The Internet in India and China

Larry PRESS <lpress@isi.edu>
California State University, Dominguez Hills
USA

William A. FOSTER <wfoster@bpa.arizona.edu>
University of Arizona
USA

Seymour E. GOODMAN <sgoodman@leland.stanford.edu>
Stanford University
USA

Abstract

India and China are unfriendly nations, share a common border, and have different forms of government. They have 38 percent of the world's population, their expanding middle classes are an important global market, and they are major producers and polluters. The development of their Internets will have global implications.

This paper is based on an in-depth Mosaic Group study of the state of the Internet in China and India and the factors that explain it. It begins with a brief summary of the study methodology and framework for analysis, then compares the Chinese and Indian Internets on six dimensions: pervasiveness, geographic dispersion, sectoral absorption, connectivity infrastructure, organizational infrastructure, and sophistication of use. China is found to equal or exceed India on each dimension. Explanations for this situation are offered by comparing determining factors in telecommunication infrastructure, human resources, equipment and the economy, and government interest and support.

We then look to the future. In spite of frequent claims that the Internet will erode national sovereignty, government interest and support is seen to be important both directly and indirectly through its influence on the other factors. We examine changing government roles, primarily the adoption of an ambitious Action Plan in India and the reorganization of Ministries and Internet service providers in China. The Indian Action Plan addresses each of our six diffusion dimensions and is designed to elevate India to the level of information technology superpower. The impact of the Chinese changes is less direct, but will also be important in determining the future of the Internet there.

Contents

Introduction

It is our hypothesis that the Internet will make a significant contribution to the quality of life in developing nations. Since roughly 38

percent of the global population lives in China or India, the progress of the Net in those nations deserves careful study and consideration. We conducted a study of the state of the Internet in China and India during the summer of 1998 [1] and found much that is typical of developing nations in both.

The paper begins with a comparison of the state of the Chinese and Indian Internets along six dimensions. India joined the Internet before China, but the Chinese Internet quickly caught or surpassed India on each of our dimensions. We offer explanations of this situation by comparing determining factors in telecommunication infrastructure, human resources, equipment and the economy, and government interest and support.

In spite of frequent claims that the Internet will erode national sovereignty, government interest and support is seen to be important both directly and indirectly through its influence on the other factors. Both governments are now committed to the Internet, and we examine changing government roles, primarily the adoption of an ambitious Action Plan in India and the consolidation of two key ministries in China. The Indian Action Plan addresses each of our six dimensions, and is designed to elevate India to the level of information technology (IT) superpower. The impact of Chinese consolidation is less clear, but will also be important in determining the future of the Internet there. We conclude with a discussion of sources of uncertainty.

Comparing the Internet in India and China

We evaluated the Indian and Chinese Internets on six dimensions, starting with *pervasiveness*. The Internet is more pervasive in China where there are an estimated 1.2 million accounts versus only approximately 200,000 in India, and host count estimates give China a lead of roughly eight to one.[2] The research and education networks have been particularly effective in China, where they account for more than half a million users.

China also leads in *geographic dispersion*. Commercial Internet access is available in over 200 cities representing all Chinese provinces, while India has Internet points of presence (POPs) in only 17 of 32 states and union territories. China qualifies for a higher rating on our scale, but usage is concentrated in large cities in both nations, and villages (roughly 70% of both populations) are completely unserved. India has opened the Internet service provider (ISP) market, which was a government monopoly at the time of our study, so it may therefore improve rapidly.

China leads in *sectoral absorption* as well. Business connectivity is rare (under 10%) in China, but fewer than 400 businesses are connected in India. While connectivity is almost nonexistent in primary and secondary schools in both nations, over 300 Chinese universities and 200 research institutes have direct connectivity. Government connectivity and websites are rare in both nations as is usage in the health sector.

Connectivity infrastructure is a function of domestic backbone, the prevalence of high-speed access, Internet exchanges, and international bandwidth. India has little terrestrial backbone, relying almost exclusively on satellite links. China uses both satellite and terrestrial links. For example, ChinaNET connects its centers with 155 Mbps circuits and connects to its 200 POPs at between 2 and 34 Mbps. Nothing close to this exists in India. Neither nation operates Internet exchange points at present, but China has plans to do so.[3] China has more organizations connecting with leased lines, and is experimenting with cable modem and xDSL (digital subscriber line), but they are not deployed in either nation. Finally, China has more than double India's international bandwidth. In spite of China's relative advantage, we must bear in mind that aggregate bandwidth per user is very low compared with that of a developed nation, rendering interactive applications such as Web access impractical in many cases; e-mail is the primary application in all developing nations.

Organizational infrastructure is concerned with competition in the telecommunication and Internet industries and with coordination and organization in the Internet industry. Telecommunication is monopolized in both nations. Ironically, there has been more Internet competition in China where there are four interconnecting networks. Two of these serve only education and research, but the other two are open, and there are 200 competing access networks downstream from these. Until recently, the Indian government monopolized the Internet, but backbone and access competition have now been authorized. While interconnecting network competition is beginning in India, the ministries that operate China's commercial interconnecting networks, the Ministry of Electronic Industries (MEI) and Ministry of Post and Telecommunications (MPT), are being merged into a new Ministry of Information Industries (MII), which may reduce backbone competition.

