the similarities as the new competition from Asia during 1970s and 1980s and the differences in terms of size of competition environment and national specialization.

We first turn to the transformation of the innovation system of China, in the context of market-oriented economic reform. It is interesting to note that the motivation for the reform of the R&D-system initiated in 1985 was ‘highly systemic’ in the sense that the focus was on re-shaping the division of labor and the interaction between producers and users of knowledge and innovation. As we shall see the problems that remain after the reform can also be defined as 'highly systemic’. The fundamental weakness of the system, having a negative impact both on the absorption of foreign technology and on domestic innovation, has to do with an economic structure that does not support learning by interaction in organized markets[2].

Through the rapid development since the reform and opening up, China’s economic operation mode and knowledge creation pattern have undergone tremendous changes. China has primarily formed a complete and balanced-developing national innovation system, including technological innovation system with enterprises as the main body, regional innovation system, innovation system integrating military and civilian, knowledge innovation system with universities and research institutes as the main body, as well as science and technology intermediary system. The functions of the above innovation systems are in a constantly forming

[1] Henric Sornn-Friese, Frontiers of Research in Industrial Dynamics and National System of Innovation, Industry and Innovation, Volume 7, Number 1, 1-13, June 2000.

[2] Shulin Gu, Bengt-Åke Lundvall, China's Innovation System and the Move Toward Harmonious Growth and Endogenous Innovation, Industry and Innovation.

and perfecting process. Universities have become an important component of the research system. After transitional reform, significant changes have taken place in the original functions and positioning of research institutes. The power and status of enterprise's R&D have been raised. Innovation chain of innovation system under national institutional arrangements and distribution involves basic research, applied research, experimental development, as well as all aspects of industrial applications, covering a variety of important military and civilian areas. This is supported by "National Long- and Medium-term Planning on Science and Technology Development in 2006-2020" released by the Chinese government in 2006. In the perspective of participants, initially the research system had government-owned research institutes as the only main body. Now it has a compound main body composed of government-owned research institutes, universities and industry. Non-profit research institutes, private research institutes are emerging from the restructured scientific research institutes. Private universities have also emerged in higher education system. Moreover, various public technological service platform, incubators, productivity service centers continue to emerge. They have provided new forms of organization and content, which have enriched the national innovation system and enhanced national innovation capacity.

China has dramatically scaled up its investment in R&D over the past ten years. From 1995 to 2006, full-time equivalent of R&D personnel doubled, from 0.75 million to 1.5 million man-year. R&D expenditure as a share of GDP (R&D intensity) rose from 0.5 percent to 1.42 percent. With fast GDP growth of around 9 percent per annum, total R&D expenditure increased sharply by 5.5 times in real terms. Over the past decade or so, business enterprises have replaced R&D institutes (RDIs) and universities, which are mostly government owned, to become the most important performing sector of R&D. In 1995, RDIs and universities as performing sectors jointly accounted for 54.1 percent of China's total R&D expenditure and 51.7 percent of full-time equivalent of R&D personnel. In 2006, these had dropped down to 28.1 and 31.6 percent, respectively. On the other hand, 71.1 percent of total R&D expenditure was spent by enterprises in 2006, which also employed 65.8 percent of FTE of the country's R&D personnel.

In India, the new policy regime of liberalization was implemented in a gradual manner in two distinct phases of internal and external liberalization. During the first phase of internal liberalization, beginning from the mid-eighties onwards up to 1991, the policymakers had largely their thrust on the start of a process of internal competition. The policy makers were encouraging the Indian corporate sector to acquire the means of industrial upgrading though technology importation and removal of internal controls. While domestic firms got the government to protect the Indian market from the entry of new foreign firms, in almost all the sectors they made the governments to de-license sufficiently the industrial space, relax the regulations regarding foreign collaborations and foreign exchange and dilute the controls over the expansion of Indian big business to provide them with enhanced access to the home market. At the early time of 1990s, there was a massive change in the country’s economic and technological environment due to the introduction of economy wide liberalization of trade and investment. For the Indian corporate sector the policy change of the nineties has implied a wide range of new competitive pressures from the foreign companies.

Compared with China, the national innovation system of India is not so complete or balanced, with a limited variety of participants, but its national innovation system still has obvious features. It includes national research institutes, higher education system, a large number of technical workforce, world-famous network research centers, and national laboratories. India’s research system relies on national research institutes administrated by the central government. It exerts the research power from a small number of national universities to conduct planned scientific research and technological development activities to accomplish national strategic objectives. For instance, India defined space technology, defense technology research and nuclear energy technology as the symbol of its enhanced global power status, and thus invested huge amounts of money into these fields. R & D investment in these three fields accounted for around 64% in the total R & D investment. The second important field invested by the Government is agriculture, mainly to address the irrigation, fertilizers, pesticides and varieties of germplasm issues, and to improve crop yields. Oriented by national development goals, India established a national research system controlled by the central government. Specifically, India set up a "Research Council" under the central government, and then established national research institutes of various numbers under the "Research Council". These national research institutes were funded by the central government. Their scientific and technological R & D activities were operated and managed by the “Research Council”. India’s largest research council is the “Council for Scientific and Industrial Research (CSIR)”, which is under the jurisdiction of “Ministry of Scientific and Industrial Research” (vice-ministerial departments) belonging to Ministry of Science and Technology. It manages 38 national research institutes located in various areas of India. It is funded and allocated by the budget of Ministry of Science and Technology, and operated and supervised by the Research Council. Other departments such as Ministry of Agriculture, Ministry of Health, and Ministry of Water Resources also have similar “Research Council”. The only difference lies in a smaller number of national research institutes and researchers compared with “Council for Scientific and Industrial Research (CSIR)”. Public R & D institutes in India are highly concentrated and administrated by the central government. States or below have no or few science and technology institutes or R & D organizations. A few states, such as Bangalore in Karnataka state has “Biotechnology Park”, which is funded and operated by the state.

This is one of the few exceptions. The State Government is responsible for part of the promotion of primary science and technology, but most of the promotion is managed and operated by private voluntary associations and non-governmental organizations. Since the Government's chief goal is to achieve import substitution, substantial research funds have been invested for applied research areas (41.7%); while in the field of industrialization, capacity of technology-to-industry transformation is extremely weak due to a mismatch with enterprise R & D activities.

Since India's economic reform in 1990s, private enterprises have emerged. The growth of private enterprises mainly benefited from the wave of globalization, especially from industry subcontracting of United States and Europe. Industry subcontracting refers to outsourcing of low-end and non-core technology development and services to these enterprises, integrating them into the production chain of European and the United States enterprises. Since then, India's private enterprises began to export intelligence-based software and outsource services to reduce the pressure on domestic resources and environment. However, the rise of private enterprises is not planned by India's scientific and technological system. It is market-oriented and focused on civilian scientific and technological fields, such as information technology, software technology, international service outsourcing, and pharmaceutical industries. This does not match the government-led fields such as space, defense, and nuclear energy, and pushes out the combination issue between applied research results from national research institutes and the market demand of enterprises.

According to "Indian R & D Statistics Report" by Ministry of Science and Technology in September 2006, the annual total R & D investment was 4 billion dollars, accounting for 0.80% of gross national product in 2003. During 1999 to 2003, R & D investment maintained an annual growth rate of 9.6%. Among national R & D inputs in 2003, the central government accounted for 62.6%, local governments accounted for 8.5%, higher education accounted for 4.1%, state-owned enterprises accounted for 4.5%, and private enterprises accounted for 20.3%. Clearly, governmental investment, especially the central governmental investment accounted for most R & D investment. Local governments had not invested much; universities invested quite a little. Among national R & D investment, basic research accounted for 17.8%, applied research 41.7%, experimental R&D 34%, and others 6.5%.

In 2003, total entrepreneurial R & D investment of Indian reached about 1.1 billion dollars, accounting for 0.47% of entrepreneurial annual sales revenue. Among them, the state-owned enterprises accounted for 18%, mainly for national defense (41.9%), electricity (22.1%) and electronics (14.2%). Private entrepreneurial R & D investment reached 36.4825 billion rupees, accounting for 82% of business R & D investment, focused on pharmaceuticals (21.3%), communications (9.3%) and transport (7.6%). Obviously, although the proportion of enterprise R & D investment was not high, it was relatively concentrated on the pharmaceutical industry, which had become a highlight. Government and enterprises complemented each other in science and technology R & D investment. The government paid more attention to defense, space, and nuclear energy, while entrepreneurial R & D investment was more concerned about people's livelihood and market, focused on medicine, information, biology, electricity, agriculture, forestry, and fishing. Overall, entrepreneurial innovation investment is not strong in India. Entrepreneurial R & D investment accounted for 25% of the total R & D investment.

It is a very regular pattern to find the government plays an important role in industrial development in developing countries, for them to realize their catching up. When we trace the historical industrial dynamics both in India and China, we can easily find the different evolutionary process and development trajectories, especially from the perspectives of policy, even though they may have the same policy development targets at the initial stages. Clearly, in IT industry, both China and India governments tried to develop hardware and software industry (the latter in a second stage and in a slightly lesser extent). But presently one sees only Chinese hardware industry and just Indian software industry to have gained a world reputation. World Factory and World Office, the two slogans on these countries, have been mainly named from these two industrial developments in the IT sector. From this, it seems that government shows the preferable development directions, but that enterprises select the business models and go to other directions based on the assets and capabilities they have under the institutional environment. In analytical terms, one is faced with seriously testing the ‘common knowledge' that hardware developed in China out of opening to foreign Joint Ventures while a State-protected electronics stagnated in India, and that Indian software blossomed out of investments from 'Non-Resident Indians' in a way that was largely initially un-noticed thus unregulated by the Indian State, while nothing like this could easily happen in China. Beyond this accepted common knowledge, lie two questions, at both the firm and the national levels. At the firm level, what was the emancipation technological trajectory of indigenous firms? At the national levels, what were the interplays between the web of firms and the State's actions?

Keeping back to the larger picture, under the presently same opening economy background, though India is nearly 10 years behind China, more and more FDI are dominating internal markets in different sectors through joint ventures or Greenfield affiliates, which put several limitations on the possibilities for national firms to achieve technological catching up. India and China have followed different strategies with different implications concerning technology emancipation and innovation capabilities accumulation. Taking the IT industry development as the example, we could find that domestic firms play more important roles to the industrial development in terms of productions values, exportation in India, and while in China, obviously both foreign firms and national firms contribute more to the industrial development. However, IT industry in both these two countries shows international market driven, especially software industry in India, and hardware industry in China during recently 5 years. Despite that, domestic market keeps its critical roles in both software and hardware industry in China, but are still very marginal as for India. In addition, the comparative analysis on international market driven or domestic market driven and FDI driven or domestic firms driven essentially reflects different modes of industrial innovation, production innovation or process innovation, Organizational innovation, market innovation (business model innovation), radical innovation or incremental innovation. Different innovation modes have been come out based on the national knowledge and industrial base and institutional environment, while different innovation system and within institutional arrangement decide the innovation modes. Further, different innovation modes influence the economy development models. Normally, the production innovation may create more jobs, while much process innovation always has relationships with jobless growth. Here, it is also interesting that we found the different industrial innovation system in these two countries. The general same actors in the two countries show different interactions among each other within the industrial innovation system, and the different characters and organizational modes of national innovation system.

2 Literature review and analytic framework

2.1 National Innovation System as the basic analytic background

Chris Freeman, Bengt-Ake Lundvall and Richard Nelson coined the notion of national innovation system (NIS) and together with Bo Carlsson, who introduced the notion of industrial dynamics (Carlsson 1989), which laid the foundations for the new agenda of research on specialization, innovation and economic performance. The agenda emphasizes institutional learning and intends to answer the questions including "what determines the possibilities of innovation?", "How do national patterns of specialization, including the location of firms, affect innovation and economy performance?", "How do national specific institutions affect innovation and economic performance?", "How are different innovation processes affected by economic policy?" and so on[3].

There are several basic insights about NIS, which includes understanding the economic success in industrial innovation depends on long-term relationships and close interaction with external agents, such as the firms' attention to the needs and wants from users; non-market relationships such as power, trust and loyalty;

[3] Henric Sornn-Friese, Frontiers of Research in Industrial Dynamics and National System of Innovation, Industry and Innovation, Volume 7, Number 1, 1-13, June 2000.

possibilities for establishing organized markets differ from one country to another. In general, it includes the rules, routines, and norms together with the dispersed and local knowledge agents possess with affect the interactive learning and innovation connected to everybody economic activities. Nowadays, NIS researches are much more intensive and focus on specific issues. Different scholars have approached the issues by different tracks and analyses of NIS and of other types of innovation systems (regional, technological, sectoral and so on) are diverse. For instance, in order to further analyze the sectoral or industrial development of the sectoral innovation system, Malerba et al. (2001) and Nelson et al. (2001) considered the domains of knowledge and technologies, demand conditions (or market regimes), actors and networks and coordination among them, and the surrounding institutions including IPRs, laws, and culture, etc. This framework further allows disentangling of the similarities and differences of industries at the regional, national and even multinational levels.

In this general framework of technical and institutional analysis of innovation, we want to contribute with one additional angle. To the four parameters stated above, one has to add another one, which is that dynamics within firms interact with their environment in a temporal sequence, and then one has to integrate the dimension of the business models pursued by firms. If we adopt a rather coarse but dynamic definition of a business model as being the dynamic interactions between market development, technological portfolio change and value chain positioning, then we can speak of stylized models or modes of business models. Of course, business models first set out a priori market goals and technological targets. But these interplay to set out what is a posteriori the business model in which a firm stabilizes. We thus thinks that looking at the business model of a firm is a rewarding heuristic way to look at market drivers for innovation, as well as to look at how market forces and internal industrial organization interact in shaping innovation.

This point we add is related to comparative dynamics. In that respect, within a *given* NIS, we compare IT sector so as to comparatively identify how innovation is explained when the strategic dimension of technology or when the strategic importance of locating ones industry at a point of the value chain changes. In the same comparative mode, we compare China and India for these sectors, not so much in terms of different characteristics of their respective NIS, which is implicit, but also by explicitly relating the individual trajectories of firms' business models to the national trajectories. In order to so, we establish and work based on stylizations of business models, and stylization of groups of firms which, within an industry, follow similar models.

