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Global Diffusion of the Internet - I: India: Is the Elephant Learning to Dance?

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GLOBAL DIFFUSION OF THE INTERNET I: INDIA: IS THE ELEPHANT LEARNING TO DANCE?

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ABSTRACT

With his proclamation in 1998 that "IT is India's tomorrow", Prime Minister Vajpayee captured a vision of a 21st century India substantially different from that of the previous century, with its high levels of poverty, bloated bureaucracies, and protectionist policies. He envisioned the new India as a major IT power, fully integrated with the global economy, bringing about substantial domestic and international benefit. The Internet is a key to this vision, both as an enabler of technology-based change, and as an indicator of the vision's fulfillment.

Using an analytic framework developed by the authors and others, this study documents the growth of the Internet in India, from the pre-Internet networks through the boom of the Internet from 1998 to 2003. The Indian experience provides an example of how fundamental, focused changes in policy and legislation can unleash forces that accelerate Internet diffusion. Private sector initiatives greatly expanded the Internet infrastructure and Internet services market. At the same time, government initiatives promoted the expansion of the Internet into parts of the country not well served by private ISPs. Poverty and limited telecommunications infrastructure currently limit the rate and extent of Internet expansion. However, time is an ally; the basic elements for continued growth of the Internet are largely in place.

Keywords: India, global diffusion of the Internet, telecommunications policy, Internet service, diffusion of innovation

PREFACE: GLOBAL DIFFUSION OF THE INTERNET FRAMEWORK

The analytic framework used in this study was initially formulated in a paper published in monograph entitled Global Diffusion of the Internet An Initial Inductive Study [Goodman et. al., 1998a], based on a more general analytic concept developed in The Information Technology Capability of Nations [Wolcott, Goodman, and Burkhart, 1997]. Its theoretical basis is presented in A Framework for Assessing the Global Diffusion of the Internet [Wolcott et. al., 2001]. Most broadly, the framework consists of dimensions and determinants. Dimensions contain six variables, described below in Table 1, that capture the state of the Internet within a country at a given point in time. Determinants reflect the factors that led to the observed state and which will likely influence future development.

A useful analytic framework should be rich enough that it captures the multifaceted diversity of countries' experiences with the Internet. At the same time, the number of variables should be small enough that they can be easily kept in mind. Each of the variables should describe an important, somewhat intuitive, and measurable attribute of the Internet in a country. The variables should collectively address nearly every aspect of the Internet in a country; yet each variable should offer something unique to the overall analysis. Finally, for the framework to be useful the variables must be measurable given a modest investment of resources; otherwise, its effectiveness is compromised.

The six dimensions of Internet Diffusion are shown in Table 1. Each dimension variable may be assigned one of five levels indicating the state of the Internet in a particular country at a given point in time. Levels for the pervasiveness dimension are described in Table 2. The United Nations Economic and Social Commission for Asia and the Pacific employed a similar dimension/level approach in its Technology Atlas Project [Liff, He and Steward, 1993]. While Table 2 defines the levels for only a single dimension, *Pervasiveness*, it outlines the general characteristics of each level common to all dimensions. Using an order of magnitude differential between levels increases the probability that two observers looking at the same country at the same point in time will assign the same value, even though the data about the Internet is rapidly changing, incomplete, and of variable credibility. In addition, while the measure is fundamentally quantitative, there is a qualitative aspect to the levels. When a country progresses from one level to another, the change is substantial enough that one is likely to observe a significant change in the impact of the Internet and a shift in its use.

Table 1. Dimensions of the Diffusion of the Internet

Dimension	Description
Organizational Infrastructure	Internet service market characteristics; a measure of the richness, robustness, and level of choice among Internet service providers.
Geographic Dispersion	Physical distribution of infrastructure. Primarily a function of the fraction of first-tier political subdivisions (states, provinces, governorates, etc.) with Internet points of presence (POPs).
Connectivity Infrastructure	Capacity of the technical infrastructure; primarily a function of the capacity of domestic and international backbones, and the types of access available to users (e.g. modem vs. high-speed).
Pervasiveness	Percentage of total population using the Internet.
Sectoral Absorption	Extent of connectivity in four social sectors: Education, Commercial, Health, and Government.
Sophistication of Use	Integration, transformation, and innovation; a measure of the nature of Internet usage by a leading segment of the user community.

Table 2. The Pervasiveness of the Internet

Level 0	Non-existent	The Internet does not exist in a viable form in this country. No computers with international IP connections are available. There may be some Internet users in the country, however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1	Embryonic	The ratio of users to total population is on the order of magnitude of less than one in a thousand (less than 0.1%).
Level 2	Established	The ratio of Internet users to total population is on the order of magnitude of at least one in a thousand (0.1% or greater).
Level 3	Common	The ratio of Internet users to total population is on the order of magnitude of at least one in a hundred (1% or greater).
Level 4	Pervasive	The Internet is pervasive. The ratio of Internet users to total population is on the order of magnitude of at least one in 10 (10% or greater).