At the same time, there is immense pressure on the part of the central government and Premier Rongji to introduce competition into the telecommunication industry. As part of this attempt, China UNICOM, the nation's second telecommunications provider, is being reinvigorated. During the latter part of 1998, a number of plans for restructuring China Telecom were considered by the Chinese State Council. The one most likely to succeed involves separating the paging, wire-line, and mobile communication businesses, and breaking the wire-line business into 18 separate companies along regional lines. What impact this restructuring will have on the competitiveness of the Internet backbone market remains to be seen.

Sophistication of use is comparable in the two nations, with the Internet increasing efficiency of conventional organizations and processes, such as in substituting for mail and fax. Both nations may make similar innovations in the future since they are demographically similar in many ways. For example, both have large rural populations and will be motivated to innovate in the use of the Internet to address the needs of villages and in inventing new applications, technology, and organizations to enable that service. (The Indian government has officially recognized this as a priority.)

In summary, table 1 shows that, today, China is currently doing as well or better than India on each of our dimensions and key subcomponents. This situation may change with the advent of Internet competition and the government adoption of an ambitious IT Action Plan in India. We will discuss this changing government role below, but first, we will discuss why China started late and how

it surpassed India.

Comparing key determinants

Internet progress in a nation depends upon determining factors including the availability of telecommunication infrastructure; networking technicians and trained, demanding users; networking and end-user hardware; and an interested, supportive government.[4] China enjoys advantages in many of these areas.

Telecommunication infrastructure

Telecommunication infrastructure is an important element in Internet growth, and, although India and China lag behind industrial nations, China has invested heavily during the 1990s. As a result, Chinese telecommunication infrastructure has rapidly outgrown that of India, and leads in virtually all indicators. For example, in 1996, Chinese teledensity was 4.46 mainlines/100 capita versus 1.54 in India.[5] The gap has continued to widen since 1996, as India's capital expenditure for telecommunication was $1.794 billion in 1996 while China invested $13.038 billion.[6] This rapid buildup in China requires outside financing, and China has been much more successful than India in attracting direct foreign investment.[7] The Chinese may not have been thinking of the Internet when they decided to invest in telecommunication infrastructure, but it has helped regardless.

The Chinese also operate their telecommunication system more efficiently. They have over 4.4 times the revenue per employee and 3.3 times as many mainlines per staff member as India.[8] One explanation of Chinese efficiency is that they decentralize decision making, pushing investment and service decisions to the provincial or city level.

India's legendary bureaucracy also cuts efficiency. For example, spectrum allocation is parceled out to government agencies, each of which manages its own slice, leading to suboptimization.

Human resources: Technicians and users

A robust Internet also requires investment in human capital. Both networking leaders and technicians and demanding users are required. India and China followed a common pattern in that the Internet began with universities and research institutes.[9] In such cases, the early networking community provides leadership and technical knowledge.

While Chinese academic networking began with X.25 in 1987, Internet protocol (IP) connectivity did not begin until 1993, and broader university Internet access (both UNIX-to-UNIX copy program [UUCP] and IP) began to take off in 1995. The two academic networks, CERNET and CSTNet, were instrumental in extending the Internet beyond the academic and research communities by their example and leadership and in offering commercial service, and they have continued to thrive, accounting for roughly 50 percent of Chinese users. Approximately 25 percent of Indian users are from universities.

The education and research network (ERNET) pioneered Indian networking, but did not play as important a technical and leadership role. They were funded by United Nations Development Programme (UNDP) for many years, and were therefore isolated from performance and market demands. They spent early years planning at a time when UUCP networks were being rapidly deployed in other developing nations, and when available, their service was often unreliable. When UNDP funding was withdrawn in 1995, it was not clear that ERNET would even survive.[10] They had interim funding for two years and finally became an autonomous society in 1998, but their budget, staffing levels, telecommunication-subsidy levels, and office location are yet to be determined.

Chinese universities were more entrepreneurial than those of India. Funding in China came from both the Ministry of Education and the individual universities, while Indian universities received very little money from the government and paid nothing themselves.

Network leaders and technicians are on the supply side, but the Internet also needs trained, demanding users. These users come initially from the university and research communities, but demand from other sectors soon becomes dominant. At this early stage, a lack of demand does not appear to have constrained Internet diffusion in either nation. While education and literacy rates are low (particularly in India), the absolute numbers of potential users are high. Roughly 5 percent of the population of South Asia speaks English.[11] This translates into nearly 50 million potential Indian users since English speakers are generally well educated and able to afford a computer and Internet account or access at a public venue. The educated middle class in China is also large in absolute terms. Both nations have large university systems -- in 1990, 4,425,247 Indians and 2,651,396 Chinese were enrolled in higher education.[12] For the time being, the number of educated, middle-class people in both nations is large relative to the number of Internet users.