Indeed, though NIS theories include the economic factors like market as the demand side in their analytic framework, they still mainly focus on the knowledge base and technological innovation issues. The development of industrial dynamics theories in early 2000s contributes in a very critical complementary way. Industrial dynamics revolves around the manner in which the confrontation between the creative innovators and economic actors who select projects yields economic growth. Economic growth is basically a result of experimental project creation and selection in dynamics markets and in hierarchies, and of the capacity of the economic system to capture winners and removers, which is the core nature of the experimentally orgnized economy (EOE) (Carlsson 2003). In order to explain the mechanism those creates new technologies and convert these into economic growth, in stead of define the demand and supply side, Gunner Eliasson defines the intersections of the technological system and the competence bloc as the market for innovations where technologies are combined innovatively into new composite technologies that are selected on commercial criteria to be allocated to profitable uses supported by the actors in the competence bloc. Other factors, notably institutional ones, are also at work in the economy, supporting the creative mechanisms in the technological system and the selection mechanisms in the competence bloc. The dynamics of EOE represent a theory of micro-based endogenous growth. The EOE yields economic growth through experimental creation and selection of innovative projects in markets (entry), while at the same time forcing badly managed incumbents or new losers to exit. This is a typical (dynamic) efficiency problem. It is the mechanisms that generates innovations and filter them by economic criteria, and thereby to endogenize economic growth. Here we could see that comparing with the innovation system framework; EOE focuses more on the firm strategic selections facing the market dynamics.

2.2 Multidimensional innovation modes with core of innovation capabilities

When corporations select different business models for dealing with the market and technology in order to enhance their innovation capabilities, they select multidimensional innovation modes. Regarding innovation capability, Ernst (2008) suggested using a broad definition, including not only technological knowledge but also complementary ‘soft’ entrepreneurial and management innovations. Especially useful here is work on measures of firm-level innovations (Hobday 1995). The last of these developed the first comprehensive taxonomy of firm-level capabilities required for production, investment, minor changes, strategic marketing, establishing inter-firm linkages, and major changes. Its emphasis on strategic marketing is supported by recent case studies of Lenovo and China’s handset industry (Xie and White 2004) that highlight the roles of distribution channels and close interaction with end users as preconditions for developing innovative capabilities.

According to Dieter Ernst, “innovative capabilities” broadly to include the skills, knowledge and management techniques needed to create, change, improve and commercialize successfully products, services, equipment, processes and business models. R&D is important but so are complementary “soft” capabilities. Research on successful innovations demonstrates that “the technology is the easy part to change. The difficult aspects are social, organizational, and cultural, according to Norman (1998). In short, in addition to R&D, the following complementary “soft” innovative capabilities: sense and respond to market trends before others take note (“entrepreneurship”), recruit and retain educated and experienced knowledge workers who are the carriers of new ideas, global knowledge sourcing for core components, reference designs, tools, inventions and discoveries raise money required to bring an idea quickly to the market (the litmus test of innovation) deliver unique and user-friendly industrial designs (especially for fashion-intensive consumer devices, like mobile handsets) develop and adjust process management (methodologies, organization and routines) in order to improve efficiency and time-to-market manage knowledge exchange within multidisciplinary and cross-cultural innovation projects; participate in and shape global standard-setting; combine protection and development of intellectual property; and develop credible and sustainable branding strategies.

Literature study shows that innovation can be classified differently by different dimensions. For our convenience, with innovation as the core of our comparative study, we conducted literature review on these different methods of classification, and integrated all these methods to form a more favorable classification for analysis of ICT innovation mode.

In the perspective of innovative content and characteristics, innovation can be classified into product innovation, process innovation, organization and market innovation, based on several national large-scale innovation surveys organized by the National Bureau of Statistics in China in recent years. Process innovation is defined as enterprises adopt new technology or significantly improved process equipment or production methods to produce new or significantly improved products or services. New or significantly improved process here must be new for enterprises, but it does not require the enterprise adopt the technology ahead of other enterprises, no matter whether the process is developed by this enterprise or by other enterprises. Process innovation does not include a simple change of organizational or management mode. Product innovation is defined as enterprises put new products or significantly improved products into the market. The new products or service should not have been previously put into the market by enterprises (new for enterprises). Such products and services may have previously been on sales market of enterprises (not necessarily new for the industry or market of enterprises), no matter whether the process developed by this enterprise or by other enterprises. Organizational innovation means to change the organizational structure and management mode of enterprises in order to enhance the use of knowledge, improve the quality of products and services, and improve technology. Market innovation is defined as enterprises adopt new or significantly improved design and sales methods to appeal more customers for the products and services.

The above classification method adopted by the innovation investigation in China basically followed the OECD / Eurostat (2005) classification method, which classified innovative activities of enterprises as product innovation, process innovation, market innovation and organizational innovation basically with the same meaning. Product innovation is defined as enterprises put new products or significantly improved products into market, such as products with improved software or components, or products easier for customer’s use. Process innovation or production process innovation refers to introduction of new or significantly improved production processes and distribution methods. This innovation is new for enterprises, but not necessarily new for sales market of enterprises because other enterprises may use this innovation. Production process innovation does not include simple adjustment of organizational structure for enterprises. Market innovation and organizational innovation have the same meaning as mentioned before.

Innovation can be classified as original innovation, integrated innovation, and re-innovation after digestion and absorption by the path it is fulfilled. Original innovation is defined as enterprises master the core or key technologies with independent intellectual property rights through R&D activities; integrated innovation refers to innovation of enterprises by integrating multi-kinds of resources and technology; re-innovation after digestion and absorption refers to innovation of enterprises based on digestion and absorption of imported technology.

Innovation can be classified as incremental innovation, architectural innovation, modular innovation and radical innovation by its degree. “Incremental” innovations take both the dominant components and architecture for granted, but improve on cost, time-to-market and performance. They do not require science inputs but do require skill and ingenuity, “Modular” innovations introduce new component technology and plug it into fundamentally unchanged system architecture. This type has been a defining characteristic of the PC industry - within each generation of the Wintel architecture (combining Microsoft’s Windows operating system and Intel’s microprocessors), specialized suppliers have introduced new component technology, for instance for memory, storage and display devices (e.g., Langlois and Robertson, 1992; Baldwin and Clark, 2000). These have been made possible by a division of labor in product development: “(m)odularity is a particular design structure, in which parameters and tasks are interdependent within units (modules) and independent across them.” (Baldwin and Clark, 2000: 88). “Architectural” innovations are “innovations that change the architecture of a product without changing its components” (Henderson and Clark, 1990: 9). They use existing component technologies but change the way they work together. “Radical” innovations involve both new component technology and changes in architectural design. They require breakthroughs in both architectural and component knowledge. Distinguish among incremental, modular, architectural and radical innovations (Henderson and Clark, 1990). Dieter's study showed that the more successful Chinese IT firms tend to focus on a combination of incremental and architectural innovations, modular innovations are less frequent, and radical innovations are limited to state-supported mega-projects.

We exemplify here how integrating innovation modes on firm level by business models complements existing approach and allow in turn to establish in a more symmetric manner how policies on the one hand and technology-leverage *as well as* market leverage on the other hand interplay.

We base our work on case interviews, studies we have been done in China and India, the secondary data industrial level analysis, governmental documents and relevant literature.

3 Origins and Growth dynamics of ICT Industries in China and India

This section provides for the institutional and regulatory background of sectoral regulation and State-led innovations that have long shaped the construction of a NIS, and still influence its change.

3.1 IT industry: from the similar strategic starting point to different trajectories

3.1.1 Evolving large scale manufacturing capabilities of Chinese hardware industry

In China, in Pre-1978, with governmental policies under the era of planning economy and the military system, China established strong, and self-reliant industrial S&T infrastructures including research institution, educational system and factories, both hardware and software industry have benefit it a lot and developed in-phases. Semiconductor industry technological level once reached high level even comparing with advanced level in the world. From 1978 to 1989, the administration of electronics industry has been shifted from military to civil, and the Ministry of Electronics industry has been established. More and more firms started to produce civil electronic products through technology importation and technology alteration under the initial opening economy stage. Electronic industry was one of the earliest industries which open to the abroad. The first group delegation to investigate abroad could be traced in 1972. Technologies transfer had been strongly encouraged by the government from research institutes to firms. Many institutes had their own economy entities. After the discussions of the policy makers, the industrial development strategy was decided in 1986, which was to first develop consuming electronics industry. Before that (1980-1985), electronics components once were the strategic targets in order to solve the problem of low technology and quality of electronics products. These strategies mainly designed on the domestic market demands, and through the development of consuming electronics products pull components and IC development. Another judgment was that investment industry still had no huge potential market demands at that period. Still at that period time, computers, IC, software and switching board were the four policy development priorities, and gave many favorable policies including taxes and wages etc. Hardware industry (mainly consuming electronics industry like TVs) has been booming since then. From 1990 to 1999, in 1993, taking the samples of Golden Bridge, Golden Card and Golden Custom project, Chinese Informatics Process has been implemented. Hence, hardware industry including computer industry, telecommunication industry and software and services industry develop very rapidly. During this period of time, market structure once formed the concentration trend due to the "national champion strategies" issued by the government in order to construct big national electronics companies through merger and reconstructions. Since 2000 onwards, we could see rapid growth of international demands and still high domestic demands on Chinese IT industry. In addition to hardware industry, clearly shows the exportation led growth, software industry started the booming growth due to the strong policy influences (NO.18 document etc.) but still rely on domestic demands. The market structure presently shows co-existence of large and small firms, with software and IC industry initially rapid growth.

Figure 1: Dynamics of the Number of China Electronics Industry Enterprise

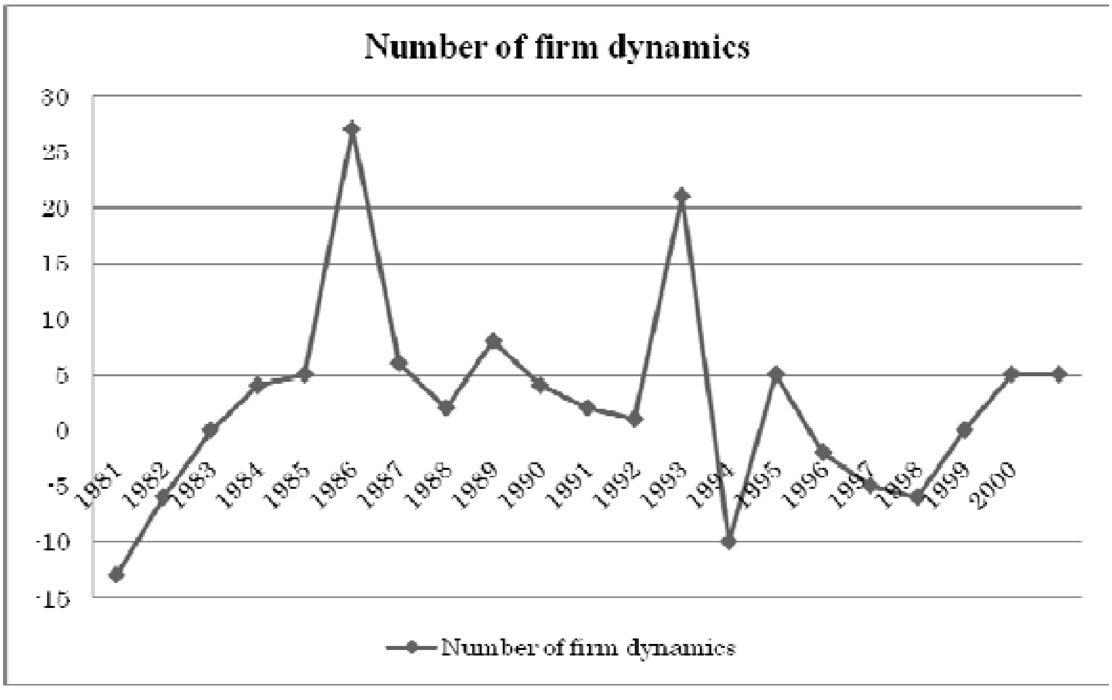


Table 1: Economy Types of Electronics Industry Enterprise Percentages of TPV

Year	FDI	State-owned	Others
1985	3.35	73.89	22.76
1990	10.09	69.79	20.11
1995	37.48	40.10	22.41
2000	46.85	25.91	27.24
2001	54.70	21.08	24.22
2002	67.79	10.15	26.62
2003	69.68	10.62	16.32

Calculated according to the data from China's Electronics Industry Yearbook.

Current market structure presents China's electronic information product manufacturing industry as a decentralized monopolistic competition market. Specifically, the ICT market, which has a large number of small and medium-sized enterprises as the main body, is dominated by large enterprises. In 2007, there were 397 large enterprises in the industry, the number of which was much smaller than that of small and medium-sized enterprises, 2632 and 11269 respectively; however, economic indicators of large enterprises were all significantly higher than that of small and medium-sized enterprises.

Table 2 Comparisons among electronic information product manufacturing of different sizes in 2007 (in: 10000 RMB)

Economic indicators	**Large-sized**	**Medium-sized**	**Small-sized**
Number of Enterprise	397	2632	11269
Output value of new products	55767380	26084813	9770857
Export value	176770878	81273266	22959660
Industrial Added Value	53457290	29650168	16371820
Average number of employee	2365890	2530727	1851566
Main Business Revenue	255022930	132769522	66454839
Total Profit	7968725	5578464	3086580

Sources: Editorial Committee of Yearbook of China Information Industry, Yearbook of China Information Industry in 2008, electronics.

Table 3: The main business revenue shares of different sub-sectors in China electronic information industry in 2007

Sub-sectors	Percent (%)
Electronic Devices	11.3
Electronic Components	18.9
Domestic TV Set and Radio Receiver	8.2
Telecommunication Equipments	16.6
Computers	34.7
Radar Equipments	0.2
Others	10.3

Sources: Editorial Committee of Yearbook of China Information Industry, Yearbook of China Information Industry in 2008, electronics.

The following is export situation of electronic information products in China. In 2007, total import and export of electronic information products amounted to 804.7 billion dollars, accounting for 37% of total trade. Exports amounted to 459.52 billion, accounting for 37.7% of total exports. Imports amounted to 345.18 billion dollars, accounting for 36.1% of imports. From the perspective of product structure, in 2007, computers, communication equipment and household electrical and electronic products remained the main body in the import of electronic information products, totaling 313.14 billion exports, accounting for 74.4% of total electronic information products exports. In 2007, import of electronic components, computers and electronic components reached 278.1 billion dollars, accounting for 80.6% of total electronic information products imports.