While the "state" of the Internet at a given point in time within a given country can be captured using the dimensions given in Table 1, the analysis is accompanied by a discussion of the political, technological, social, economic, and historical factors that shaped the evolution of this complex phenomenon.

In summary, the analytic framework captures the state of the Internet within a country in a rich, multifaceted, yet relatively straightforward way through the use of dimensions. Together, the dimensions and the discussion of factors shaping the Internet's evolution provide an analytical tool that can be used to conduct longitudinal studies, for multi-country comparisons, and for formulating policy recommendations.

I. INTRODUCTION

BACKGROUND

India is the world's largest democracy and the second most populous nation, with a population of over one billion people (Figure 1). Constituting the majority of the landmass of Southern Asia, India's ethnic, linguistic, religious, economic, political, and geographic diversity is greater than perhaps any other country in the world. Its population (Table 3) consists of two major ethnic groups, Indo-Aryan and Dravidian. Fifteen official languages are spoken in India as are dozens of distinct unofficial languages and hundreds of dialects. As a result of this linguistic divide, English became the language of inter-communal business, central (Union) government operations, and the judicial system. As one Mumbai (Bombay) resident mildly exaggerated, "India has 980 million people and even more gods. Travel 30 or 40 kilometers, and everything changes: people, climate, culture, geography, food, religion."

Despite its large population and high population density, India remains a largely rural country, with about 70 percent of the population residing outside of the major metropolitan areas. Approximately 67 percent of the work force is employed in the agricultural sector [U.S. Central Intelligence Agency (CIA), 1997]. The varying geological and climatic conditions and the dispersion of the country's vast population make the development and maintenance of basic infrastructure components (e.g. roads, electrical power distribution, telecommunications) difficult and expensive. This condition is compounded by frequent natural disasters such as flooding and earthquakes.

Initially knit together by British law, bureaucracy, and technology, the modern Republic of India was created in August 1947, when the British government granted its former colony independence. Since independence, India predominately followed a policy of self-reliance motivated by social, economic, and security considerations. The modern Indian state is characterized by extreme poverty, a bloated and corrupt government, and a highly regulated and

Figure 1. India

Table 3. India in Statistics

Metric	Value	Source
Population	1 billion	July 1999 estimate July, 1999 estimate ["World Factbook 1999 -- India," 1999]
Population growth rate	1.68%	July 1999 estimate July 1999 estimate ["World Factbook 1999 -- India," 1999]
GDP	$420.8 billion	1998 estimate ["India at a Glance," 1999]
GDP per capita	$429	1998 estimate ["India at a Glance," 1999]
Inflation rate	6.8%	1998 estimate ["India at a Glance," 1999]
	14%	Consumer prices, 1998 estimate ["World Factbook 1999 -- India," 1999]
Literacy	52%	1995 estimate ["World Factbook 1999 -- India," 1999]
	52.2%	1991 Census of India ["India at a Glance," 1991]
Telephones	12 million	1996 estimate ["World Factbook 1999 -- India," 1999]
	19.4 million	November, 1999
	30 million	February, 2001 ["175 mn Phone Connections," 2001]
Teledensity	2%	April, 1999 estimate [Agarwal, 1999]; November, 1999 estimate ["DoT to Add 18," 1999]
	3.1%	February, 2001 ["175 mn Phone Connections," 2001]

protectionist domestic market motivated by self-reliance rather than global integration and innovation.

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A severe economic crisis in 1991 during which India nearly defaulted on a number of loans forced a basic change in economic policy. The New Industrial Policy (NIP), put in place in 1991, reflected a greater willingness to let market forces shape economic decisions. This policy introduced competition in a number of non-strategic sectors and lowered barriers to trade and foreign investment. As a result of these new policies, foreign direct investment rose from $162 million in 1990 to $1.3 billion in 1995 [World Bank, 1995].

Not surprisingly, the mindset that shaped economic policy also impacted the Indian information technology (IT) sector.

The IT industry experienced a temporary boost in 1984 when then-Prime Minister Rajiv Gandhi identified telecommunications and information technology as a "core sector," together with traditional industries such as electrical power generation, steel, oil, and automobiles [Yourdan, 1998]. Following Gandhi's electoral defeat in 1989, however, the IT sector and the Internet languished. The new administration used the authority granted in the Indian Telegraph Act of 1885 to prevent private Internet Service Providers (ISPs) from operating. Only powerful government agencies were able to become ISPs, and then serving only limited communities, while the Ministry of Communication maintained a monopoly over commercial ISP service. Whether motivated by a desire to maintain revenue, power, or control over technical issues, the Indian government moved slowly in embracing the Internet, resisting the global trend toward privatizing telecommunications.

Nevertheless, in 1994, in response to growing criticism, the government issued a National Telecommunications Policy (NTP 1994). The NTP emerged as India's first attempt at crafting a comprehensive policy to address the failings of the government's monopoly telecommunications provider, the Department of Telecommunications. In absolute terms, NTP 1994 was a small step forward. While it did envision the private sector as a partner in providing basic services (largely because the goals of the policy far outstripped the government's resources), it left the monopolistic regime largely intact.