Equipment and the economy

The Internet also requires end-user equipment (personal computers [PCs]), and networking equipment. Relatively large numbers of PCs are a direct advantage in that they are available for use and an indirect advantage in that the people operating them become trained potential users. The International Telecommunications Union (ITU) estimated that 3.7 million PCs were installed in China and 1.1 million in India in 1996.[13] Dataquest expects this gap to grow rapidly, estimating 1996-1999 PC sales in China at 18.1 million units versus 2.32 million in India.[14]

The Chinese advantage in PCs reflects two factors. China has been more heavily involved in PC manufacturing and trade and has established brands such as Great Wall and Legend. China produced over 1.5 million PCs in 1996 and the government predicts over

10 million units by 2000. One company, Legend, produced 350,000 PCs in 1997, while all of India assembled only 500,000. China also produces and exports PC components, including 12 million motherboards and 8 million monitors in 1996.[15]

The second factor is affordability. Whether a computer is purchased by an organization for employees or by a family for the home, the cost is large relative to budgets in developing nations and hard currency is required. A low-end, Internet-ready PC costs around $1,000 in either nation, but China is richer, making PCs relatively more affordable.[16]

Networking equipment is also an issue. To date, it has nearly all been imported in both nations; however, China seems more likely to eventually develop a network equipment industry. One clue to the possible future differences between the two is provided by the fact that the Chinese telecommunication-export industry was more than 25 times as large as that of India in 1996.[17] Cisco Systems has agreed to assemble routers in China. This agreement may have been partially motivated by pressure from the Chinese government, but access to infrastructure, local availability of components such as power supplies, and service such as sheet metal fabrication make China an attractive manufacturing location. Cisco has decided to invest $100 million in various activities within China.[18] Bay Networks (now part of Nortel) will establish an architectural lab in Beijing,[19] and 3Com will invest $100 million in several activities, including networking.[20]

It is interesting to note that Cisco has opened a 75-person software development center in India, but this reflects a smaller investment.[21] It parallels the effort of the Microsoft Windows NT development group in Hyderabad with roughly 20 programmers.[22] The sizes of these programming groups and the hardware manufacturing volumes in China indicate that the hardware side of the "information economy" may have a greater impact on gross national product (GNP) than the software side will.

All of the above factors -- telecommunication infrastructure, human resources, and equipment -- require costly investment that must occur within the context of the broader economy. While both India and China are developing nations with scarce resources, China is more productive and prosperous today. In 1980, gross domestic product (GDP) per capita (in 1987 dollars) was $134 in China and $262 in India.[23] Indian policy changes in 1980 helped GDP growth accelerate to over 5 percent per year during the 1980s, but since China's market-oriented reforms began in 1978, real GDP growth has averaged over 9 percent per year,[24] leading to a GNP per capita of $620 versus $340 in India.[25]

In addition to being more productive, China has greater propensities to save, invest, and trade than India. Since the time of Mahatma Ghandi, India has followed a self-reliance policy motivated by economic and security considerations. Reform and opening began in 1991, and direct foreign investment rose from $162 million in 1990 to $1.3 billion in 1995,[26] but China still enjoys a wide, growing lead in international investment and trade.

Government interest and support

While telecommunication, including the Internet, may erode some aspects of national sovereignty, all of the factors we have mentioned are influenced directly or indirectly by government policy and action. In every nation, government plays a central role in Internet diffusion, but that role can change over time. For example, the U.S. government led in establishing the Internet and earlier networks through purchases, research, and direct operation, but it has drawn back as industry stepped in.[27] Historically, the Indian government has impeded the Internet with a combination of indifference and government monopoly, though it appears ready for a bold change of direction, and the Chinese government first considered the potential risks, then moved relatively rapidly once it decided to join the Internet.

Indian IT policy has vacillated over the years. The deployment of mainframe computers was interrupted when IBM withdrew from India in response to a 1976 law limiting foreign ownership of business to 40 percent. Rajiv Gandhi assumed leadership after the assassination of his mother in 1984 and identified telecommunications and information technology as a "core sector" along with traditional industries such as power, steel, oil, and automobiles.[28] The Internet languished after Gandhi's assassination with the government using the authority granted in the Indian Telegraph Act of 1885 to stop private ISPs from operating. Only powerful government agencies have been able to become ISPs serving limited constituencies, and the Ministry of Communication has kept a monopoly over commercial ISP service. Whether it was revenue, power, or control over technical issues that India wished to maintain, the Indian government moved slowly in embracing the Internet, and resisted the global trend toward privatizing telecommunication and introducing competition.

The election of the Bharatiya Janata Party (BJP) in 1997 signaled renewed interest in IT and the Internet. BJP advocates economic liberalization, and listed IT as one of the government's five top priorities. This commitment led to the establishment of a high-level IT task force in May 1998. If the recommendations of the task force are implemented, the Indian Internet will grow dramatically and may close the gap with China.

Governments are aware of the potential advantages and risks of the Internet.[29] It is seen as having potential to improve the economy, education, health care, environment, and the quality of life, particularly in rural areas, but these are weighed against the possible threat to the stability of the regime,[30] national security, and cultural values.

While the Indian government appears to have been slow to act out of bureaucratic indifference, other threats do not seem to have played a major role. This relative lack of concern is consistent with India's long-standing commitment to a free and often highly critical press, and Indian pride in being the world's largest democracy.

China is more concerned than is India about the political risks of information in general, including the Internet. The Chinese government is sensitive to the impact that the mass media, facsimile machines, tape recorders, and Internet news groups had during the Tiananman Square demonstrations. It also witnessed the fall of the Soviet Union after information flows were liberalized, including the use of the Internet during the Soviet coup attempt.[31] Ironically, Chinese national security concerns led the

government to focus its attention on the Internet before India did, which may have accelerated growth.