Table 4: The export shares of main products in China electronic information industry in 2007

Main electronic Products	Percent (%)
Electronic Devices	8.6
Electronic Components	10.1
Domestic TV Set and Radio Receiver	15.7
Telecommunication Equipments	16.7
Computers	42.3
Radar Equipments	6.6

Sources: Editorial Committee of Yearbook of China Information Industry, Yearbook of China Information Industry in 2008, electronics.

During the whole evolutionary from IT industry in China, one thing should notice about the sources of knowledge base and the technological infrastructure at the initial stage industrial development. In the mid-1980s to the late 1990s, through reform of the nation's science and technology (S&T) institutes and the organization of industrial enterprises related to them, China engaged in the indigenous innovation in the computer industry. Chinese computer firms like Stone, Lenovo (former Legend), Founder and Great Wall in becoming self-sustaining enterprises, they emerged out of and drew upon the technological resources of China's infrastructure, itself a legacy of the era of central planning. These firms also absorbed technology from abroad through a variety of organizational arrangements, but these firms didn't merely engage in learning from the advanced economies, rather they integrated foreign technology into their indigenous innovation strategies. S&T infrastructure that China had put in place during the era of central planning was important for providing technological capabilities to indigenous innovation in the 1980s and 1990s. It was scientists and engineers who had a deep understanding of the key technological disciplines involved and who were willing to take leadership positions to transform that knowledge into revenue-generating products. While they invariably started their careers as salaried (or "rion rice bowl") employees within the state S&T infrastructure, they were willing to play entrepreneurial roles when given a chance. China's economy reform process gave them that chance by making it possible for them to use the S&T infrastructure as a foundation for their entrepreneurial endeavors[4].

Besides, it is worth mentioning that FDI has had a great impact on the development of China's electronic information industry in the past 10 years, not only on capacity and size of production, but also on the technology and innovation capacity. Of course, impact of technology transfer of foreign-invested enterprises on technological capability, especially innovation capability of China's electronics industry is a dynamic change process. This process changes as domestic market and technological capabilities of domestic enterprises change. Analysis showed that foreign-invested enterprises and state-owned enterprises have a significant gap in technological capability. Foreign-invested enterprises are several times or even dozens of times of state-owned enterprises in technological capability accumulation and technological innovation output indicators, including investment on R & D personnel, capital investment, and outputs of new products and patents. This gap has narrowed significantly in the past two years, but still exists. In electronic industry in 2005, engineering and technical personnel of foreign-invested enterprises was 2.43 times more than that of state-owned enterprises, technological development fund 1.81 times, total inner expenditure of technology development fund 1.61 times, fund for new product development 1.61 times. Gross output value of new product, sales revenue, total profits and taxes were 2.5 times more than that of state-owned enterprises. Patents authorization was 1.49 times more than that of state-owned enterprises. For

[4] William Lazonick, Indigenous Innovation and Economic Development: Lessons from China's Leap into the Information Age, Industry and innovation, Volume 11, Number 4, 273-297, December 2004.

foreign-invested enterprises, the main source of technology was from abroad. In 2005, fund for technology transferring in foreign-invested enterprises was 6.73 times more than that of state-owned enterprises in the electronics industry. Meanwhile, foreign-invested enterprises have a strong export orientation, and the value they create mainly shift abroad. In electronics industry for consuming, key and core electronic components, chips, operating systems, and large numbers of specialized instruments and equipment are dependent on imports, in particular screens for flat-panel television, totally relying on imports.

By comparing economic indicators of domestic-funded and foreign-invested enterprises in electronic information product industry in 2007, we can see foreign-invested enterprises were higher than domestic-funded enterprises in all the following indicators, new product value, value of export, industrial added value, average number of employees, product sales revenue and total profits. If Hong Kong, Macao and Taiwan enterprises were counted as foreign-invested enterprises, then the gap would be even larger.

Table 5: The Comparative Analysis of Electronic Information Product Manufacturing Between Domestic Capital-Owned and Foreign Capital-Owned in 2007 (in: 10000 RMB)

Main Economic indicators	Domestic Capital-Owned	Hongkong, Macao, & Taiwan	Foreign Capital-Owned
Number of Enterprise	7746	2884	3668
Output value of new products	31719717	14341621	45561711
Export value	28199517	50785714	202018572
Industrial Added Value	24972452	21062855	53443971
Average number of employee	2013028	1764082	2970373
Main Business Revenue	95648904	94623214	263975174
Total Profit	4469668	3027844	9136257
Comparative Analysis of Software Industry in 2007 (in 10000 RMB)			
Main Economic Indicators	Domestic Capital-Owned	Hongkong, Macao, & Taiwan	Foreign Capital-Owned
Number of Enterprise	12338	420	1615
Revenue of Software	39188830	5149026	14005643
:Revenue of Software Products	12413146	2202384	3212665
Revenue of System Integration	8010652	970956	1695897
Revenue of Software Technology and Services	8370352	1176713	4191516
Revenue of Embedded System Software	9558694	614111	3989346
Revenue of IC Design	835986	184862	916219
Export of Software Service Outsourcing	850993	82979	472214
Export Revenue of Software	610966	61118	352338
Export of Software Service Outsourcing	56930	2972	43894
Export of Embedded System Software	484866	6468	193037
Number of Employee at the End of 2007	1116484	103339	309154
Software R&D Personnel	425145	29972	118630
Manager	132969	8862	28199

Sources: Editorial Committee of Yearbook of China Information Industry, Yearbook of China Information Industry in 2008, electronics.

3.1.2 Evolving service capabilities of Indian software industry

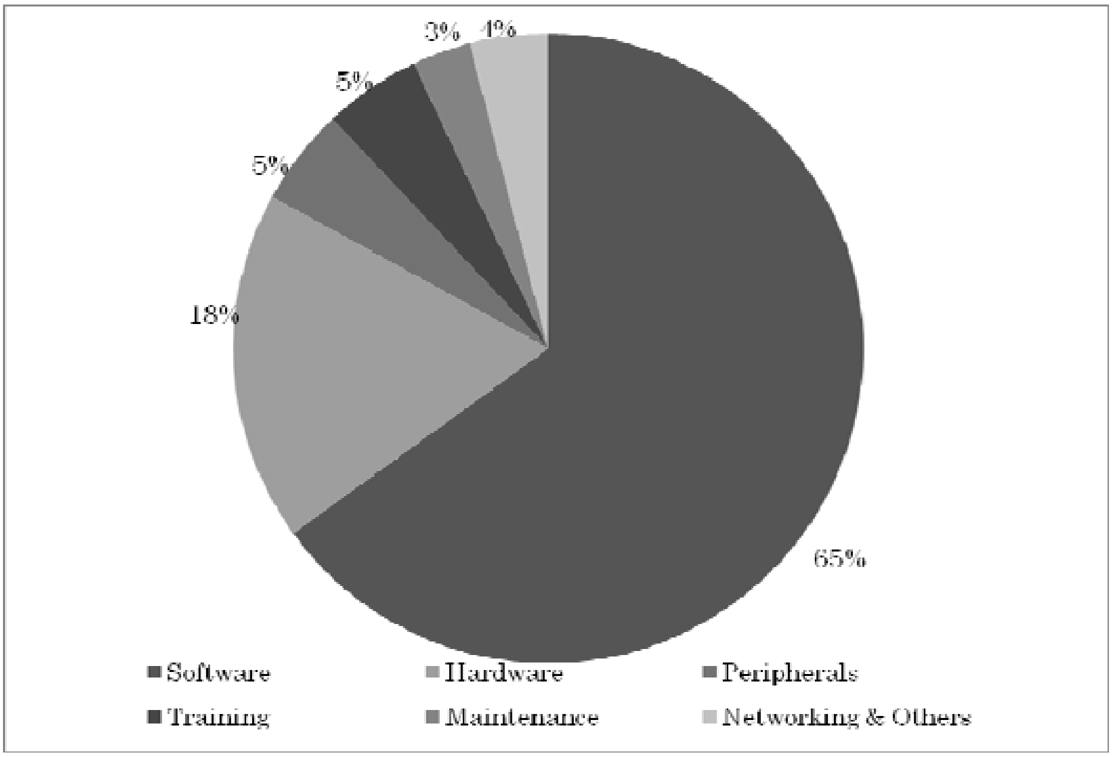
The study of the software sector (which notably includes telecommunication software but not telecommunication systems) shows that processes of value chain integration had already started from the mid 1990s, but that there is definitely a turning point around the 2000 internet crisis in the developed economies. The Indian IT Industry had grown from 40% to 50% per year from 1994 to 2000. The CAGR is then of 28% over the period 1998-2005. Its turnover marked acceleration with the end of the internet bubble, when firms from the West had to curtail costs and accelerate outsourcing to India. Having started from US$ 2.0 billion in 1994-95 (initially with a large hardware component at that time), it was US$ 8.7 billion for the year ended in March 2000, reached US$ 13.5 billion in 2001-2002, based on the export of services (60% exported to the US and 24% to Europe; source: Nasscom).

The IT sector in few years managed to cover a large variety of products and services with a wide range of technical content in both these segments. The fast growth of these segments led to relativise the share of the hardware component, which after 1997 remained stable in absolute output but sharply decreased in relative share, never managing to develop its exports, the first engine of growth of the Indian IT sector. Table shows the evolution and breakdown of turnovers from 1994 to 2000. Services and Software clubbed with training and maintenance constituted the major part of the turnover amounting to 73% of the total by 2000.

Table 6: Changes in the Breakdown of Turnovers 1994-2000

	1994-95 in mil. US$	**1995-96** in mil. US$	**1996-97** in m. US$	**1997-98** in mil. US$	**1998-99** in mil. US$	**1999-00** in mil. US$
Software	(40.9)	(42.4)	(46.1)	(53.7)	(64.4)	(65.7)
Domestic	350	490	670	950	1,250	1,700
Exports	485	734	1,083	1,750	2,650	4,000
Total	**835**	**1,224**	**1,753**	**2,700**	**3,900**	**5,700**
Hardware(incl. Peripherals)	(45.1)	(44.1)	(40.2)	(32.8)	(22.7)	(23.0)
Domestic	738	1,233	1,231	1,434	1,355	1,885
Exports	183	41	300	220	22	113
Total	**921**	**1,274**	**1,531**	**1,654**	**1,377**	**1,998**
Training	**107**	**145**	**183**	**263**	**302**	**400**
Maintenance	**142**	**172**	**182**	**221**	**236**	**263**
Others	**36**	**710**	**156**	**193**	**237**	**310**
Grand Total	**2,041**	**2,886**	**3,805**	**5,031**	**6,052**	**8,671**

Figure 2: Breakdown of Turnover (Domestic) in 1999-2000



Source: NASSCOM

The 'second period' after the turning point of 2000, saw a sharp increase in IT services, and an accelerated relative decline of hardware. IT services themselves developed comparatively to the sole software segment of the sector, and later on BPO started in a big way (after 2002-03). All this led to large evolution of the structure of the sector. Taking a different sectoral break-up[5], more adapted to this new evolution, table describes this evolution.

Although total value has been increasing (booming) since 1990s, ITES-BPO which is located at the low value end the industrial chain. While the IT services and software, which has been accumulated technological competence and quality until the middle of 1990s shows the decreasing trends.

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[5] The sharp sectoral evolutions led the Nasscom to largely reframe its categorization: BPO emerged from the 'other' category, hardware and 'peripherals' were merged so as to present a synthetic view, and hardware-related service activities were clubbed with hardware. This makes strict difficult strict comparisons between tables 1 and 2, and explains two different figures for the 'hardware' between the two tables.

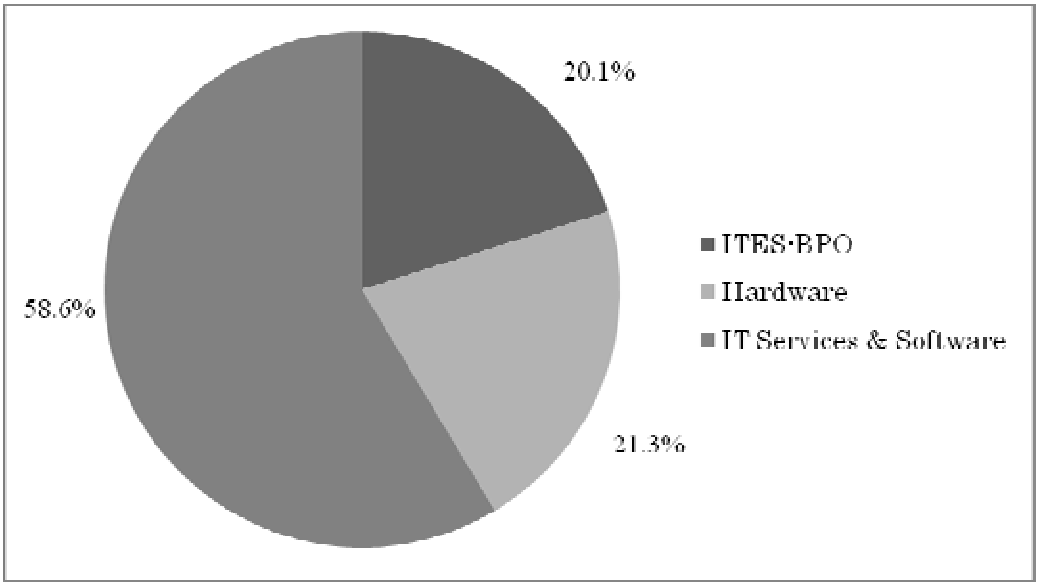
Table 7: Changes in the Breakdown of Turnovers 1999-2005

	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05
IT service & software (%)	64.6	64.5	65.0	62.2	59.4	58.6
ITES – BPO (%)	6.1	7.4	11.1	15.5	18.2	20.1
Hardware (%)	29.3	28.1	23.9	22.3	22.4	21.3
Total value (bn $)	8.2	12.1	13.4	16.1	21.5	28.0
Share in GDP (%)	1.9	2.7	2.9	3.2	3.5	4.1
Exports value (bn $)	4.0	6.2	7.6	9.9	13.3	17.9

Source: NASSCOM

At the turning point of 2000-01, the sector represented 2.7% of India's GDP. The year 2001-2002, which witnessed a global crisis in the IT sector (in terms of the evaluation of assets as well as growth) and a recession in the United States (the market-leader), reinforced the significance of India's comparative advantages, as predicted by Bomsel and Ruet (2001). Indeed, growth remained positive at 10.6% and earned US$ 13.4 billion in revenue in 2001-02. There is no doubt that growth slowed down considerably after the crisis (annual average growth between 1998-1999 and 2000-2001 had been 42%). Nevertheless, this business model of development was firmly established, and recuperated as soon as from 2002-03. Thereafter, analyses forecasting the acceleration of outsourcing of American IT firms to India were reinforced by subcontracting, and BPO developed, explaining the accelerated surge in exports share in the sector's income, noticeable right from 2002-03.
The situation today is well graphically represented by Figure.