INDIA AND THE INTERNET

In the latter half of the 1990s, the pace of reform quickened considerably, with the Internet playing an integral role, both as a factor driving reform, and as a beneficiary of change. The election of the Bharatiya Janata Party (BJP) in 1997 signaled renewed interest in IT and the Internet. The BJP advocated economic liberalization and listed IT as one of the government's top five priorities, along with more traditional issues such as the provision of potable drinking water and education [Kulkarni, 1998]. "Indian IT has had many small voices, but the BJP is attempting to give IT a national voice" [Kulkarni, 1998]. In May 1998, Prime Minister Vajpayee organized a national IT

task force to make recommendations for a comprehensive policy overhaul. The task force's recommendations were instrumental in initiating wide-ranging and fundamental changes in Indian IT policy.

The speed with which the Indian National Task Force on Information Technology and Software Development moved was indicative of the changing government attitude. Within 90 days of its establishment, the Task Force produced an extensive background report on the state of technology in India and an IT Action Plan with 108 recommendations [Kulkarni, 1998; IT Task Force, 1998a]. The Task Force could act quickly because it built upon the experience and frustrations of state governments, central government agencies, universities, and the software industry. Much of what it proposed was also consistent with the thinking and recommendations of international bodies like the World Trade Organization (WTO), International Telecommunications Union (ITU), and World Bank. In addition, the Task Force incorporated the experiences of Singapore and other nations, which implemented similar programs. It was less a task of invention than of sparking action on a consensus that had already evolved within the networking community and government.

Prime Minister Vajpayee captured the changing attitude toward technology in India in his claim that "IT is India's Tomorrow" [Vajpayee, 1998]. This assessment offers a vision of a 21st century India substantially different from that of the 20th century. With its high levels of poverty, bloated and corrupt bureaucracies, protectionist policies, and large size, 20th century India was like the Asian elephant, plodding and turning slowly. At the dawn of a new millennium, Vajpayee and a growing number of politicians, bureaucrats, industry leaders, foreign investors, and bright-eyed entrepreneurs are trying to teach this Asian elephant to dance [Nidumolu and Goodman, 1993].

The shift towards IT reflects more than just the cultivation of a new sector of the economy. It has the potential for fundamentally changing India's relationship with the world, and the lives of its own citizens. The scope of the vision is enormous. It could change the structure of industry, the processes and procedures by which a modern state is governed, the relationship between the governed and their governments, and the individual's vision of what his or her life could be. In Vajpayee's words [Vajpayee, 1998],

> *[IT] is revolutionising life on this planet like no other technology has in human history. It has been impacting on the economy, communication, culture, educational system and social interaction in all the countries, bringing them closer in a world transformed into a Global Village and laying the foundation for a new civilisation. India, as the cradle of civilisation, is poised to become a major IT power in the coming years and contribute to the realisation of its many promises for our own benefit and for the global good.*

The IT Action Plan of 1998 was followed by several major pieces of legislation changing the telecommunications regime. The New Telecommunications Policy, 1999 (NTP 1999) went much further than NTP 1994 in liberalizing the telecommunications sector. The Information Technology Act 2000 placed electronic transactions and commerce on firmer legal footing. The pending Convergence Bill 2000 seeks to establish an integrated regulatory regime for voice, data, and broadcasting communications. Despite the establishment of new IT policies the gap between the vision and the current state of India is enormous. In 1998, the year of Vajpayee's remarks, India's was one of the lowest fixed telephony penetration rates in all of Asia, at 1.5 lines per 100 people. In addition, there were fewer than 2 personal computers per 1000 people, nearly half of its population was illiterate, and the GDP per capita was only US $429. At the same time, however, the number of educated, middle-class people was large relative to the number of Internet users, indicating that a large, un-serviced market existed for the Internet. Roughly five percent of the population of South Asia speaks English [Keniston, 1998], which translates into nearly 50 million people in India alone. These people are generally part of the middle class, which is educated and able to afford an Internet account, and access at a cyber café or other public venue.

The Internet is central to the new vision of India as an IT power in many respects.

1. First, to a substantial degree, the Internet and the associated technological, economic, and social phenomena embody the notion of "IT" in the late 20th and early 21st century. While in years past a country's technological status was often measured by the performance of the country's most powerful supercomputer, today it is more likely to be measured by the number of Internet users, the number of Internet hosts, the volume of electronic commerce, and the capacity of its communications lines.
2. Second, the Internet itself is an enabling technology. Thanks to the browser as a "universal client" and global connectivity based on open-standards, the technical infrastructure has enabled network-based person-to-person, business-to-consumer, and business-to-business interaction that potentially can change the way people and organizations conduct their affairs. In the case of India, the use of the Internet and telecommunications technologies were central to the growth of the export-oriented software industry.
3. Third, by its very nature, the Internet is a technology for the masses. It is difficult to speak of a country's being "a major IT power" if over 99% of its citizens never used the Internet. Achieving significant penetration of the Internet beyond major metropolitan centers must therefore be a central thrust of any IT vision.
4. Fourth, the Internet is a driving factor with respect to supporting technologies, government policies, laws, and services. Among these factors are such diverse elements as telecommunications infrastructure; legislation regarding taxation, accounting, and privacy; book publishing; Internet service provision; commercial Web-page development, and consulting. The number of factors shaping the evolution of the Internet is extensive [Goodman et. al., 1998a].