While it took some time to decide to what extent they would participate in the Internet and which agencies should be involved, the Chinese decided the benefits outweighed the risks. Once they decided to move, they acted quickly. The Chinese State Council authorized four government organizations to run networks that interconnect with the global Internet, and the threat of competition between them influenced deployment, service, and pricing. In addition to running their own ISPs, both China Telcom's ChinaNET and the MEI ChinaGBN were willing to sell support to private ISPs, whereas in India there was no backbone competition.

While the Chinese government has moved forward with the Internet, it is attempting to minimize the risks by maintaining control over access, use, and content. The December 1997 regulations promulgated by the Chinese Ministry of Public Security are extremely broad and forbid the transmission of information that injures the reputation of state organs or incites division of the country or resistance to the constitution, laws, or implementation of administrative regulations. There are also prohibitions on promoting feudal superstitions, sexually suggestive material, gambling, and violence, and user registration is also mandated. The recent sentencing of Lin Hai to two years in prison for providing 30,000 e-mail addresses to a "hostile foreign organization" and the establishment by the national police ministry of task forces for Internet monitoring in search of "seditious talk" indicate China's determination to control the Internet.

To some extent, the differing levels of concern with security issues between China and India may result from the influence and size of their respective militaries. Chinese military expenditures are nearly four times those of India,[32] and the People's Liberation Army has been more heavily involved with the Internet (seeking to be an ISP) than the Indian military has been.

In contrast to the union government, Indian state governments have had a positive influence on the Internet.[33] For example, in West Bengal and the capital of Andhra Pradesh, Hyderabad, proactive state governments have provided incentives to involve private firms in Internet-related ventures, in which both the government and the firm share equity, establishing a Singapore-like middle ground between government control and *laissez faire*. In these and other cases, state projects and partnerships between state and local governments and private enterprise have preceded and contributed to national planning and action in India.

Similarly, decentralization has played a role in China. The distributed nature of the Internet has worked well within the context of the distributed organization of China Telecom itself. Posts and telecommunications bureaus at the city level can invest in their own ISPs while being connected to the provincial or national backbone, which led to a rapid rollout of ChinaNET during 1995-1996 to all provinces. China has embraced markets, and there is considerable competition among local governments in IT and other areas.

Looking to the future

The governments have played major roles in both nations. The Chinese government addressed the Internet late, after their own academic networks and world developments made it clear that this was strategic infrastructure. Once they decided the potential benefits outweighed the risks, they created two backbone providers and many access providers, while attempting to maintain control over access, use, and content. The Indian government has been more passive, neglecting the Internet and allowing it to be controlled by bureaucratic monopolies.

However, the situation in both nations is now changing dramatically. Coincident with the merger of the MEI and MPT into the MII, the Chinese government separated the regulatory authority from the operating organizations, and is seeking to introduce some degree of competition. It remains to be seen what the impact of this move will be, but it will surely affect the course of Internet diffusion in China.

The changes in India are potentially more dramatic. The speed with which the IT task force moved is indicative of the changing government attitude. Within 90 days, it produced an extensive background report and a 108-recommendation Action Plan.[34] The task force could act quickly because it built upon the experience and frustration of the state governments, universities, and industry. Much of its plan is also consistent with the thinking and recommendations of international bodies like the World Trade Organization, ITU, and World Bank, and it had the example of similar plans in Singapore and other nations. The task force did not start from scratch -- it surveyed the opinions of Indian computing and networking leaders and recommended what it heard. This was less a task of invention than of sparking action on a consensus that had already evolved.

The remainder of this section compares the likely impact of the Indian liberalization, the task force recommendations, Chinese consolidation, and other factors on the diffusion of the Internet in the two nations. We consider the six dimensions introduced earlier.

Pervasiveness

At present, the Internet is confined to large cities in both nations. While these groups are far from saturated, high levels of pervasiveness will require service to the lower urban classes and villages, which raises issues of public access, service in villages, education and language, and affordability.

It will be many years before PCs are affordable to average Indian or Chinese families, and the bulk of urban residents will depend upon public access facilities. The Indian Action Plan calls for the establishment and facilitation of public access points, and it suggests that Internet access might be provided by upgrading the 600,000 privately run public telephone offices in the country today. This will not solve the entire problem, because many are small and undercapitalized and staffed, but some will doubtless become Internet access points. Some state governments also have plans for public access programs. While the Chinese have no policy on universal access or the spread of the Internet to villages, they do plan to extend telephone service to every village, indicating that universal access is a consideration.

Pervasive penetration will require connectivity in villages, which comprise approximately 70 percent of the population in both India and China.[35] The Indian Action Plan calls for taking "all the necessary steps to boost IT for agricultural and integrated rural development" and calls for pilot and research projects. These are lofty goals, but telephone service in rural India is very poor, with approximately half the villages having no phones. The Indian government may be reversing a policy of neglect, and the government appears to be more aware of villages than China is.