Figure 3: Breakdown of Turnover in 2004-2005



Source: NASSCOM

Table 8: The Shares of India Exported Electronic Information Products in 2007

Electronic Products	Percent (%)
Electronic Components	11.9
Electronic Products for Consumption	24.6
Electronic & Telecom Equipments	7.8
Wireless Communication & Radar Equipments	-
Medicine & Industry Equipments	2.7
Control & Laboratory Equipments	8.2
Office Equipments	0.7
Electronic Data Processing Equipments	20.3

Sources: Editorial Committee of Yearbook of China Information Industry, Yearbook of China Information Industry in 2008, electronics.

The following is export and import of electronic information products. In 2006, India's total import and export of electronic information products reached 13.667 billion dollars, of which imports reached 12.2 billion dollars. Import of wireless communications and radar equipment reached 4.129 billion dollars, accounting for the largest part of total import, 33.8%. Import of electronic data processing equipment reached 3.98 billion dollars, accounting for the second largest part of total import, 32.6%. In 2006, India's total export of electronic information products reached 1.467 billion dollars. Export of electronic components reached 498 million dollars, accounting for the largest part of total export, 33.9%. Export of electronic data processing equipment reached 3.72 billion dollars, accounting for the second largest part of total export, 25.4%.

Table 9: The Shares of India Exported Electronic Information Products in 2006

Electronic Products	Percent (%)
Electronic Components	33.9
Electronic Products for Consumption	7.45
Electronic & Telcom Equipments	3.6
Wireless Communication & Radar Equipments	9.4
Medicine & Industry Equipments	7.6
Control & Laboratory Equipments	12.5
Office Equipments	0.3
Electronic Data Processing Equipments	25.3

Sources: Editorial Committee of Yearbook of China Information Industry, Yearbook of China Information Industry in 2008, electronics.

To contrast with the electronics industry, Athreye (2005) indicates that “an immediate impact of the liberal policies of eighties in India was an unprecedented shift in the product structure. The growth became concentrated in sectors with higher linkages in terms of imports, whereas sectors with higher linkage in terms of value added and employment lagged behind in output growth. The component sector remained characterized by the lack of investment coupled with low scale of operation and under utilization of capacity. By the end of 1980s the share of semiconductor industry in total electronics investment in India was around 10 percent as compared to the figure of 30 to 35 percent in the developed countries. There was a marked increase in the share of electronics consumer products at the cost of electronic intermediates and electronic capital goods. However, in case of computers, due to the controlled nature of internal liberalization it did become possible to make the foreign companies that had preferred exit to sharing equity with local firms in the 1970s to enter into joint ventures with the Indian partners. The absence of a strategic approach to the strengthening of international competitiveness is even more sharply reflected in the nineties. During the decade of 1990s, the share of communication equipment experienced a marked decline. The production of data processing equipment was not able to keep pace with the ongoing IT trajectory and their share in total output remained stagnant or declined. In the case of electronic intermediates, not only their share declined over the years but also components incorporating higher level of technology like the semiconductor devices recorded a sharp decline, it is to be underlined that even after the introduction of liberalization there has been an increase in the number of products, which recorded high production growth but low export intensity”.

3.1.3 Evolving service capabilities of Indian software industry

A clear contrast comes already despite the initial similarity in State’s efforts. The overt JV policy of the Chinese, often quoted, undoubtedly allowed the sector to take-off for exports, but a continued mix of large and small, public and private, domestic-oriented and international market oriented structure of production ensured the resilience and complementarities of the system at the national level. In contrast, the concentration in the public sector with a continuation of domestic-dominated strategies and a certain continuation of protection measures, inherited from the import-substitution period, definitely led the Indian hardware sector to stagnate in absolute terms, and decline in relative terms.

As far as the evolution if the software sector in India, what is important is the capacity that its firms showed in climbing the value chain. From the mid to late 1980s large numbers of Indian IT professionals migrated to the US, where deregulation and the technological revolution in the telecom sector had created a huge demand for software for switching, routing and multiplexing technologies. By the early 1990s, US as well as European companies had started developing ‘off-shore platforms’ in India (the first ones to do so were Lucent, Cisco, Sun, Microsoft, Siemens and Alcatel). They initially mostly addressed lower modular tasks such as debugging and transcoding, using the wage advantage (nearly one tenth at that time) between India and the US but the model fast changed. The key dynamic that allowed Indian IT firms to climb the value chain was initially to leverage on service by developing their own assets. Indeed, by multiplying the execution of outsourced contracts, they started being able to find some modularity across all of them, and to develop software modules, to benefit form economies of scale, and soon of range. That allowed them to generate enough cash flow to invest into proprietory algorithms, software, modules, and from there to raise issues of climbing the value chain. Their positioning of the international markets provided them with the scale opportunity to leverage on their cost advantage, into quality. Being in a field where the capital intensity of technological equipment is low, the software industry did not utilize much the NSI, nor had the investment the Indian State done in it (except in terms of induction of trained professionals).

The Indian government exempts the software enterprises that registered between 1999 and 2009 from the enterprise income tax and imported equipments tax for ten years. The government provides the land, water, and electricity for the R&D enterprises at a favorable price, and permits oversea capitals to control the R&D enterprises. According to the statistic of the National Association of Software Service Companies (NASSCOM), the overall value of information industry and outsourcing in India was 29.6 billion dollars in 2006, and the export reached 23.6 billion dollars, which increased by 33% than the last year. Of the 29.6 billion dollars, information services amounted to 13.3 billion dollars, ITES and BPO 6.3 billion dollars, and project services and products 4 billion dollars. 95% of Indian software products are sold to the international market, and the domestic demand is very weak. The export of software in India ranks the second in the world. The export destinations include more than 100 counties and territories. 200 enterprises out of the world’s top 500 have contracted software development tasks with India. Currently, export of software has taken up to 10% of India total exports.

The top 10 software enterprises, which grew up after 1980s, accounted for 80% of the gross output value of Indian software industry. For instance, Infosys, the largest Indian software company, had only 7 employees in 1981 when it was established, 300 in 1992, and 3000 in 1999. In 2006, the number of employees increased sharply to 56000. The sales revenue was only 300 dollars in 1981, and sharply increased to 2.5 billion dollars in 2005. It was successfully listed on NASDAQ in the United States in 2005. In the view of Mr. K. Denish, the board chairman, also one of the company’s founders, the success of Infosys lies in the strong market competitiveness brought by talented software personnel, strict company management, and high-quality customer services.

To eliminate the concerns about intellectual property rights and information security from American enterprises, Indian software enterprises take the most strict security measures. For instance, unlocking equipments with key are installed to all doors to prevent personnel from different departments to drop around; there is no access to Internet, no any storage or download interface in the internal computers, and any E-mail must be filtered by public relations department. All data input, processing, and analysis are controlled by the central server; immediately the data processing is over and the results are submitted, the data will be completely closed and saved. All data are confidential and only the users have the right to check them. No other people, even the board chairman, have the access to the data. Enterprises are very vigilant to security of online data transmission. They make sure that any attempt to illegally log in to steal the data will be written down at the transmission port and in the dataset so as to trace the security issues.

However, as the main customers of ICT in India are large foreign enterprises, and the domestic demand is small, with a limited employment capability, the ICT in India has about 2 million employees, and plays a limited role in the economic growth. In order to win the campaign, the governing party makes many extraordinary promises to the electorates, such as lowering the medicine price, electricity price, and water price. This further compresses profit space of the private enterprises, and big enterprises transfer to foreign market to get more revenues. This leads to a high internationalization extent of India enterprises, and excellent performance of a few huge enterprises, which bring the image that Indian enterprises have strong innovation capacity.

Another notable feature of Indian software industry is that, rather than the development of the core technology, the R&D inputs focuses on building rigid, world-level, model–based enterprise internal management system and high quality service system. Along with the selection of talented people from the world, talented people, management, and service become the three crucial elements of innovation competiveness of enterprises.

4 Different innovation modes of ICT enterprises in China

Currently, electronic information industry in China is entirely transiting to an innovation-driven pattern. Foundations of this transition have been met. Firstly, a large-scale production capacity has been formed, so as to share the huge R&D costs which are required by industry innovation development. Above-scale manufacturing sectors reached main business revenue 5.1 trillion RMB, and the added value was

1.49 trillion, accounting for 5% of total GDP in 2008. The industry scale ranked second in the world. Secondly, the continuous growth of investment ability provides strong support for industry innovation and development. In electronic information industry, multinational companies are increasingly moving research and development agencies to China with the concern of closing to the production base and market. Thirdly, the opening up keeps on deepening, and segmentation and expansion of the domestic demands are growing, both of which provide great space and potential for the reorganization of elements during the transition process. Fourthly, through continuous economic growth due to the reform and opening up, electronic information product manufacturing industry has formed a relatively complete industrial organization system, and has possessed a high level of capacities to organize production elements and keep sustained high yield; industry matching conditions are continuously improved. Typically, the electronic information product manufacturing clusters in the Pearl River Delta, Yangtze River Delta and Bohai Rim, are conducive to the deepening of labor division, technological and organizational innovations during the transition of growth pattern.

Under the national innovation system analyzed above, the different strategic decisions and actions determine the main directions of industry development and industry structure in the process of industrial development. Whether industry development is mainly dependent on innovation, and the extent to which industry development relies on innovation, are closely related to the strategic decision-making of different main bodies. According to our investigations of the Chinese ICT enterprises, innovation strategy of ICT industry can be summed up as two major points, gradual catch-up strategy of enterprises based on market, and radical innovation effort based on technology supply at the national level.

4.1 Enterprises' gradual catch-up strategy

At present, a small amount of companies leading innovation in China's electronic information industry have emerged, such as Huawei Technologies and ZTE in communication equipment manufacturing. Although they were not the creators of core technology in the early stages of development, and started their business relying on switches for small-scale users in the 1980s, they seized the opportunity of the mobile communication technology upgrading from the first generation to the third generation, and initially grasped the development capabilities. When the overall technical capabilities have caught up with the first-class leaders, they began to own original innovation, and thereby achieved technological catch-up. Now, Huawei is among the world's first camp in the field of 3G, and ZTE is leading the world in the terms of GoTa digital clustering products. As shown by World Intellectual Property Organization (WIPO), Huawei applied 1737 patents and became the world's largest patent application enterprise in 2008. In addition, in emerging industries such as multimedia chips and gene antibody, some enterprises owning core technologies and international cutting-edge R&D capabilities have appeared. Taking Vimicro as an example, it made breakthroughs in the seven core technologies in multimedia field, and applied more than 600 domestic and international patents, and received more than 120 patent licensing. Original innovations of these leading enterprises have played an important exemplary role in improving innovative capability of the entire industry.

Because China's electronic information product manufacturing enterprises are entirely weak at the core technology, and have been at the low end of global industry chain since the beginning stage, the majority of enterprises, therefore, take a gradual catch-up strategy during the development process. The gradual catch-up strategy shows the growth trajectory of these enterprises. Firstly, they managed to get the existent and initiative opportunities by cost advantage and production scale expansion; secondly, they tried to transfer to an innovation-driven pattern by gradually achieving partial catch-up of technology, organization, and marketing. These enterprises emphasize continuously improving innovation, integration technology innovation, and breakthrough of partial key technologies based on the domestic demand. Haier Group, Langchao Group, and Haixin Group are typical examples.

Case 1: Haier Group

Haier has developed into a giant multinational enterprise, producing domestic appliances, electronic products, information equipments, computers and accessories, cooking appliances, industrial robots and etc. Major products such as white domestic appliances, electronic information equipments and home appliances accounted for 70% of the sales revenue. In 2005, the sales revenue reached 103.375 billion RMB, and the export 1.308 billion RMB. The funding on R & D reached 4.565 billion RMB, accounting for 4.4% of the sales revenue. In 2008, the sales revenue reached 122 billion RMB, with 2.2 billion RMB profits, which had increased by 20.6% compared with the profits in 2007. The increase of profits was twice more than that of revenue.

Haier is the world's 4th largest white goods manufacturer and the most valuable brand in China. With 29 manufacturing plants, 8 comprehensive R&D centers, 19 overseas trading companies across the world and more than 50,000 global employees, Haier has developed into a giant multinational company. According to China Market Monitor, the most reliable market consultancy company in China, Haier held over 26.2% of China's household appliance market in 2008, thereby consolidating its market-leading position; and, in particular, its advantage is more noticeable in the high-end market, with an impressive market share of about 30%. It has been taking the lead among white goods brands. Moreover, Haier leads the world in intelligent home appliances integration, network household appliances, digitization, large scale integrated circuit and new materials. "Innovation driven" Haier has been committed to providing effective solutions to global consumers and achieve a win-win situation with them. Up to the end of 2008, Haier has applied for 8,795 patents, among which 2,261 are patents of invention. In 2008 alone, Haier applied for 912 patents, 525 of which are patents of invention, averaging 2 patents per working day. Haier, with its own independent intellectual property rights, has been involved in the formulation of 19 international standards, three of which will be launched soon. It indicates that the independent innovation of Haier has been recognized by the international standard. Haier has been in charge of or taken part in the formulation and modification of 192 national standards (eight of which has won the China Standards Innovation & Contribution Award) and other 439 standards such as the industry-level ones. Haier is the appliance company most involved in raising international, national and industry standards.

Haier's innovation is carried out in different stages. In terms of strategic innovation, different eras have different development themes. Since its inception in 1984, Haier has gone through stages of branding strategy, diversification strategy, going-global strategy, and entered the global branding strategy in 2006.