This study examines the evolution of the Internet in India, from its largely academic origins in the late 1980s through the highly dynamic environment of today[1]. The future challenges are formidable, but the actual and potential changes in India are significant. The government has become increasingly aware of the strategic importance of telecommunications and the Internet. This study employs an analytic framework developed as part of the Global Diffusion of the Internet (GDI) Project [Goodman et. al., 1998a] to analyze the Internet's evolution, enabling us to draw conclusions about its future development. Section 2 presents a brief history of pre-Internet networks in India. Section 3 provides an overview of key policy and legislative changes that have affected the development of the Internet. Section 4 applies the GDI analytic framework to the Indian Internet. Section 5 offers conclusions.

II. BEFORE THE BOOM: EARLY NETWORKS IN INDIA

THE TELECOMMUNICATIONS REGIME FOR BASIC SERVICES

All civil and commercial telecommunications in India, except for radio and television broadcasting, fall within the purview of the Ministry of Communications (now called the Ministry of Information Technology) and the Telegraph Act of 1885. As a result of this Act, the Government of India held a total monopoly on all types of communications until the late 1990s; this monopoly included voice and data transmissions, domestic and international, and local and long distance. Not only did the government control the operational aspects of telecommunications services, but the policy-making and regulatory functions as well [Dossani and Manikutty, 2000]. The Ministry exercises its authority through the Telecom Commission, consisting of a chairman and four members to oversee services, technology, finances, and production. The Telecom Commission oversees the Ministry departments that provide telecommunications services and licensing, and policy functions, which, prior to 1999, were almost exclusively provided by the Department of Telecommunications (DoT). Until the mid-1980s, the DoT handled all aspects of telecommunications in India. During this decade, however, some initial steps towards

[1] The data used in this study were current through early 2003, unless otherwise indicated.

liberalization were taken including the creation of a publicly owned company, Mahanagar Telephone Nigam Limited (MTNL), set up to provide local telecommunications service in Delhi and Mumbai. In addition, responsibility for all international long-distance communications was granted to Videsh Sanchar Nigam Limited (VSNL), a publicly held company. Domestic long-distance and local telecommunications outside of Delhi and Mumbai continued to be provided by the DoT.

Under the National Telecommunications Policy, 1994 (NTP 1994), the Indian government introduced measures that would, for the first time, permit the private sector to supplement the government's telecommunications services. Through a problematic bidding process, licenses were to be issued to a private carrier in each of the country's 20 telecommunications circles. By the year 2000, however, only six licenses had been awarded and private companies were in operation in only four of the 20 circles [Mokhariwale, 2000].

PRE-INTERNET NETWORKS IN INDIA

The telecommunications infrastructure provides the physical underpinnings of data networks. Prior to the introduction of the Internet in India a number of organizations pursued the development of wide-area networks. While the discussion in this section focuses on developments before the Internet, in recent years most of these networks provided gateways to the Internet, or were converted to Transmission Control Protcol/Internet Protocol (TCP/IP) and became part of the Internet.

Table 4 presents the time-line of the most significant of these developments.

Table 4. Indian Networking Time-Line

Mar. 1975	NIC established
Oct. 1976	Computer Maintenance Company (CMC) established
1978	CMC takes over former IBM India maintenance operations
1980	NCST developed/deployed proprietary e-mail software for LANs
1982	NCST established indigenous, proprietary VSAT network Experimental 32 Kbps packet-switched network, COMNEX, connected Ahmedabad, Mumbai, and New Delhi.
1986	INDONET X.25 network commissioned by CMC ERNET project initiated NCST established first inter-campus e-mail link (NCST to Indian Institute of Technology, Bombay (Mumbai))
1987	NICNET (first nationwide VSAT network) established District Information System (DISNIC) program established by NIC
1988	NCST established first e-mail link with the USA VSNL commissioned Gateway Packet Switching System
1989	NCST connected to I-NET/X.25 via dial-up connection NCST connected ERNET to the Internet via UUNet Technologies IndiaLink established to serve regional Non-Government Organizations (NGOs)
May 1989	NCST registered as the *.in* domain manager
1990	NCST established leased line to I-NET
1991	VSNL introduced Gateway Electronic Mail Service Election results disseminated in near real-time via NICNET
1992	VSNL introduced 64 Kbps leased line service NCST up-graded I-NET leased line to 64 Kbps
1993	VSNL introduced EDI services
Aug. 1995	VSNL started offering commercial Internet access [Sadagopan, 1998b]
Apr. 1998	ERNET reconstituted as an independent “society”

In 1986-1987, the Indian government initiated three wide-area computer networking schemes: INDONET, initially to serve the country's hundreds of IBM mainframe installations; NICNET, the National Informatics Centre Network, a nationwide very small aperture terminal (VSAT) network for public sector organizations; and the Education and Research Network (ERNET), to serve the academic and research communities. VSNL also initiated several wide-area networks (WAN) during the 1980s.