Whether in villages or urban areas, computer users must be literate, and illiteracy will constrain Internet penetration in both nations.[36] The problem is greatest in India, with an overall illiteracy rate of 48 percent as compared with 19 percent in China.[37] This gap may be expected to continue into the future, since the average primary school class in China has 22 students per teacher compared with 64 in India.[38]

Language is also a major issue in achieving widespread network utilization. The Indian constitution recognizes 14 languages, but an estimated 179 languages and 544 dialects are used. While 30 percent of the population speaks Hindi, it is still an unpopular, foreign language in the south, Bengal, and other regions. [39] China is dominated by the Mandarin dialect, and both Cantonese and Mandarin use the same character set. Because standardization on a native language is easier in China than in India, there is a higher level of Chinese content on the Internet.

The fact that most e-mail packages did not support 8-bit encoding made using English a necessity at first, but today, as programs that support Chinese become common, more and more Chinese are utilizing Chinese in e-mail. There has been a government effort to develop Chinese-language content.

In India, the local language market is fragmented, and English is therefore used on most websites; however, the Action Plan states that "[a] major promotional campaign shall soon be launched to boost IT in Indian languages." In addition to developing content, technical issues of support for Indian languages in software packages and font standards must be addressed. The government has supported some research in this area [40], and Windows 2000 will support Hindi and Tamil. ERNET also distributes local-language software free of charge.

While government action and programs will encourage Internet penetration in both nations, free-market purchase of PCs will still be a key determinant of pervasiveness, and this is tied to affordability. The Indian Action Plan will help with duty reduction and other incentives to lowering computer prices, elimination of gift taxes on PCs, financial subsidy for teachers and students, and so on; however, both nations will benefit from the rapid reduction in the cost of Internet-capable PCs arising from competition for the low-end central processing unit and PC market in the United States.

The foregoing has assumed increased pervasiveness is a goal. The Indian Action Plan is clear on this intention, declaring "IT for all by 2008" as one of its three basic objectives, but some Chinese may be somewhat ambivalent, choosing to restrict the Internet to those who will use it effectively to increase productivity and not be outspoken. Chinese restrictions on access, content, and acceptable use will tend to reduce Internet pervasiveness. In the long run, there will be inevitable conflict between security concerns and the desire to use the Internet for universal education, electronic commerce, government services and transactions, and more. This debate has also begun in India, but, with its history of democracy and an active free press, India is not likely to be as restrictive as China.

Geographic dispersion

While China has at least a 64 kbps link to some point in each province, the bulk of Internet connectivity and utilization remains in the large eastern cities. Similarly, an estimated 98 percent of Indian Internet traffic is from the six major gateway cities.[41]

Many of the measures described in the prior section will impact geographic dispersion, and the Indian Action Plan explicitly mandates geographic dispersion by ordering the Department of Telecommunication to establish Internet access nodes in all district headquarters and local charging areas by January 2000. In the meantime, all Internet-access calls are to be charged at local rates. This direct government action guarantees wider access by the year 2000, but opening the backbone and access-ISP markets to competition may have a more profound effect on geographic dispersion with market forces carrying the Internet into the smaller urban areas.

The Action Plan recognizes the inextricable connection between infrastructure planning and social planning, and also contains measures that will indirectly encourage diffusion. For example, it calls for 50 Hi-Tech Habitats in the various states; singles out states with low levels of IT skill, education, literacy, and English language for special attention; and calls for demonstration projects in *each* state (italics added).

ISP competition has helped to carry connectivity beyond key large cities in China, and will do so in India as well; however, dispersion into villages and remote areas may prove more difficult. The Indian Action Plan calls for the military to help with remote dispersion and encourages wireless and cable-TV-based last mile connectivity which may impact villages and remote areas. However, village connectivity will be very difficult to achieve in both nations. (Satellite-based IP backbones such as Teledesic's may eventually ease this problem.)

Sectoral absorption

Our framework is concerned with diffusion of the Internet into the business, education, government, and health sectors.

Commercial sector

The Indian Action Plan makes stimulation of the software and IT services industries a basic objective, with a goal of $50 billion in exports and a commensurately large domestic IT market. These measures will have a direct impact upon business use of the Internet since networking is integral to the activity of software and IT service companies. The Action Plan lists 38 steps to assist IT firms with venture capital, credit, subsidies, reduced taxes, duties, and fees and fewer bureaucratic roadblocks. (These measures will of course have secondary effects on all of our dimensions.)

The Action Plan also supports offshore programming services with a call for diplomatic pressure to make it easier for Indian programmers abroad to obtain visas. This is a double-edged sword. If the United States or other nations ease visa and work permit restrictions, programmers emigrate. While this brain drain hurts the domestic software industry, professional nonresident Indians are an important source of hard currency and business contacts.

While most of the business emphasis in the Action Plan is in support of software and IT service, there are also measures to encourage other electronic business, such as by ordering the Department of Telecommunication to meet "communication requirements" for electronic commerce and electronic data interchange, expediting electronically based export orders, and mandating bar coding. To the extent that this traffic flows on the Internet, it will add to penetration; however, related legislation concerning privacy, digital signatures, and encryption is not yet specified.