From the Haier Group's innovation and development path, we can see the following salient features:

1. In terms of technological innovation, Haier relies on industrial integration, horizontal and vertical alike, to conduct research on basic technology innovation in areas like software, chips and materials. Horizontally, Haier takes network appliances technology, appliances recycling, studies on countermeasures to "two European Union directives", and lead-free soldering technology research as starting points. Vertically, with chip technology, SOC platform research, information security technology, environment-friendly materials and nano-materials as the start, Haier masters indigenous technology to guide the way for home appliances and enhance the competitiveness of both Haier and China. At Haier, technology breakthrough must seek legal protection. Without applying for patent, any new technology research and development can not be regarded as completion. Patent application and technology R&D results are one for one or multiple for one, that is, one innovation must apply for at least one patent, and no exception. Through patent application one by one, new products and technological innovation can enjoy a full range of legal protection. During the past 19 years, Haier not only has a large number of patents in China, but also witnesses a growing number of patents in other countries. Now on average, Haier develops 1.3 new products and applies 2.6 new patents everyday. Demand-oriented, research-targeted and timely protection form a "three-in-one" technological innovation model, which ensures market relevance, timely patent applications and global protection. For example, concerning product innovation, Haier provides users with solutions. Haier further improves its six localized offshore centers, located in the Americas, Europe, South Asia, the central and eastern Africa, Asia-Pacific region and

ASEAN respectively, maximizes local-procurement, manufacturing and distribution, thus speeding up logistics and shortening capital turnover. Haier's products have successfully made their way to the top 10 chains stores in the U.S., top 5 in Europe and top 10 in Japan, realizing the goal of selling mainstream products through local mainstream channels. To seize the opportunity brought by China's campaign on "home appliances going to the countryside", Haier has accelerated the deepening of 3rd and 4th- level marketing network, and unveiled "counter lightning and weak signal program", "energy-saving and environmental-friendly program", "special needs plan," "Rural Informatization Program "and so on. Since most washing machines in rural areas are used in the open air, Haier particularly developed washing machines with anti-freeze, sunshine-resistant plastic shells. Since some dairy farms need to use warm water to feed the cow in order to increase milk yield, but without running water and can not install the common water heater, Haier developed solar water heaters which can work without tap water. As some rural areas lack quality electric facilities, even without ground wire, and is prone to electricity leakage and appliances damage, Haier produced water heaters with leakage proof walls, refrigerators with electricity leak-proof sockets and waterproof, electricity leak-resistant washing machines, which are very popular among farmers. Haier has also created a marketing network accessible to villagers, a logistics network that provides door-to-door delivery, and a service network "reaching out to households", so that rural users can truly enjoy the convenience and benefits of the "home appliances going to the countryside," Meanwhile, Haier has achieved its new economic growth.

2. In terms of innovation on organization and management model, the "OEC" management style, the "market chain" management and "individual-goal combination" model, explored and implemented by Haier, have attracted wide attention from the international management community. The "individual-goal combination" model provides new perspective on solving inventory and overdue receivables, wining the international acclaim as a management model that has "accurately measured the pulse of global commerce". Haier is building an autonomous management body that realises "individual-goal combination". The autonomous management body is, by nature, to combine each individual's personal development with that of the enterprise, which builds a platform for every employee. On this platform, staffs' talents can be given full play and be integrated with value creation for users. In this way, Haier can best tap the potential of each employee and follows the people-oriented approach. The autonomous management body works in this way, in which staff from different departments including management, R&D, manufacturing and marketing are brought together with local clients to jointly analyze local demands, and develop products accordingly, so that the enterprise can react to market changes faster. In practice, the enterprise first works with the autonomous body to determine its market share objective, and then links the autonomous body's

income with its performance. Market development costs are included in the costs of the autonomous body and profits are shared by both the autonomous body and the enterprise.

3. Haier Group introduced the "supply upon demand at zero inventory". The model relies on modern information technology and advanced management concepts, abolishing inventory and sending ordered goods straightly to the users, so that market development, product R&D, product supply chain cover the whole process from user demand to user satisfaction, meanwhile, the company can keep abreast of the rapidly changing market needs. The main characteristics of the model are: order-based production; demand-based R&D with the help of advanced supply-demand information dissemination and effective and efficient product R&D approaches; demand-based production; marketing characterized by "cash on delivery" and zero inventory; and demand-based logistics and delivery. Haier's new business model has created a new business process, which has realized supply opon demand and zero inventory, and has effectively desolved the risks of bad debts and high inventory. With the new model, Haier is able to reduce inventory turnover from the previous 20 days to the current five days, or one-tenth of that of other domestic industrial enterprises on average.

4. In terms of market innovation, Haier has put forward a notion of "upgrading the overseas market", that is, using highly value-added products to take up the high-end market. Haier summarized this process into "three steps": first, using niche products to "going out"of China, then the mainstream products to "enter" the mainstream market, and finally highly value-added products and localized brands to "climb" into the high-end market. At present, Haier's India-made refrigerators that you don't need to stoop, Thailand-made anti-bacterial deodorizing refrigerators and Pakistan-made fast-frozen refrigerators have become best-selling high-end products in overseas market. For the U.S. market, Haier has designed a large capacity refrigerator with 700 liters, with a drawer big enough to store a complete turkey, convenient for users on Thanksgiving. In China, Haier believes that it has to burrow deeper. Since the "home appliances going to the countryside" campaign was launched, Haier has seen growing market share. In the domestic market, Haier has accessed all the way to the grassroots levels, including townships, towns, villages, and communities. To this end, Haier has created a marketing network accessible to villagers, a logistics network that can "deliver door-to-door" and a service network "reaching out to households".

Case 2: Dawning Information Industry Co., Ltd.

Dawning Information Industry Co., Ltd was founded in June 1995 as a high-tech enterprise, under the great promotion of the Ministry of Science and Technology, the Ministry of Information Industry and the CAS on the basis of the achievements of national "863" program. It relies on the technology support from the Institute of Computing Technology of CAS, the National Research Center for Intelligent Computing System and the National High Performance Computing Center. It has a strong technical power. Dawing has focused on the R&D, production, and application in the field of server for many years. Relying on solid foundation of supercomputer technology, Dawing has produced a full range of excellent servers with complete intelligent properties by R&D activities and constant technical innovations. These servers have met various application demands of customers from supercomputers to PC servers, and have gained immense successes in the network industry, finance industry, telecommunication industry, biology industry, weather industry, petroleum industry, research industry, and electric power industry.

Dawning’s high-performance computer has been listed as the No. 1 in the high performance computer market for 14 consecutive years, owning more than 70% shares among the domestic high performance computer market. Domestic brands achieved excelling over the international brands in high-performance clustering area. In 2006, the sales revenue of Dawning was 1.6 billion RMB, achieving a growth of nearly 30% for three consecutive years. In October 2009, 2009 annual academic meeting of the high-performance computers was held in Changsha, China. In the meeting, an authoritative statistical agency announced that the share of Dawning high-performance computers took the first place in the TOP100 list. In the TOP100 of China’s high-performance computers list published in the meeting, a total of 27 sets of Dawning high-performance computers were selected. The win of Dawning broke the record owned by HP, keeping on being the first of the TOP100 for seven years. It was also the first time that the share of China’s high-performance computers being the first since the mathematical branch of China Software Industry Association began to select TOP100 list in 2003.

As early as China high-performance computer industry taking the first step, China had encountered a strict embargo on high-performance computers by foreign countries. From 1995 to 2009, Dawning has gone through 14 years as a witness of the whole journey and an active participator in the development of China's high-performance computers. Among the 14 years, China high-performance computers have experienced tremendous development from owning nothing or being weak to being strong. Today, Dawn has launched the "Dawning 5000", the world's top 10 supercomputers.

On Dawning's innovation and development path, following features are salient:

1. Appropriate decisions on technological development are the crucial factor of Dawning's success

With strong competitors everywhere in the IT industry, technological development directions, in which a company can overtake its opponents, are few. The success of independent innovation must be based on sound technical decisions. In other words, in the IT industry, what to do is even more important than how to do it. The correct choice of technology direction is already half way through. During Dawning's development, it has made several major decisions on changing technological directions, sometimes on the technology itself. Fortunately, Dawning has basically made the right decisions, which have much to do with its success today.

Dawning was founded thanks to Dawning No. 1, which itself was a result of the right technological decisions. There would be no Dawning if the original plan to develop smart computers, laid out in 863 Plan (National Hightech R&D Plan）, was carried out, which was to follow Japan's footsteps in developing fifth generation computers. When the large-scale parallel computer, Dawning 1000, came into the picture, 90% of all TOP500 supercomputers were vector computers or large-scale parallel computers, while cluster system carried little weight in the market. Intelligence Center, based on the Moore's Law and the trend of computer standardization, boldly altered the technical development direction to cluster technologies, especially the cluster operating system which had yet to become the industry's standard. Meanwhile, Dawning company, according to users' actual demand, shifted its R&D focus from improving performance of a single aspect to "SUMA", that is, spreadable, usable, manageable and available, and "It'sSUMA" was registered as the trademark of Dawning. Monitoring and control systems with an aim to improve the maintainability of the server have become an important feature of Dawning's various severs and has become the de facto industry standard with many enterprises following suit. The reason that Tianchao products like Dawning 1700 and Dawning 4000L can be widely used in petroleum and other sectors is also because of the decision to develop computer cluster technology.

With the launch of Dawning 3000, cluster system has dominated the high-performance computers in the market. How to achieve new technological breakthrough and break the "ceiling" of traditional cluster system became a major technical hurdle facing Dawning and the Intelligence Center. While developing Dawning 4000A, Dawning and the Intelligence Center developed several network grid components, enabling Dawning 4000A to become a server for the grid and at the same time identified Massively Cluster Computer (MCC), which combines clusters and large-scale parallel technologies, as the new direction. In this way, MCC is as efficient as Massively Parallel Processor (MPP) and as affordable as cluster system. This decision enabled Dawning servers to strike bigger success. In addition, according to the needs of different industries, Dawning promptly proposed the "downsizing plan" of "integrating computing and diversifying application", changing general-purpose servers into those suitable for specific industries. Forming a strategic alliance with AMD to be the first in China to promote 64-bit servers was another important technology decision. Back in 2003, few people used 64-bit servers, so being the forerunners to promote it tested Dawning's judgment of technology and market, but also benefited Dawning as the pioneer.

2. From integrated innovation to core technology innovation

Dawning's independent innovation follows the rule of "doing something while letting go others", as well as the pragmatic path from integrated innovation to core technology innovation. In the early days of Dawning, it was a small company whose brand had yet to be approved by users. If Dawning produced servers all by itself, from the chip, main board, the Internet, the operating system to application software, it was difficult to win customers. So Dawning took integrated innovation as the start, beginning with value-added OEM and using mainstream products for node components and operating systems. It mainly focused on integrating a number of nodes into the cluster operating system, as well as value-added components to improve machine availability (reliability and maintenance). The pragmatic technological roadmap was approved by users. A few years later, Dawning began designing its own main boards, and adopted an open-source Linux operating system. Dawning was the first to launch 2U4CPU 64-bit main board and recently unveiled 8CPU16 road parallel node computer, and its server main board technology has reached the international frontier. Dawning's next step is to use China-made CPU chips and especially Godson 2ECPU to produce low-end servers. During the "Eleventh Five-Year" plan period, the Institute of Computing Technology of Chinese Academy of Sciences (CAS) will unveil a multi-core multi-threaded high-performance CPU, which can be used not only in Dawning 5000 and Dawning 6000 with as much as 100 trillion computing times, but also in developing low-cost, high-performance servers, bringing high- performance computer to common people.

Over the last decade, foreign companies have been committed to improving the CPU chip and server performance. But a closer analysis on the computers used reveals low utilization of PC machines and the servers. For developing countries like China who has a huge population but limited financial resources, we must follow the low-cost path of developing information technology and build a conservation-oriented country. Intelligence Center and Dawning are making bold, original innovations in "low cost" servers. In the next two or three years, Dawning strives to launch acceleration machine with 100 billion computing capacity which costs 10,000 to 20,000 yuan each, affordable to students and researchers in general. The cost of supercomputers with one trillion computing capacity will also be reduced to less than one million yuan. On the other hand, it is necessary to greatly upgrade the existing computer systems used by all enterprises and institutes, using the CPU servers, storage servers, etc. to provide users with the required computing and storage capacity and bring down the cost of the entire computer system. The existing cluster system will be concentrated in one main board or even in a chip and it is also the case for optical Interconnection.

3. Institutional innovation is a guarantee and motivation for independent innovation

D. North, a key figure of Institutional innovation school, once said: "It is the institutional factors, rather than technical factors, that play a decisive role in economic growth. Efficient economic organizations are the key to economic growth." The mismatch of research and the economy, long-standing in China, is the bottleneck of independent innovation. To tackle this problem, Intelligence Center and Dawning have spent ten years on this, constantly adjusting the relationships between research institutes and enterprises. In the first five years, the Intelligence Center was incorporated in Dawning as its R&D department, and in the second five years, it returned to the Institute of Computing Technology, while still keeping close contact with Dawning. The Intelligence Center, as a national research institute, should not do the same as a company, nor should it cut out of companies. It should know its own position clearly, truly play a leading role, and serve as the source of technological innovation of enterprises. In addition, Dawning and Intelligence Center are constantly conducting internal institutional reforms.

4. Business model innovation

As early as October 2001, Dawning put forward SUMA, and introduced the "customized servers", both of which resulted from the accurate grasp of the market. SUMA reflects users' essential requirement for the server and is also a server producer's goal. In line with this objective and according to the need of specific user groups for tailored, function-oriented servers, Dawning unveiled operation mode of "customized servers". And in October 2001, it formally launched China's first education-targeted server. The "integrated computing and diversified application" strategy in HPC proposed by Dawning in 2003 further improved the "customized servers" model. The "customized servers" model is based on user requirements and meets the shared requirements of a group of people through the market segmentation. It meets market and customer needs and solves the contradictions between large-scale mass production and individual needs. This operation mode is an innovation in China's server business. The future specially-made servers used in meteorology, oil, finance and other fields, as well as the use of Dawning 4000A in Shanghai Supercomputer Center are the results of the "customized servers" business model. This mode has changed the simple commercial activities of buying and selling and renders both buyers and sellers as the partners and markets engines to drive IT technology forward. Even notions like "High-tech comes from utilization" are also created from this model. This business model also prompted the interaction between science and technology and economy. In 2009, Dawning conducted governance system and business model adjustments, changing from passively looking for markets to actively managing markets, form selling to marketing, in a bid to better meet future challenges.