INDONET

The deployment of mainframe computers was interrupted in November 1977 when IBM withdrew from India in response to a 1976 law limiting foreign ownership of Indian companies. The Indian government commissioned the Computer Maintenance Corporation (CMC) Limited to take over the responsibility of maintaining approximately 800 IBM India installations (the "IBM Go Back" initiative) [CMC Ltd., 1998a; Sadagopan, 1998a]. In 1984, CMC branched out into areas of computer education, software development, and turn-key projects. By 1986, the company established the country's first nationwide Systems Network Architecture (SNA) network, INDONET, using lines leased from the Department of Telecommunications (DoT) [CMC Ltd., 1998b]. The network was subsequently up-graded to the X.25 packet-switching protocol[2] [CMC Ltd., 1998c].

By 1998, INDONET connected eight cities via 64 Kbps leased lines. These links are shown in Figure 2.

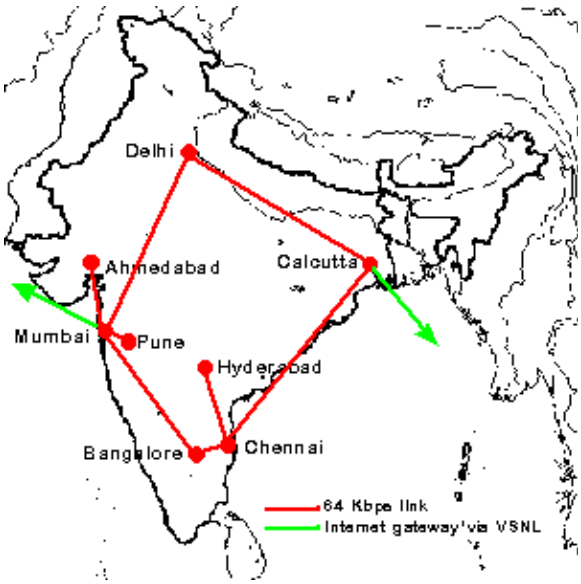


Figure 2. INDONET, Circa 1998

NICNET

In 1987, the National Informatics Centre (NIC) commissioned the country's first nationwide very small aperture terminal (VSAT) satellite network, NICNET, to provide data communications for government agencies. The network linked the national capital with all state and territory capitals

[2] Packet-switched networks use protocols that split messages into smaller "packets", which are independently transmitted (switched) through the network. These packets are reassembled at the receiving end into the original message. X.25 is an international standard that describes the interface between such networks and the systems that use them. Errors are detected and corrected each time a packet makes a "hop" from one node to the next as it traverses the network.

and 440 of the country's 531 district headquarters. The main processing center was located at NIC's headquarters in New Delhi, and regional processing centers were established in Bhubaneshwar, Hyderabad, and Pune. NICNET's services included e-mail, remote database access, data broadcasting, electronic data interchange (EDI), and the Emergency Communication System [NIC, 1994].

One of NICNET's more interesting innovations was the creation and deployment of a rural development information system targeted at illiterate farmers. The system was distributed to rural development offices on CD-ROM, and provided pictorial and oral information about government assistance programs.

VSNL Networks

VSNL operated the Global Packet-Switched Service (GPSS), an international packet-switched service at speeds up to 64 Kbps [VSNL, 1998b]. The GPSS network consisted of three Packet Switching Exchanges (PSE) in Calcutta, Mumbai, and New Delhi), with high-speed interconnections as shown in Figure 3. It provided connections to most foreign packet-switched networks and served as a gateway to the Internet, supporting text communications.

Figure 3. The GPSS Network Infrastructure. Source: [VSNL, 1998a].

VSNL also operated the Gateway Electronic Mail Service (GEMS 400), an international e-mail network with nodes in Bangalore, Calcutta, Chennai, Mumbai, New Delhi, and Pune. In addition, an e-mail gateway between GEMS and the Internet and the system could be used to send Telex messages and facsimiles [VSNL, 1998a].

In 1998, VSNL signed a national data carrier agreement to market services developed by Global One, a joint venture of Sprint, Deutsche Telekom, and France Telecom, including Global X.25, Global Frame Relay[3], and Global LAN-to-LAN, in India. Managed network nodes were established in Bangalore, Mumbai, and New Delhi to provide high speed connections to Global One's 1,400 points of presence worldwide ["Global One and VSNL," 1998].

[3] Frame relay is a packet switched network technology that, in contrast to X.25, leaves error correction (retransmission) up to the end-points, thus reducing transmission overhead and improving performance.