Intellectual property laws and customs will also have a major impact, and these have been an ongoing source of tension between software companies and the government in China. In both nations, poverty and limited familiarity with credit cards and other banking services among the general public will also constrain the level of consumer-oriented electronic commerce, but this should be less of a problem in business-business transaction processing. Still, it should be noted that Internet commerce is in early stages of development in both nations, and it will be some time before it significantly impacts the Internet.

Education sector

China has been more successful than India in pushing the network into higher education; however, neither has had primary or secondary school programs. One of the three basic goals of the Indian Action Plan is "IT for all by 2008," and India has ambitious plans for networking schools at all levels. For example, there is a mandate that "computers and Internet shall be made available in every school, polytechnic, college, university and public hospital in the country by the year 2003." Investment in distance education and financial incentives for computer purchase by students and teachers are also mandated, and these would lead to greater use of the Internet.

Health sector

While the Action Plan mandates Internet "availability" to all public hospitals in the country by 2003, it does not spell out what that availability might consist of -- it could run from a single analog modem to a high-speed digital link connecting a hospital local area network (LAN) to the Internet. Perhaps the fact that this is the only mention of health in the Action Plan is more significant than the nature of the mention itself. The 18-member task force has representatives of industry (telecommunication, software, and IT), government, and education, but not health. This may explain the lack of emphasis on health care in the current plan. China has experimented with telemedicine links to the United States, and telemedicine pilot projects are under way at some of the military hospitals.

Government sector

Government applications are designed to facilitate government-citizen interaction or increase internal efficiency. The Indian Action Plan promises to increase government activity in both areas. Three of its recommendations are concerned with facilitating network-based information sharing and transaction processing between the government and citizens, and thirteen are on the use of IT in government. It is noteworthy that the co-chairman of the task force, Chandrababa Naidu, is governor of Andhra Pradesh, the state that has been most active in government initiatives. His use of IT has convinced him that IT is a powerful tool in increasing government efficiency. He is also convinced that a transparent, open government will be motivated to be responsive to the needs and wishes of the people -- to be more democratic. He sees networks as facilitating SMART (simple, moral, accountable, responsible, and transparent) government.[42]

In January 1999, the Chinese government announced an ambitious program calling for 60 percent of the ministries to have websites by the end of 1999 and 80 percent by the end of 2000.

Connectivity infrastructure

One of the three overall objectives of the Indian Action Plan is setting up a "world-class information infrastructure" at the local, national, and international levels, and 18 recommendation are directed toward that end. Each of the connectivity-infrastructure subcomponents of the analysis framework is directly encouraged: international connectivity, fiber optic backbone, IP exchanges, and high-speed access. There is even a duty exemption for infrastructure firms. A wave of infrastructure deployment may follow the removal of government restrictions.

People -- networking managers and technicians -- can also constrain the deployment of connectivity infrastructure. The Indian Action Plan addresses the training of IT professionals with a call to triple the output of IT students by restructuring programs at the national-level institutions and establishing Indian Institutes of Information Technology like the one established under Governor Naidu.

The impact of the Chinese ministry consolidation and the restructuring of China Telecom on the rate of backbone deployment is less certain. The uncertainty caused by the restructuring may temporarily delay deployment. It is too early to tell whether China UNICOM will be able to deploy a national infrastructure and provide an alternate source of leased-line capability to organizations running national networks. It is also unclear whether breaking China Telecom into 18 regional businesses will spur deployment of leased line and backbone infrastructure.

Organizational infrastructure

Organizational infrastructure is a function of the competitive state of the ISP and telecommunication industries in a nation, and these should open considerably in India. On the other hand, the level of ministerial competition has been reduced in China with the recent consolidation, while competition between operating entities may have increased.

ISP industry organization and cooperation is also a consideration here, and, while India has a fledgling ISP organization, the E-mail and Internet Service Providers Association, it is mostly a paper organization at this time since the industry barely exists. This dimension should increase with the others as they improve.

Ministry consolidation and the elimination of the MII Steering Committee appears to have simplified the organizational infrastructure in China. Coordination and planning are still taking place; however, the process is less visible and inside the MII.

Sophistication of use

Usage in both nations is conventional today, with e-mail substituting for fax and phone calls, but is not causing fundamental changes in applications or forcing the invention of new technology. Innovation in nations occurs in areas that have special needs or applications.[43] Since roughly 26 percent of the world's population lives in Chinese or Indian villages, there is a strong motivation to develop innovative organizations, finance methods, applications, and technology for connectivity in villages of developing nations. We hope to find cheap, mass-producible kiosks, portable ground stations, satellite and terrestrial wireless connectivity, solar-powered nodes, community ownership schemes, local training and staffing techniques, micro-credit or other schemes for financial self-sufficiency, voice and video content, agricultural information, news, entertainment, and more being developed in these nations. Such progress may or may not come to pass, but it seems a practical and meaningful "niche" for networking innovation.

Uncertainty

Regardless of the action of the governments, the Internet will continue to grow in all aspects in both nations. The Indian government seems to have the will to move forward at this time, as evidenced by the rapid work of the task force and ratification of the Action Plan, but they are far from finished.

The cost of many of the recommendations would be great, and there are competing priorities. Fifty-six of the Action Plan recommendations call for increases in service levels or subsidy, and many of the regulation changes will result in reduced government revenue. There may also be increased bureaucracy -- the Action Plan would create seven new working groups, task forces, and agencies; it requires 5-year plans of all state and federal departments; and 1 to 3 percent of every ministry/department budget is to be earmarked for IT. Much of the funding will have to come from private firms, both domestic and foreign, and, as we have seen, India has had much less success than China in attracting direct foreign investment.