Compared with multinational companies, Dawning is a latecomer and small enterprises in their early stages can not afford to produce many products and develop all the important technologies. Dawning's strategy is to focus on developing most critical technologies of some areas and avoid developing technologies that are not immediately relevant, which is also Dawning's principle. For example when the National Research Center for Intelligent Computing Systems were set up in 1990, the center decided not to focus on intelligent computing technologies, since although a hot topic in academic circles then, intelligent computing was still too far away from industrialization. Therefore, the center decided to focus on parallel computing-based high-performance computers, avoiding developing technologies that multinational corporations enjoy unparalleled advantage. For example, the reason that Dawning, at its early stage of development, chose not to compete with transnational corporations in CPU and storage technology was that Dawning could hardly make breakthrough in the short term. So it concentrated on emerging technologies, rather than mature technologies. For example, National Research Center for Intelligent Computing Systems, while developing its first product, Dawning 1, chose parallel computing as the core technology. This technology was not yet mature, and with the lack of generally accepted industry standards comes room for innovation. Another example, in the mid-1990s, Dawning selected emerging cluster technologies as the core technology of its next-generation products, focusing on software development. Dawning believes that they have an advantage in software technology, thus using the software development to achieve technological breakthrough. In fact, the company's major innovations, like the UNIX operating system, cluster operating system and system software are based on software technology.

Case 3: Digital China Networks Co., Ltd.

Digital China Group entered the network market in 1997, and two years later a full range of own-brand network products were launched. Digital China Networks Co., Ltd was officially formed in 2000, and now has branches in 32 provinces, municipalities, and autonomous regions.

As an INTERNET and INTRANET networking equipment and solutions provider, Digital China Networks is a leader in domestic IT industry, whose business scope covers LAN, WAN, wireless network, metropolitan area network and broadband access networks. The product lines of Digital China Networks include routing switches for enterprise-level backbone network and metropolitan area network, intelligent switches, routers, network security products, broadband access products, wireless LAN products, Network Management System series, as well as user-friendly NetEase pass for small and medium enterprises, all of which has been widely applied to government, education, business, telecommunications, finance, military, medical and other industries. After many years of effort, not only has Digital China Networks set up complete product lines, but also has provided education sectors and government agents with a variety of customized products. Besides, Digital China Networks has come up with a series of solutions for industry development orienting the fully investigating customers' demands. The leading technology advantage of Digital China Networks is well received by customers from Europe, Asia, and North America, and so forth, which accelerates the internationalization process of Digital China Networks.

Without constantly adhering to the enterprise's culture for long-term development, which is "continuous innovation and responsible", as well as the support of national policy, Digital China Networks couldn't become the domestic leader or keep pace with the world's development in the field of IT networks. Since the establishment, Digital China Networks has constantly devoted lots of manpower and resources into the research and development of innovative products with independent intellectual property rights, so as to create national brands. Currently, Digital China Networks has obtained fruitful achievements in the areas of IPv6 network technology, DCNOS, NP, access management, and security, and owns completely independent intellectual property rights. At the same time, Digital China Networks has pooled many successful cases covering more than 500 different industries, which can meet the demands of any tough user, and can quickly and accurately resolve the customers' various issues. For the reasons mentioned above, Digital China Networks has become one of the fastest growing companies.

As early as in 2003 and 2004, Digital China Networks foresaw the future development prospects of IPv6, and its IPv6 technology, therefore, has not only become the domestic leader and has kept pace with the worldwide technology, also got the first-mover advantages to develop the next generation network. IPv6 campus network set up by Digital China Networks has been used for scientific research and office park by Hainan Normal University, Hainan Medical College, Northeastern Electronic Power University and other clients. Not only has the IPv6 campus set a template to promote IPv6 for the whole country, but also has made outstanding contributions to the popularization of IPv6.

On the other hand, the mature core development platform DCNOS which is based on long-term technology accumulation and many years of research and development, is also one core content of Digital China Networks with complete independent intellectual property rights. Currently, relying on various products built by DCNOS network operating system, Digital China Networks already covered LAN, WAN, wireless network, metropolitan area network and broadband access networks and other fields. Since Digital China Networks developed the operating system, foreign manufacturers have lost the power to monopolize the Internet equipment market, and the government agents relating to confidential also do not have to worry that they might only use foreign network equipments which keep the security door.

The design and development of the operating system is also very complex. Thousands of R&D personnel participated in the development, and the software codes are more than 10 million lines. After years of test and accumulation based on large-scale commercial application, DCNOS has reached the domestic advanced level in terms of performance, stability and richness of the agreement, integrity and so on. And it has become a set of mature and advanced network operating system.

In addition, Digital China Networks is also a leader in network security research within software industry. In 2005, based on the original security solutions, Digital China Networks re-extracted a solution, namely 3D-SMP also known as "Dynamic Distributed Defense Security Management Policy". Aiming at the increasing concerns for the safety from customers, the solution helps to form a unified security platform from the fragmented information security islands which work independently through internal and external linkage and the strengthened performance of linkage security between the various devices, and to create an entire network security solution which protects both the internal and the external by combining external border protection, the core monitoring, aggregating the linkages, and desktop terminals, and to constitute a complete, strategy-based security mechanism integrating protection, detection, and response. Currently, 3D-SMP has also been widely used by various users from different industries, and it well received for providing a safe network which is reliable both inside and outside.

On the path of innovation development of Digital China Networks, we can see the following outstanding features:

1. Digestion & absorption and re-innovation model

Digital China Networks, based on introduction, digestion & absorption, and re-innovation, pools related resources of the company together, so that it could seize the initiative in integrated innovation, introduction, digestion & absorption, and re-innovation. By doing do, it unveiled a series of data communication network products, including routers, switches, firewalls and network management billing system, based on independent research and development in a relatively short period of time and achieve localization. While developing DCNOS system, Digital China Networks introduced routing protocol packets, Zebos, of the industry's leader, IPI, digested and absorbed it for about half a year, and perfectly integrated it into the DCNOS system, so that Digital China Networks' various types of routing products enjoy the support of leading, integrated routing protocols of various types, thus boosting its sales. In 2005, Digital China Networks, after fully digesting and absorbing ZebOS software, developed IPv6 routing protocol support and was the first to get IPv6 Phase1 and Phase 2 certification in China, getting the upper hand in the area of IPv6.

During re-development, Digital China Networks and Beijing University of Aeronautics and Astronautics (BUAA) established "network joint laboratories". Digital China Networks, a primary provider of network interconnection devices and solutions, has accumulated a wealth of experience in scientific research in recent years, while BUAA is the forerunner in high-speed network hardware and software research and has many well-known experts and professors who will take on many projects of the joint lab. The establishment of the joint laboratory greatly enhanced the company's R&D strength, spelling strategic importance for product development, scientific research, as well as raising the competitiveness of core technologies. In this way, the short-term co-operation has evolved into strategic partnership. On the one hand, BUAA"s research can be sustained, thus farther cementing its prominence. On the other hand, the research capability of the enterprise can be greatly strengthened, increasing its market competitiveness.

2. Technological innovation guided by the market demand

In terms of network technology routers and switches, it is particularly important to grasp the market demand and set R&D goals, which is the reason behind Digital China Networks' success. Digital China Networks believes that in this area as long as you make constant investment, it is only a matter of time before you tackle the problems, so speed matters and is what related companies are competing for. Therefore, the R&D must focus on market demand.

Although during the first half of 2009, international financial crisis casted a shadow on all walks of life, Digital China Networks' domestic sales increased by 20%, and its revenue jumped by 40%, meaning that a large part of revenue growth came from the hard-hit overseas markets. The fundamental reason is that the financial crisis actually helped Digital China Networks in its overseas expansion, since during the financial turmoil, customers put more emphasis on cost-effectiveness, rather than blindly pursuing brands. The products performance of Digital China Networks is as good as those international well-known brands, and with more comprehensive services and prices 10% - 30% lower, more customers surely choose Digital China Networks. In addition, since the products of foreign manufacturers are globalized, rather than customized for a certain country or a certain industry, thus may creating some inconvenience in using these products. Global China, on the other hand, would provide tailored services to a particular industry, such as the forestry and security industry. The technical adjustments orienting market demands have won a good reputation for Digital China Networks.

3. Emphasis on long-term accumulation and high-level R&D

Focus on accumulation is crucial to the success of Operators Division of Digital China Networks. Accumulation is indispensable in terms of technology progress, market decision-making experience, and product sales practice. The long-term accumulation can not only enrich marketing experience, but also enable companies to launch market-oriented products, thus reducing unnecessary production inputs; technological accumulation can enable companies to react to market changes fast, thus having the upper hand in the market. Digital China Networks has taken independent research and development very seriously, and has started accumulation since its establishment. Accumulation in the prophase of R&D activities really matters and it always takes a long time. When the platform has been constructed, it is very easy to add on it. Digital China Networks has a complete systematic platform, so it can launch new products very fast, and unveil products that are based on market changes and customers' demands.

Digital China Networks' R&D team was originally from the Chinese Academy of Sciences, which has rich accumulation in basic research. As early as 1997, Digital China Networks identified several research directions: network security products, including routers, switches, network management, network testing. It also undertook National 863 high-end routing projects. With such a foundation, when Digital China Networks began to manufacture products in 2002, it launched and upgraded switches very soon.

The early start at basic research, the support of national projects, and other factors like industrialization decided by the company may not happen to every company and the innovation path many not be copied, but they are key to the eye-catching success of Digital China Networks on independent innovation.

Digital China Networks' rapid development has its strong R&D capabilities to thank for. The "technology-driven" philosophy has led the company to achieve a series of innovations: In terms of the second-generation Internet core technology, IPv6, Digital China Networks is the first domestic firm to have its whole line of products passed the IPv6 Ready Phase-2 Enhanced. Through helping users of various industries to build IPv6 campus network, Digital China Networks established its leading position in the field. In terms of network security, Digital China Networks unveiled a series of security gateway, "Terminator", which is based on multi-core-embedded processor, expanding network defense to ultra-Gigabit level; Digital China Networks has always kept a close eye on intranet security, management, operation and the sustainable development of network. With the accumulation of a decade in the DCN, the company puts forward an integrated innovation solution, titled "N-dimensional Green Network". Under the theme of "N-dimensional Green Network, Digital China Networks", the company's network is people-oriented, and application-first with long-term sustainable growth as its goal, constituting the main theme of the Web 2.0

era.

Case 4: Beijing Hanwang Technology Co., Ltd.

Hanwang Technology co. LTD was established in September 1998, and the headquarters are in the core R&D zone of Zhongguancun, Beijing. Now there are 500 employees totally. Since its establishment, Hanwang has insisted on the core value which is “focus brings miracle, innovation leads to future”. For a long time, Hanwang has been working hard on the research, development, application and promotion of the “intellectual human-computer interface with the mode identification as the core” technologies and products. For more than ten years, Hanwang has focused on the mode identification field, and input more than one half of its revenue to support R&D each year, which ensures the new innovation. Through generations’ hardworking, Hanwang has not only become the leader in many aspects in domestic software industry, also has owned some world-leading core technologies. The main technologies owned by Hanwang include handwriting identification, handwriting input, optical character recognition (OCR), embedded software and hardware and so on, and many technologies are world-leading. In 2001 and 2006, the handwriting identification technology and OCR application technology were respectively awarded the first prize and the second prize of national S&T advance prize which was the highest level prize in China. In 1998, Hanwang authorized the license of using “handwritten Chinese character recognition” in Windows CE to Microsoft. Hanwang, and became a pride of China’s software enterprises for its first authorization of its technology to Microsoft. In October 2006, "HanWang" brand was awarded as China's well-known trademark. In 2009, the share of Hanwang’s global sales in the electronic book industry has exceeded that of Sony, ranking the second, following Amazon. Hanwang has been stably ranking the first in the domestic electronic book industry with the share of 95%.

The following characteristics are shown in the history of Hanwang's innovation and development:

1. Making breakthrough in handwritten Chinese character recognition

Handwritten Chinese recognition entails daunting technical challenges, rapid replacement rate, long development cycle and difficult marketing. Now with fierce worldwide competition, the single handwritten system has been improved to cover dictation, reading, writing and listening techniques, developing from the initial identification of 6,763 words according to GB2312－80 (national standard), 5,401 traditional characters, 790 Hong Kong variant forms as well as other variant characters and simplified Chinese characters, altogether 13,000 words, to the current Super Chinese Character database of nearly 30,000 characters, and now you can handwrite Chinese, even illegible sometimes, English, numbers and symbols; you "can write and draw," on Hanwang's products, reaching the latest track technical level, which means you not only can sign in the electronic files, but also in the full-screen mode, the editing mode, using the touch screen or on the desktop, signifying new heights of handwriting. In recent years, you can directly write notes on PPT and other documents while using the overhead projector; the formula handwriting can also be recognized by the computer, a major breakthrough of handwritten Chinese character recognition technology. The "e-chalk", capable of recognizing handwritten formula developed by Hanwang, is the new product in education and computer-aided teaching. While engaging in R&D, Hanwang also partnered with many international and domestic companies. For example, nearly 40 kinds of PDA adopted Hanwang's handwritten Chinese character recognition, leading the development of the industry. Furthermore, 110 types of smart phones and learning machines use Hanwang recognition technology of handwritten Chinese, English and Thai, further boosting the industry.