DoT Networks

The Department of Telecommunications offers domestic satellite communications services through the High-speed VSAT Network (HVNET), as well as nationwide packet-switched services via the India Network (I-NET). Remote access for data communications was provided by the Remote Area Business Message Network (RABMN).

The I-NET packet-switched public data network (PSPDN) nodes were located in eight cities: Ahmedabad, Bangalore, Calcutta, Chennai, Hyderabad, Mumbai, New Delhi, and Pune. Connections to GPSS were available in Bangalore, Calcutta, Chennai, Mumbai, New Delhi, and Pune.

In early 1998, the DoT announced a new category of private network, Broad User Group (BUG) Data Networks. BUG Data Networks were virtual private networks created through the interconnection of two or more private networks. A BUG could be set up on the basis of INET or leased line access from the DoT. One of the first organizations to take advantage of this new network category was the *Société International de Télécommunications Aéronautique* (SITA), an international cooperative that operates a global network primarily serving the air travel industry [Mahabharat, 1998]. SITA began offering public networking services on a commercial basis in 1995.

E-Mail

In 1995, several value-added services, including e-mail and the operation of private networks, were liberalized. By late 1995, eleven non-Internet-based e-mail service providers (Table 5) and 13 closed user group (CUG) VSAT network operators operated in India (Table 6). An additional five VSAT network proposals were pending at that time ["Status of Value Added," 1995].

Table 5. E-Mail Services Licensees

Archana Telecommunication Service.	Global Telecom Service Ltd.
CMC Ltd.	C.G. Graphnet Pvt. Ltd.
Dataline & Research Technology	ICNET Pvt. Ltd.
Datapro Information Technology	Sprint RPG
Swift Mail Communications Ltd.	VSNL
Wipro BT Telecom Ltd.	

Table 6. Closed User Group VSAT Network Operators

Amadeus Investments & Finance	Hughes Escorts Communications
Comsat Max	ITI
Dataline & Research Technologies (I)	MARCSAT Communications
HCL Comnet Systems and Services	Punjab Wireless & Systems
Himachal Futuristic Communications	Rama Associate
RPG Satellite Communications	SATNET Communications
Wipro	

THE EMERGENCE OF THE INTERNET (1989-1998)

ERNET

The Education and Research Network (ERNET), a multi-protocol network, was established in 1986 by the Department of Education (DoE) and seven other government organizations: the National Centre for Software Technology (NCST); the Indian Institute of Science (IISc), Bangalore; and the Indian Institute of Technology (IITs) in Chennai (Madras), Kanpur, Kharagpur, Mumbai, and New Delhi. The project received technical and financial support from the UN Development Program (UNDP). The goals of the project were to set up a nationwide computer network for the academic and research communities, conduct research and development in computer networking, and provide network training and consulting services [ERNET, 1998].

During its first two years, the ERNET project was directed towards the development of a nationwide academic network and the evaluation of software and hardware systems. The UNIX operating system was selected as the basis for the network because it was inexpensive, it supported most of the existing Internet software, and technical assistance was widely available [Ramani, 1998]. During this time, NCST established the first inter-city (Bangalore) and international (with the United States) electronic mail links, in 1987 and 1989, respectively.

NCST, an independent agency, played a critical role in the development of the Internet in India. It was the first institution in India to establish an international connection to the Internet, and subsequently acquired the responsibility for managing the *.in* national top-level domain (TLD), since the organization established a root-server and the first *.in* (India) Internet domain (ncst.ernet.in).

The first connection to the global Internet, a 9.6 Kbps Unix-to-Unix Copy (UUCP) link between NCST and UUNet (UNIX-to-UNIX Network) Technologies in the United States, was established in February 1989. It was up-graded to a 9.6 Kbps leased line[4] and full TCP/IP connectivity by the end of 1989. The international link was up-graded to 64 Kbps in 1992.

ERNET's infrastructure included landlines within metropolitan areas and VSAT links between cities. The network consisted of eight "backbone sites" (Table 7) and 104 VSATs, based on Hughes Network System (HNS) technology. Seven connections were provided to the Internet via VSNL international gateways, of which five operate at 2 Mbps (Table 8). The ERNET supported approximately 80,000 users at 700 organizations, carrying more than 10 GB of traffic daily [ERNET India, 1998b]. In 1998, approximately 12,000 ERNET subscribers were "serious" users who logged on every day and used the Internet extensively. An additional 20,000 only used e-mail [Ramani, 1998].

Table 7. ERNET Backbone Sites. Source: [ERNET India, 1998a]

Department of Electronics (DoE), New Delhi (Delhi)
National Centre for Software Technology (NCST), Juhu, Mumbai (Maharashtra)
Indian Institute of Science (IIS), Bangalore (Karnataka)
Indian Institute of Technology Madras (IITM), Chennai (Tamil Nadu)
Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune (Maharashtra)
Variable Energy Cyclotron Center (VECC), Calcutta (West Bengal)
Indian Institute of Technology (IIT), Kanpur (Uttar Pradesh)
Central University, Hyderabad

[4] A leased line is a communications line that is leased by an organization for its exclusive use, 24 hours per day.