Indian IT and Internet progress may also be tied to politics to a degree. The Action Plan may be set back if the BJP government falls. It is also vulnerable to attack as focusing on a luxury area in a nation in dire need of necessities and of special treatment and subsidy for IT industries.[44] India also has a history of protectionism, and there are protectionist hints in two of the Action Plan recommendations.

The major short-run question marks in China have to do with the effect of the ministerial consolidation and the restructuring of China Telecom. China Telecom, even if broken into 18 entities, may use this transition to solidify its position as the dominant provider of physical layer national backbone facilities. Will its dominance of both the backbone and the ISP market be a serious barrier to innovation, investment, and service, and will this barrier limit the rate of Internet diffusion? Or will their new, more distributed structure enable them to effectively expand capacity, roll out service, and chose technologies? China Telecom is a government organization and the Internet is very much a government enterprise in spite of private ISPs.

Whether another government corporation, China UNICOM, will be able to build a national infrastructure from the excess telecommunications capability of the Ministries of Railways and Power is open to question as is how much actual competition this would provide. Some argue that China needs to develop a second national telecommunications firm before it opens its markets to global telecommunications companies. Others urge strengthening China Telecom so that it will be strong enough to compete with the foreign companies. Will China Telecom preserve its dominance of the physical backbone, and will this, combined with access and content control, stall China's development, allowing India to pass it?

Chinese government policy with respect to Hong Kong and even at some point Taiwan will also impact the Internet. The Internet and telecommunication in Hong Kong and Taiwan are far more advanced than in China. In spite of British rule and Taiwanese independence there are strong cultural and business ties: A surprising 46.75 percent of China's switched, outbound telephone minutes are to Hong Kong and another 8.02 percent are to Taiwan.[45] Hong Kong has a vibrant Internet with 126 ISPs and a major international IP exchange. To date, the Hong Kong Internet has remained autonomous (for example, Chinese international bandwidth is 70 Mbps, but less than 1 Mbps via Hong Kong). Even if that remains the policy, there will be technology and skill transfer between the two, and this will enrich and benefit the Chinese Internet.

Contrasts in the decision-making processes in India and China also lead to different forms of uncertainty in predicting government telecommunication and Internet policy. India had an open, decentralized process in which government, industry, and academic leaders became involved and expressed opinions. Once the task force was established, the process was made explicit and public. The government published the list of members, their charge, and time limit for deliverables. As soon as the background report was published, it was placed on a Web server, and, as befits the world's largest democracy, comments were solicited. Over 3,000 suggestions were received from IT professionals around the world. The pros and cons and chance of success of the Action Plan have been debated in the press and on the Internet. This openness contrasts with the internal decision-making and power struggles that characterize Chinese decision making. Each style introduces uncertainty in different ways. In India, we know what has been recommended, but are uncertain about when and even whether the measures will be carried out. In China, we learn of decisions after they are made, but they are likely to be quickly implemented.

We are also struck by the fact that to date, the Indian union government has hindered the diffusion of the Internet, and some of the states have been quite innovative. China has also done well to the extent that decision making on investment in telecommunication and Internet access provision has been decentralized. Will the MII tend to centralize decision making, losing some of this edge? The Indian government appears to be ready to embrace private and state initiatives.

No matter how the government policies and their implementation play out, the Indian and Chinese Internets bear watching. They are unfriendly nations, share a common and disputed border, and have very different forms of government. They have 38 percent of the world population, their expanding middle classes are an important global market, and they are major producers and polluters. The development of their Internets will truly have global implications.

Table 1: Dimension Comparison Summary

Dimension or Component	**Advantage (C = China, E = Even)**
Pervasiveness	
users	C
hosts	C
geographic dispersion	
top-tier political divisions with POPs	C
number of cities with POPs	C
sectoral absorption	
commercial	E
education	C
government	E
health	E
Connectivity infrastructure	
domestic backbone	C
high-speed access	E
exchanges	E
international bandwidth	C
Organizational infrastructure	
telecommunication competition	E
backbone competition	C
access provider competition	C
coordinating organizations	E
Sophistication of use	E

Note

A version of this paper that includes statistical tables is at http://som.csudh.edu/fac/lpress/articles/chind.htm.

References

1. Goodman, Seymour E.; Burkhart, Grey E.; Foster, William A.; Mittal, Arun; Press, Laurence I.; and Tan, Zixiang (Alex), *The Global Diffusion of the Internet Project, Asian Giants On-Line,* Chapter 3 (India) and Chapter 4 (China), The Global Information Technology Assessment Group, Fairfax, VA, November 1998.
2. The populations of India and China are roughly 0.93 and 1.2 billion.
3. We are treating China independently of Hong Kong.
4. Press, L., Developing Networks in Less Industrialized Nations, IEEE Computer, vol. 28, no. 6, June 1995, PP 66-71.
5. ITU, 1998 World Telecommunication Development Report, Geneva, March 1998.
6. ITU, Asia Pacific Telecommunication Indicators, International Telecommunication Union, Geneva, June 1997.
7. In 1995, direct foreign investment in China was 10 times that in China, World Development Indicators, World Bank,