2. Break technological barriers on Optical Character Recognition (OCR)

Hanwang started from research on recognition and input of handwritten Chinese characters, and then expanded into the field of Chinese characters and symbols recognition. Since 1992, Hanwang applied to conduct intelligent computer interface projects of the national plan "863", including "intelligent handwritten character recognition system (super-OCR)", "off-line handwritten Chinese characters recognition system", "Multi-font large printed Chinese character recognition research", "automatic printed Chinese character recognition system" as well as "Practical Research on Chinese Business Card Recognition System". "Hanwang OCR--new century version", with high recognition rate and speed, can identify files mixed of simple Chinese, traditional Chinese and English, as well as simple Chinese and traditional Chinese with a recognition rate of up to 99%, and 99.9% for English. It can also identify numbers, punctuations, as well as hundreds of fonts including Song, Fangsong, Kai, black, Weibei, Lishu, Yuan and Xingkai. It provides automatic layout analysis, identification and restoration for both horizontal and vertical layout, printed forms in Chinese and picture-text images. Hanwang OCR is also an integrated system with the highest recognition rate at the time, which can recognize off-line handwriting, printed documents and on-line handwriting. In May 2000, among the 6 Chinese OCR software, covered in the "CHIP New Computer", Hanwang OCR--New Century, Professional Edition, for its "highest recognition rate and advanced layout analysis", was acclaimed as the "Best Chinese characters recognition software", ranking top in terms of technologies used and reaching world-class level. In addition, based on the core technology of OCR, Hanwang developed handwriting recognition system for postal automatic letter sorting system, business cards recognition, notes authentication checking, biometrics recognition and intelligent traffic management system, and made technological breakthrough, reaching the international advanced level. Hanwang OCR was produced, promoted and used in related industries.

3. Core technology R&D of graphic tablets

Hanwang's goal is to design computer graphic tablets with independent intellectual property rights. Since 1998, Hanwang has upheld independent innovation and conducted graphic tablets R&D. Hanwang set "breakthrough, comprehensive and superior" as its guideline and adopted patented "wireless passive" and "micro-precision pressure sensor" technologies as the core, and Hanwang's products have caught up with or surpassed similar products of Japan. One of the key technologies of this high-end graphic tablets hardware, "wireless passive pressure sensor technology", had long been monopolized by foreign manufacturers. Hanwang, after years of research and experiment, finally broke the technical barriers, used a new theory to master "wireless passive pressure sensor technology," and became one of the few companies to master this technology. China's first professional edition of graphic tablets, launched in 2006, were sold to the United States, Canada, Singapore, Malaysia, Kuwait, Iran, United Arab Emirates, Australia, Hong Kong, etc

4. World's first embedded facial recognition system-- "Face ID"

Hanwang accelerated its facial recognition algorithm since 2001, and after four years of hard work, produced PC-added facial recognition machines, which is at the par with those equipped at airports and other vital departments in the United States. In September 2008, Hanwang successfully developed the world's first embedded, PC-free "Face ID" with dual cameras, enabling facial recognition machines to be separated form PC and onto an embedded platform (without an external computer, "Face ID" has its own independent calculation system), which greatly expanded the application of Hanwang "Face ID" and won the one and only "Innovation Award" for "biometric recognition" products at the Beijing International Security Fair. "Face ID" was highly spoken of at CeBIT, the world's largest IT and communications trade fair, held in Hanover, Germany, in March 2009. Equipped with "Face ID", crucial departments can accurately identify 100,000 human faces. And its operation is simple and quick, with 10 seconds for registration and less than 1 second for verification. Its speed, security, accuracy, convenience, availability are much advanced than primary products.

Hanwang has always been pumping high investment to boost its competitiveness, with R&D investment accounting for 10%-12% of sales revenue. Hanwang's R&D investment is divided into two parts, one for the improvement of existing products to extend products life, the other for new projects development. Depending on the circumstances, Hanwang has three R&D investment strategies. First, the adventurous

"40% vs. 60%" strategy, meaning 60% of the investment is used for the main products while 40% for strategic products development (new technologies that can not generate profit immediately). Second, the prudent "30% vs. 70%" strategy, meaning 70% of the investment is used for the main products while 30% for strategic products development. The last one is the most conservative, namely "20% vs. 80%" strategy.

Thanks to the long-term commitment to R&D and promotion of intelligent human-computer interaction technology with pattern recognition at the core, Hanwang has many state-of-the-art technologies with intellectual property rights, covering on-line handwriting recognition, OCR, graphic tablets and handwritten boards. So far, Hanwang has over 130 products of five major categories, almost all of which are best domestically and many are China's first and internationally leading products. Among the world's top 146 phones, 132 of them adopted Hanwang's handwritten Chinese character recognition, taking up 95% of the top cell phone market. Hanwang OCR, unveiled right after the "Pen Tablet", won the national scientific and technological progress, second level and enjoys a market share of more than 70%.

Since its inception in 1998, Hanwang positioned its products in the Human-Computer Intelligent Interaction field, and identified Chinese character recognition as its major business. Since then, Hanwang always believe in "Concentration achieves excellent". It is the innovative brand positioning gives Hanwang the upper hand in the market. Hanwang is the world's first company to integrate Chinese handwriting technology with PDA products, thus bringing the budding PDA, palmtop computer industry. After identifying brand positioning, Hanwang, through continuous innovation, masters many core technologies with independent intellectual property rights covering on-line handwriting recognition, OCR, digital graphic tablets, etc. Based on core technologies, Hanwang now has hardware and software product lines with recognition technology at the core and targeted at different market segments. Hanwang's multi-language recognition technology pushes Hanwang even further on the world stage. In 1998, Hanwang authorized Microsoft to apply Hanwang handwriting input technology in Microsoft WIN CE (Chinese version) and Pocket Pc (Chinese version), the first time that handwriting technology was ever licensed to a foreign company. It is the first time that foreign enterprises had to pay for this patented technology, not only demonstrating the scientific and technological strength of China's high-tech enterprises, but also rendering Hanwang as the forerunner in providing technology licensing.

With the accumulation of core technologies, Hanwang realizes that Chinese enterprises must have independent intellectual property rights, in order to enjoy competitive edge. To truly go global and keep pace with international standards, intellectual property rights are the first threshold that domestic enterprises must cross.

The competition over intellectual property rights is like a war of no firing, but fierce and cruel. As an innovative enterprise, Hanwang spares no effort to protect intellectual property rights, safeguard independent innovations, and grasp the market opportunities. Hanwang employs eight full-time highly-educated personnel to form the Department of Intellectual Property Rights, responsible for the declaration of intellectual property rights and early warning, conducting patent analysis on a number of key technologies as well as identifying R&D direction and potential patent barriers. Then, Hanwang encourages employees to apply patents, provides related training to all employees and rewards those excelling in patent application. Finally, during patent application, Hanwang brings aid form the outside to form Patent Reexamination Board to pre-exam patent applied, increase application efficiency, in a bid to best protect Hanwang's independent innovations. It is because of its own emphasis on the protection of intellectual property rights, Hanwang has never lost a lawsuit in this field. Up to now, Hanwang has 187 patents, 143 registered trademarks, and 73 copyrights.

"Three-dimensional space" and "four-wheel drive" innovation. The so-called three-dimensional space refers to Hanwang's sales strategy. The first dimension is sold through the usual channels; the second, through IT manufacturers to sell technologies, like the handwriting technology used in mobile phones; the third, through industrial application, such as at customs, banking and so on. Four-wheel drive: one is technology-driven. We are engaged in pattern recognition, in which both the technology and the field are advancing and what we do is to keep pace with them. The second is called user-driven. With products sold to customers, 30,000 to 50,000 users a month, these users may need technical services and give us feedback, which will be reflected in the new version of Hanwang's products, surely more advanced than before. The third wheel is the government, which guild and fund high-tech companies and we meet the Government's requirements. The fourth wheel is the market. In hot markets like automobile, mobile phones and the Internet, if problems occur, they will be reported Hanwang and we will find ways to resolve it. These four drivers are behind Hanwang's success.

Case 5: Yingnet Information Technology Co., Ltd. (HRbanlv)

“HRbanlv”-China Human Resource Internet Software Platform & Service Provider, was established by Yingnet Information Technology Co., Ltd in 1999. It is one of the earliest HR internet software platforms in China, and the earliest HR internet software service enterprise in Shangdong province. HRbanlv is a partner of internet software platform of the sailing committee of Beijing 2008 Olympic Games. During the first decade, HRbanlv had become the biggest network HR service provider in Shangdong province, and a well-known brand in China’s network HR field, and one of the most innovative network enterprises in China. In 2009, HRbanlv started another "New Decade". In this year, HRbanlv launched "HRbanlv 5.0", a "New Decade" strategic platform which detonated a revolution of China's Human Resource network services. The highly innovative services brought unprecedented new experience and joy to both individual users and business users. As an example of Qingdao's modern service industry for ten years, HRbanlv is the unique enterprise which has provided its users with high quality services for ten years without any foreign capital. Currently, HRbanlv has 240 thousand business users and 2.8 million individual users from Qingdao, Beijng, Shanghai and other 19 cities.

On January 1st, 1999, Yingnet formally launched a website, namely "Qingdao HR", which was the predecessor of HRbanlv. Qingdao HR is the first program that Yingnet strategically invested in network, and as the biggest HR website in Shangdong peninsula, Qingdao HR provided all services for free. In 2003, four years later since it provided the users with free services, HRbanlv started to enter commercial operation for fee. At the free service stage, the number of Shandong business users was up to 50 thousand, and individual users as many as 460 thousand, which determined the HRbanlv as No.1 brand in Qingdao region and Shandong province. In October 2003, HRbanlv passed the International Software Capability Maturity attestation of CMM3, and became the first one in domestic industry, also the only one qualified to receive this international certification. The acquisition of the qualification has helped HRbanlv become the strongest enterprise in terms of technological strength in the filed of China's HR network.

HRbanlv's development shows the following characteristics:

1. A unique understanding of human resources

HRbanlv considers "human resources" as the most important resource except "monetary resources". All industries are the interaction of finance, human resources, technology, markets, management, land, raw materials, equipment, plants, and government policies. With the diminishing of natural resources, like raw materials and energy, the world economy, including China's economy, is entering the "non-natural resource-dependent economy" era, during which "human resources", as the vital "non-natural resources", is becoming the most important resource besides "monetary resources". China has the world's largest pool of human resources. With the world's largest population together with China's educational development and the emergence of new ideas, the 1.3 billion people is bound to become quality human resources, boosting China's rejuvenation and the sustainable development of world economy.

2. Innovate service models to build human resource management platform

"HRbanlv" believes that the systematic human resource management needs a "social management system of human resources": capital and human resources are the two main resources for the future economy. Capital has already got its "social capital system", i.e., the financial system, covering banking, securities, insurance, etc; but the equally important human capital, human resources, is in urgent need of a similar "social human capital management system".

As China's first batch of IT companies providing Internet services, HRbanlv, when the Internet was budding in China in 1998, made the strategical decision to commit itself to "social human resource management services". With its advanced Internet technology as an IT company, service-oriented concept, and "innovative" HR services, HRbanlv provides investors and individuals in China with "partner-style services", delivering human resources value realization, preservation, value-adding, and re-realization.

In the new service model, "HRbanlv" think that free registration of individual clients on HRbanlv platform is like "opening an on-line store on Taobao.com". Only in this "store", the clients try to "sell themselves". In this model, individual users can decide whether to make their resume accessible to others or not, free or charging a fee, how much is the fee and they can even solicit bid from enterprises. For enterprises, the new model can encourage individual users to provide their information actively and frequently, improving the efficiency of corporate recruitment. In addition, the new service also provides recruitment feedback. Job seekers pay human resources manager one yuan to get feedback on their resume and new position recommendation, during which job hunters can get detailed job search assistance, and allows personnel managers to both fulfill their social responsibility and get extra income accordingly.

Case 6: Ecode Software Co., Ltd.

Established in 2000, Ecode Software Co., Ltd. is a high-tech company specialized in information management software development and marketing services. Since its establishment, Ecode has committed to provide all levels of government and large- and medium-sized enterprises with entire solutions of network informationalization, such as E-government, cooperative business, information platform, video conference, mass data analysis, network security, and other management counseling and technological services.

After five years of continuous development, Ecode has become a domestic topping software enterprise congregating hundreds of IT elite, with Shangdong as its headquarters, and the branches or offices in Beijing, East China, South China, North China, and Northeast as its supporting branches.

Since its establishment, relying on advanced management and operation model and excellent software talented people, Ecode has consecutively launched Ecode-IMP (information management platform), E-conference, Ecode-TelAnalyse, and Ecode BI.

1. Product specialization

Ecode is committed to software product development, and its the main products are management software, including enterprise management software, the government's e-government software, etc. Ecode's goal is to provide high-end software services, create its own brand, and offer tailored projects for major clients.

"Ecode" Information Management Platform (Ecode - IMP), E-conference systems, human resources management systems, enterprise logistics management systems have become mainstream products in the world. Among them, Ecode-IMP was included in the national "Plan 863", selected as a "Torch Program Project", and won "Best Customer Satisfaction Award", "Editor's Choice Award" of "China Information World", a leading publication in China. E-conference, an outstanding product, passed the U.S. Intel's 64-bit servers test. Ecode communication and information analysis system, Ecode-TelAnalyse, has already played a vital role in public security, customs, border control, railways, etc.

2. Going global

In 2004, Ecode became the first software company of Qingdao city to get the CMM3 certification. In 2005, it was chosen by the Torch High Technology Industry Development Center (Torch Center) of Ministry of Science and Technology as a pilot company of "China Offshore Software Engineering Project"(COSEP). In terms of global marketing, Ecode and SEAROM, a ROK company, to undertake the ERP project of Pohang Iron and Steel Co. Ltd, world's largest steelmaker; it also conducted in-depth exchanges with South Korea's I & C Group; Ecode forged international strategic partnership with Japan's FQS and LINKS, and became a high-end project partner with Microsoft, Intel and IBM.

3. Standard management

In terms of management, Ecode strictly follows the global software industry standard, CMM, in software project determination, R&D, testing, certification and other related processes to ensure software quality, shorten development cycles and improve work efficiency; As for quality standards, Ecode adheres to CCID professional evaluation, promotes R&D competence and guarantees product quality; in terms of service system, Ecode strictly implements ISO9001 standard, continuously improves its service system, and means, establishes first-class service facilities and team to provide customers with detail-oriented, quality and comprehensive information service.

4. Unique personnel training strategy

Concerning personnel training, Ecode has set up its personnel training system, which is working with universities to train future employees at college. Targeted training began at the third year at the university and courses are practical and really relevant to

Ecode. Ecode uses universities as the platform, and also provide job opportunities to the universities, thus a win-win situation is realized.

Case 7: Hisense Group Co., Ltd.