Table 8. ERNET Gateways to the Internet. Source: [ERNET India, 1998c]

Location	Speed
DoE, New Delhi (Delhi)	2 Mbps
Software Technology Park, Bangalore (Karnataka)	2 Mbps
VECC, Calcutta (West Bengal)	2 Mbps
NCST, Juhu, Mumbai (Maharashtra)	64 Kbps
NCST A-1 Building, Mumbai (Maharashtra)	256 Kbps
IUCAA, Pune, (Maharashtra)	2 Mbps
IITM, Chennai (Tamil Nadu)	2 Mbps

NICNET

Since 1995, NICNET offered Internet access via VSNL gateways in the four "metros" (Calcutta, Chennai, Mumbai, and New Delhi) and Bangalore and Pune [Satyanarayana, 1998]. The National Informatics Centre also maintains web pages for its government clients.

NICNET did not, however, intend to become a commercial ISP, and saw Internet access as a supplement to its service offerings. As of mid-1998, NICNET estimated a total of 20,000-25,000 e-mail users on the network.

VSNL/DoT

VSNL's first experience with the Internet was in the early 1990s when then-Chairman, B.K. Syngal, was given an ERNET e-mail account [Ramani, 1998]. On August 14, 1995, VSNL commenced offering public Internet services via a gateway earth station and router in Mumbai that provided a single connection to MCI in the USA, essentially becoming an ISP. Local access nodes were installed in Calcutta, Chennai, Mumbai, and New Delhi, permitting connections via dial-up lines through the DoT or MTNL or an I-NET connection ["Internet Service Kicked Off," 1995].

Although no ISPs were licensed, VSNL characterized the service as a "gateway" service— Gateway Internet Access Service (GIAS)— that VSNL was allowed to provide under the terms of its license to operate international telecommunications systems. Only four months after VSNL's Internet service was commissioned, the Indian government announced that VSNL would lose its monopoly, and that commercial ISPs would be licensed. VSNL was, however, to have the exclusive right to connect these ISPs to the Internet internationally ["VSNL Monopoly on Granting," 1996].

Shortly thereafter, VSNL added five more international gateways and increased the number of local access nodes to 11 (including the gateways). VSNL also established GIAS nodes at 19 additional locations and turned them over to the DoT for operation and maintenance.

At the end of 1997, VSNL/DoT had 75,000 Internet subscribers on their network. The number of subscribers crossed the 100,000 mark in March 1998 ["India Internet Users Top," 1998], and grew to nearly 150,000 by August 1998 [Pai, 1998; Kumar, A., 1998]. The subscriber base was growing by 2,000 per month in New Delhi and 3,000 per month in Mumbai. However, the total number of dial-up lines available for subscriber access in India amounted to only about 4,000 lines, an average of about 26 subscribers per access line [Satyanarayana, 1998].

In June 1998, VSNL created a new subsidiary, VSNL Seamless Services Ltd. (VSSL), to operate four wide-area networking services: GIAS, GEMS, GEDIS, and video-conferencing. VSNL's other networking service, GPSS, was not included in VSSL's charter. The former chairman of

VSNL, B.K. Syngal, announced that this move was intended to “level the playing field for value-added services” as “private service providers enter the market.” In effect, this division placed those services that were subject to competition at arm’s length from VSNL’s core international telephony business. In principal, this arrangement prevented cross-subsidization or concessionary rates that might give VSNL’s services an unfair advantage ["VSNL Forms Subsidiary for," 1998]. GEMS and GEDIS were already subject to competition from private e-mail and EDI service operators, respectively, while GIAS would soon see competition from new ISPs.

STPI

STPI is a society set up by the Ministry of Information Technology in 1991 to encourage and promote software exports from India. To provide efficient internal and international communications for its members, the Software Technology Parks of India (STPI) society operates its own communications network. When the Software Technology Park of Bangalore was first established, STPI spent two years attempting to obtain the required communications services from VSNL. As a result, STPI petitioned the government and received permission to operate a completely independent network. Until recently it was the only organization allowed to have its own international gateways (i.e., independent of VSNL).

In summary, during the period from 1986-1998, the Indian government supported a variety of programs to establish nationwide networks. These projects targeted the needs of the government, academia, and industry, and contributed to the creation of organizations and institutional know-how that helped support the Internet in its early days.

III. GOVERNMENT POLICY AFFECTING THE INTERNET

One of the principal factors shaping the evolution of the Internet in India and the telecommunications environment as a whole is government policy. Government policy and legislation defined the role of factors shaping the telecommunications industry including competition and the allocation of resources. More changes occurred in IT-related policy in the 1990s than in any of the preceding decades.

THE TELECOMMUNICATIONS REGIME

Through the mid-1980s, all communications services, voice and data, domestic and international, local and long-distance, were provided by the Government of India, as outlined in the Indian Telegraph Act, 1885. By the mid-1980s, however, the first tentative steps towards a more liberalized regime were taken, and two state-owned corporations were founded to provide limited communications services: MTNL for telecommunications services in Mumbai and Delhi, and VSNL for international long-distance.