Washington, DC, 1997.
8. Ibid.
9. Goodman, S.; Press, L.; Ruth, S.; and Rutkowski, A., The Global Diffusion of the Internet: Patterns and Problems, Communications of the ACM, vol. 37, no. 8, PP 27-31, August 1994. Examines common patterns of Internet growth within nations.
10. Mehta, Arun, ERNET gasping for survival, Pioneer, October 31, 1994.
11. Keniston, Kenneth, Does Vernacular Software Have a Future in India? unpublished talk, July 22, 1988.
12. Johnson, Jean M., Human Resources for Science and Technology: The Asian Region, National Science Foundation NSF 93-303, May 1993.
13. ITU, Asia Pacific Telecommunication Indicators, International Telecommunication Union, Geneva, June 1997.
14. N. Suresh with L. Subramanyan, The Dragon Gets the Dollars, *Dataquest India*, 15 June 1998, www.dqindia.com/jun1598/sprep.html, (21 September 1998).
15. Ibid.
16. Based on national averages, this is roughly three years' income for an Indian and under two for a Chinese; however, incomes are higher in urban areas where networked computers are found today.
17. China exported $US 1,999 and India $US 74.6. The Chinese imported over 17 times as much as India, $US 2,647.7 versus $US 151.2. ITU, 1998 World Telecommunication Development Report, Geneva, March 1998.
18. Reuters, Cisco Systems will Invest $100 million in China, June 21, 1998, http://www.cmcnyls.edu/public/Bulletins/CoSI100c.htm.
19. Xinhua Electronics News/Xinhua News Agency, Bay Networks to Establish Architecture Lab in Beijing, http://www.idgchina.com/xinhua/vol9811/bay.htm.
20. Reuters, 3Com to Invest in China, July 28, 1998, http://www.cmcnyls.edu/public/Bulletins/3ComIICh.htm.
21. Cisco Press Release, Cisco Systems and HCL Open Software Development Center in India, August 11, 1997, http://www.cisco.com/warp/public/146/1936.html.
22. S. Somasegar, interview, August 20, 1998.
23. United Nations Human Development Programme, Human Development Report, Oxford University Press, New York, Oxford, 1997.
24. World Bank, Trends in Developing Economies, World Bank, Washington, DC, 1995.
25. World Development Indicators, World Bank, Washington, DC, 1997.
26. World Development Indicators, World Bank, Washington, DC, 1997.
27. Press, Larry, *Seeding Networks: the Federal Role*, Communications of the ACM, PP 11-18, Vol. 39, No. 10, October 1996.
28. Yourdan, Ed, India, American Programmer, Vol. 2, No. 10, October 1989.
29. Goodman, Seymour E.; Burkhart, Grey E.; Foster, William A.; Press, Laurence I.; Tan, Zixiang (Alex); and Woodard, Jonathan, *The Global Diffusion of the Internet Project: An Initial Inductive Study,* Fairfax, VA: The MOSAIC Group, March 1998.
30. Striving for stability is motivated by social concern as well as the desire to maintain power. Communist nations, including the Chinese, are aware of the difficulties of the Russian transition.
31. Press, L., Relcom, An Appropriate Technology Network, Proceedings of INET'92, International Networking Conference, Kobe, Japan, June 1992, Internet Society, Reston, VA. Reprinted in The Proceedings of the Telecommunications Conference, Moscow, Russia, June 1992.
32. United Nations Human Development Programme, Human Development Report, Oxford University Press, New York, Oxford, 1997.
33. Press, Larry; Goodman, Seymour; Mehta, Arun; and Mittal, Arun, The Role of Government in Developing India's Internet, OnTheInternet, PP 35-37, November/December 1998.
34. http://it-taskforce.nic.in/it-taskforce/infplan.htm.
35. It may be argued that the Internet will tend to slow the global trend toward increased urbanization by improving employment opportunities, education, health care, entertainment, and awareness of the outside world and improved quality of life to villages. See Press, L., The Role of Computer Networks in Development, Communications of the ACM, vol. 39, no. 2, PP 23-30, February, 1996.
36. Increased audio and video content and communication may eventually relax this constraint.
37. World Bank, World Development Report, 1997, Oxford University Press, Oxford, New York, 1997.
38. 1997 World Development Indicators, World Bank, Washington, DC, 1997.
39. Paz, Octavio, In Light of India, Harcourt Brace and Company, San Diego, New York, London, 1997.
40. Hall, Pat, Vernacular Software in South Asia: what happens now and what is needed, The International Working Conference of IFIP WG9.4 for Implementation and Evaluation of Information Systems in Developing Countries, February 18-20 1998, Bangkok, Thailand.
41. L. Satyanarayana, *The Internet Services in India*, undated paper received 24 June 1998.
42. Interview, June 1998.
43. Press, L., "Software Export from Developing Nations," IEEE Computer, December 1993.
44. The Action Plan benefits software companies, software and hardware importers and exporters, trade school and public education at all levels, and some geographic areas and projects.
45. Staples, Greg, editor, Telegeography 1997/98, Telegeography, Inc., Washington, DC, 1997.