Hisense's main products include TV, air conditioners, refrigerators, mobile phones, photoelectric conversion modules, intelligent transportation systems, business management software, commercial POS, etc. From 2003 to 2007, Hisense Group's sales revenue and net profit have jumped from 22.1 billion and 307 million yuan to 46.9 billion and 1.184 billion yuan respectively, up by 112.22 percent and 285.67 percent respectively. In 2005, Hisense's R&D investment was 1.432 billion yuan, accounting for 5.14% of the sales revenue in 2005.

1. In terms of products and technology innovation, Hisense climbs to the top of the industry through technology introduction, digestion and absorption. First, follow the latest international technological developments and introduce the most advanced technology. Although the introduction of technology is common practice among TV manufacturers, Hisense tracks the latest technology development and only brings in the most advanced technology, for we believe only through this way can we compete with other domestic enterprises and catch up with the multinationals as soon as possible. For example, in 1984, Hisense faced two choices while entering the color TV industry: One was to spend 1.5 million U.S. dollars to introduce a Hong Kong enterprise's technology and equipment, and second choice was to spend 3 million U.S. dollars to introduce the technology and equipment of a Japanese company. While the first option had much lower cost, the second option could bring Hisense the most advanced technology. So Hisense chose the latter. Another example, in 1993, Hisense chose Toshiba's technology and equipment, based on the same consideration, when it decided to go into large-screen color TV market. The same thing happened when Hisense entered the flat-screen televisions and rear projection TV market. Second, build technical digestion and absorption ability. Hisense believes that an important feature of TV industry is that consumers have rapidly changing demand for TV functions, specifications, features, prices, etc. To meet the changing demand, it takes more than just bringing in advanced technology. It is vital to build technical digestion and absorption ability, launch new products to adapt to market changes. To this end, Hisense has taken a series of measures. For example, in 1992, Hisense has established its technology center and pumped in a lot of capital. Hisense's technology center is now one of the most advanced centers of China's enterprises. Another example, Hisense pays attention to motivate researchers to innovate. Prior to 1992, Hisense wages and benefits policies favored the front-line workers and in 1992 they began to benefit researchers more. With better digestion and absorption capacity, Hisense is moving towards independent innovation. Against the financial crisis, Hisense, while

emphasizing technical support, conducted industrial restructuring with the focus on "high-end industries, top of the industry". Intelligent traffic and optical communication are two new industries that Hisense Group entered. Judging from 2008, the two sectors contributed 20% of the group, at the the forefront of other sectors. Hisense optical communication module, GPON products, has long taken up over 90% of the North American market and more than 50% in China's EPONOLT / ONU optical module market. Striving to be the top of the industry is Hisense's key to success. Through investing in frequency-alterable air-conditioners, 3G communications, audio and video processing chips, LCD modules and LED backlight display technology, Hisense laid a solid technological foundation for its white goods, telecommunications and multimedia. Accumulation of high-end technology in the industry benefits Hisense handsomely. Hisense's frequency-alterable air-conditioners have led the domestic air-conditioner industry for 12 years and its flat-panel TV's market share ranked No. 1 for 5 consecutive years.

2. In terms of organizational innovation, Hisense relies on independent innovation, and builds its own technological innovation system as a safeguard. Technological innovation system serves as the R&D standard and its key role is to ensure that Hisense's R&D results meet the market demand in terms of technical level, quality, time, etc. In the summer of 1997, Hisense began to study and create its own technical innovation system, which includes R&D framework and management documents of all R&D processes, like the ISO9000 quality management system documents. Hisense revised them again in 2002 and set R&D guidelines, as one of the basic rules in Hisense. China's first high-definition digital video processing chip, Xin Chip, is one fruit from implementing these innovation system documents. Specifically speaking, the system ensures three points. First, it ensures that technology development projects can reflect the frontier of the market and technology, guaranteeing that money can generate technologies and vice versa. Second, ensure product quality. Quality is the prerequisite for competing in the market, while the design quality is the first element affecting the quality of products. The so-called systematic quality assurance means that during design, clear product quality goals are set, and all the following design stages should realize the goals, thus delivering a quality design. Third, Hisense sets incentive and restraint mechanisms for R&D personnels systematically. When a project is first decided, its difficulty coefficient is identified, serving as the basis for remuneration. Then how fast a project is conducted determines compensation coefficients. This method promotes both efficiency and fairness, and when equality and efficiency are one, it can motivate the whole team. As for the organizational construction and division of labor of independent innovation, Hisense has four levels: first, R&D institutions directly under the R&D center. Their strategic positioning is to obtain intellectual property rights through independent innovation. They are mainly engaged in forward-looking, shared, key technologies to

ensure a certain degree of R&D resources are put in original innovation activities. Xin Chip project is from four years of R&D efforts by AISC, an affiliated R&D institution. The second level is the market-oriented professional products development agencies whose main goal is to meet the current needs of the market. The third level is a professional R&D support platform, such as industrial design center, testing center, as well as the data & literature center which is being built right now. The fourth level is the over-the-board massive innovation activities.

4.2 National strategy of constructing electronically strong country relying on self-innovation is initially forming

The Chinese government has kept on playing an important role in the development of electronic information industry. Besides persisting in the reform and opening up, establishing and perfecting the socialist market economic system, and vigorously promoting the system and mechanism innovation, which help to create a favorable macroeconomic environment for the development of the industry, the government has taken a certain amount of supporting policies. Since 1980s, the Chinese government has successively promulgated a series of policies, such as "National Eleventh Five-Year Technology Development Plan" and "Eleventh Five-Year Plan on information industry development", and so on. In addition, the establishment of an Electronic Development Fund, releasing of preferential policies for hi-tech products, the implementation of the "big corporate strategy", issuing the policy No.18 to encourage the development of integrated circuits and software industry, implementing a color TV localization of one-stop, VCR special, localization of program-controlled switches, mobile localization, localization of optical communication products and other special projects, all play a significant role in promoting the development of key product areas. In the process of making these supporting policies, industry administrative sector came up with relevant industrial development strategies and planning, carried out industrial policies, and shaped good environment for the industry development.

With the international and domestic competition becoming more and more intense, the centre government strategically came up with an aim to construct China to be a leader in the field of information industry using 10 to 15 years, namely an electronically strong nation, at the beginning of 2004. The core of this aim is to integrate research, production, service, and application in the ICT, in order to form an industrial system in which the structure is rational, the technologies are leading, and R&D capacity is advanced. Besides, the country should own some MNCs whose competiveness is strong in the world’s ICT market; and the research, manufacture, and sale of main ICT products from China play a crucial role in the world wide. Not only can the ICT fulfill the demand of economic growth, social development, and national defense for information technologies, products, and services, but also have an impact on ICT chain of the world's allocation system. The national strategy essentially claim to make innovation the core driving force for industry development. In 2006, China came up with taking the road of independent innovation and constructing an innovative country, and this further cleared development direction of ICT industry.

National Science and Technology plans and major projects of national are an important manifestation of connection between national strategy and business strategy at the industry level. The characteristics of "post-innovation strategy" can be reflected from the evolution of strategic directions of Science and Technology plans and major projects. Taking science and technology plans for example, the organization and implementation of the critical technology, as well as the main technology projects have included information technology in the system of national science and technology plans, in which the national high-tech research development plan (863 plan), science and technology support programs have relative arrangement. From the changes of these S&T plans' directions, we can see the adjustment of ICT development strategy. The direction thoughts and basic principles of "Opinions about the reform of national S&T plan and management" issued in 2006, show the new national strategy of self-innovation. In the whole text, innovation is mentioned 28 times. "Eleven-Five Planning on Electronic Information Industry" and "National Long- and Medium-term Planning on Science and Technology Development in 2006-2020" were released at the end of year 2006. The two planning classify new S&T development strategy which is priority breakthrough and great-leap-forward development. The planning emphasizes on the breakthrough of core and key technologies by concentrating the majority of resources, the setting up the innovation system with enterprises are the main body, impelling the change of economic growth mode, and transferring the electronic information industry from scale expansion-driven to innovation-driven. Based on the development direction which is transferring electronic information industry to innovation-driven, the planning further classifies the priority of electronic information industry.

S&T development in the electronic information industry is planed and deployed in the National 11th Five-Year Planning on Science and Technology released in the year 2006. The crucial contents of S&T development in electronic information industry include:

1) Seizing the strategic commanding point of information industry, substantially increasing the technological content in modern service industry, and giving priority to high efficiency CPU, and system-on-a-chip orienting to network communication, information appliance, information security, and industrial control;

2) Conducting research on the key technologies of new generation network and telecom, sensor network and intellective information processing technologies, and new open-architecture core router, Service, and low cost terminal of network

information;

3) Developing multi-language information processing technology with Chinese as the core language, key technologies of national important information system integration, spatial information processing and application technologies, and multi-mode compatible navigation and positioning terminal.

In the field of modern service industry, R&D resources are mainly input into the research and development of generic technologies and application key technologies, in order to form modern service standards, norms, and models with intellectual property rights. Also, China will develop some generic key technologies supporting application in the representative fields, such as business platform service, spatial information service, modern logistics platform, digital media service, digital education service, cooperative medical service, digital city, cultural relic protection, news publishing, tour service, training, and social security. Thirdly, China will organize and implement some major programs, such as modern service industry key technologies and application examples, and national e-government key technologies and application examples.

The development objects of information industry were illustrated in the "Eleventh Five-Year Plan on Information Industry Development" made by MIIT. Industrial technology innovation system will be initially established set enterprises as the main participators, market as the orientation, and application as the main line with the combination of government, production, education, research, and capital. Achieve some breakthroughs in the R&D of integrated circuits, software and key components, electronic equipment instruments and electronic materials. Maser and own a number of key technologies and core patents and standards. Significantly increase the self-sufficiency rate of integrated circuit. The rate will reach more than 70% in the field of information security and national defense, and more than 30% in the field of communications and digital home appliances. Remarkably increase the share of software with independent intellectual property rights, and form the 5% of the global industrial scale and the sustainable development capacity. A complete range of electronic components research and production systems have initially formed. Electronic component technology has reached the world level in the early 21st century, and can basically meet the development requirements of electronic machine. Strive to realize some breakthroughs in the following key fields, the next generation network, broadband wireless mobile telecom, digital television, family network, intellectual terminal, automobile computing platform, radio frequency identify, sensor network, network and information security, information technology application, and digital content; form some core technologies and innovative products with intellectual property rights, as well as a relatively complete industry chain that can basically meet the domestic demand for technologies and products.

At the beginning of 2009, the central government carried out "Planning on

Adjusting and Revitalizing the Electronic Information Industry" in order to reply to the international financial crisis. The planning clearly comes up with a development route which is improving independent development capacity and transferring the industry development style from scale-driven to innovation & benefit-driven. Surrounding the three major tasks which are the priority breakthrough of core industries, revitalization of backbone enterprises and new application driving new economic growth, China will carry out integrated circuit, color television industry transition and other four major programs, further perfect and implement ten supporting policies and measures, and accelerate the integration process of informationalization and industrialization. The requirement from industry chain and technology related to this planning will largely help China's electronic information industry transfer to an innovation-driven pattern. Due to the deep demands for industrial chain and technologies, the planning will play an important role in transferring China's ICT product manufacturing to innovation-driven in the following three years.

5 Conclusions

5.1 Development of ICT industry from unbalance to balance

The historical analysis indicates that the differences in innovation system between China and India determine the distinct development paths of ICT industry. It is said that the most obvious characteristic of China's path is government-driven, which focuses both on domestic demand and export-oriented, leading by manufacturing, together with the high domestic savings, huge investments to infrastructure, FDI, and export growth. India's development path, however, is special, which emphasizes consumption rather than investment, on domestic demand rather than exportation, on service industry rather than manufacturing, on hi-tech industry rather than labor-intense industry. The advantages of India's development path are strong resistance to the globe economic stagnation, powerful tenacity, and long periodicity of economic stable growth. The economic growth of India shows the contributions of knowledge economy. The driving development of software industry, business processing outsourcing (BPO), and biologic medicine illustrate the tendency of India economy leading the World Office. The development of China's competitiveness is due to the huge investments to infrastructure construction and the scale of labor-intense manufacturing. For India, however, the case is that research capacity of S&T and enterprise innovation capacity cause the strength of its competitiveness.

The current situations of ICT in China and India show that the two countries reach the same destination in different ways. Now the developments of the two countries are both based on domestic market and on balanced development between applied software and hardware. It is fully illustrated by mobile phone and Internet development. The rapid development and the increased investment in India's ICT industry enhanced competitiveness, reducing equipment costs, making the per capita telephone ownership rate increase and telephone charges lower. By the end of 2006, there are about 41 million fixed telephone users, 150 million mobile phone users, and 1.8 million broadband network users in India. Rapid increase of the prevalence rates reduced price of information services provided to individuals and enterprises. In China, the numbers of fixed telephone users, mobile phone users, and Internet users reached 368 million, 546 million, and 180 million, respectively, in 2007.

5.2 Competition drives the innovation and development in ICT industry

From the perspective of macro background, the development of ICT industry in China and India benefits from the implementation of competition policy. ICT industry is one of the earliest industries in China that have tried to introduce competition mechanism since the beginning of the reform and open policy in 1980s, and the abundant competition caused by various competitors from home and abroad continuously promoted the industry innovation and development. Since the implementation of economic liberalization in the 1980s, ICT industry in India has also made very significant progress, which was also a result of competition. Under the influence of a variety of competitive forces, multinational companies and returned overseas students have played an important role in the industry development in China and India.

5.3 innovation and development of China ICT companies are presenting a full range of integrated innovation and development trend

In the case study, it is easy to see that under the effects of competition and the market power, the China ICT companies are deepening along the gradual innovation way; a variety of innovation patterns are emerging, which integrate many styles of innovation such as industry, technology, market (business model), and organization, presenting a full range of integrated innovation and development trend.

5.4 An active interaction is being formation between the Chinese government and domestic enterprises' innovation and development

The Chinese governments play a positive promotion role in the process of domestic enterprises' innovation, integration, and development. Through the implementation of the national innovation strategy, planning, and S&T plans, the Chinese government has greatly promoted the launching of domestic radical innovation activities, and has guided the local enterprises to participate in these activities. The positive and effective interaction between government and enterprises will contribute to the enhancement of competitiveness in China's electronic information industry from a long-term perspective.

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