An economic crisis in 1991 prompted the transformation of India's economy from one extensively controlled by the State, to one more subject to market forces. The New Industrial Policy of 1991 sought to improve India's economy by introducing competition in selected sectors, (excluding telecommunications), reducing the role of the state in the determining prices and the direction of investment, and reducing barriers to foreign investment.

Through 1994, the Government of India was not only the monopoly provider of services, but also the sole provider of other functions related to the telecommunications regime including licensing, policy-making, regulation, tariff setting, and cross-subsidies. The National Telecommunications Policy, 1994 (NTP 1994) focused on the expansion of telecommunications services throughout the country, and, to aid in achieving this goal, it opened the possibility of private sector involvement in the provision of basic services. NTP 1994 did nothing, however, to separate the provision of services from their regulation.

Following NTP 1994, the government invited tenders from the private sector to participate in providing basic services. A series of awkward decisions appeared to change the rules of the game and resulted in licenses being given in only six of the 18 state telecommunications circles

and eight metros of the country. By 1998, only two private companies were providing services, and by 2000 only four were operating [Dossani and Manikutty, 2000].

To fulfill commitments made when India joined the World Trade Organization (WTO) in 1995, the Ministry of Communications was required to separate its regulatory and operating functions, with a view toward the eventual privatization of the services sector. As a result, the Telecommunications Regulatory Authority of India (TRAI) was created. Its powers were enumerated in The Telecom Regulatory Authority of India Act, 1997. Although the Act gave the TRAI broad powers to make technical, operational, and licensing recommendations, and generally "facilitate competition," there was no requirement that any other government agency seek or comply with the TRAI's recommendations. Further commitments included the corporatization of the DoT [Kohli, 1998] and the sale of publicly held majority stakes in the three operating companies.

The limited scope of the TRAI's powers was defined by a judicial ruling of the High Court in Delhi when a dispute arose between the TRAI and the DoT. The DoT had taken several actions in late 1997 and early 1998 that were questioned by various private sector companies, including the licensing requirements for ISPs. On November 5, 1997, the DoT announced its original Internet licensing policy, including its intention to license an unlimited number of applicants nationwide. The same day, MTNL announced that it was establishing a new division for the purpose of offering Internet services. The licensing specifics were announced by the DoT on January 15, 1998, and applicants were invited to purchase the application forms. The following day, the E-mail and Internet Services Providers Association (EISPA) petitioned the TRAI to interdict the DoT policy, which its members thought was too restrictive. (The DoT had apparently not consulted with the Association in establishing the licensing procedures. This fact was probably more important than any questions about the actual procedures.) The TRAI heard EISPA's petition on January 19, and issued an order on February 17 requiring the DoT to stop selling license applications, to seek TRAI's concurrence before announcing a new Internet policy, and to then comply with the TRAI's decisions. In response to these requirements, the DoT petitioned the High Court, seeking to reverse TRAI's order. On March 20, 1998, the High Court declined to rule on the case, but issued an order allowing the DoT to sell applications "at risk" while the Court reviewed the case. In July 1998, the High Court ruled in favor of the DoT ["Grant or Amendment of," 1998; "Court Snubs TRAI, MTNL," 1998], effectively undercutting the TRAI and calling into question India's entire telecommunications regulatory regime.

One of the most significant developments in the evolution of the Internet in India was the formulation of a new Internet service provider policy, which permitted, as of November 7, 1998, the licensing of companies other than VSNL to provide Internet services.

Table 9 outlines some of the key developments in the regulatory environment of 1997-1999.

Table 9 Selected Milestones in the Evolution of Internet-Related Regulatory Regime.

1997	
March	The Telecom Regulatory Authority of India Act, 1997 is passed, creating the TRAI. The Act gives the TRAI broad powers to make technical, operational, and licensing recommendations, and generally "facilitate competition," although no provision was made that would require any other government agency to seek or comply with the TRAI's recommendations.
May	A DoE draft paper outlines measures to end VSNL's monopoly on providing Internet services.
August	The government decides to set up a watchdog organization to oversee the Internet service provider business. The Internet Management Authority, similar to TRAI, will monitor the functioning of private sector ISPs and monitor technical aspects of the service.

September	Various telecommunications and technology companies express an interest in becoming Internet service providers. The National Association of Software and Service Companies (NASSCOM) submits its suggestions on guidelines for the ISP policy to the DoT. The proposal calls for no licensing fees, licensing requirements that would promote interconnection of ISPs, creation of multiple interconnected national backbones, removal of monopoly on international gateways, and the creation of an agency to manage Internet growth ["Spinal Discord," 1997].
October	The Union government sets up an interdepartmental committee to examine the need for 'cyber laws,' which might address issues of taxation, and clauses in various Indian laws that might make electronic commerce illegal. The DoT announces the clearing of the Internet policy. An Implementation Committee starts formulating plans to put the policy into practice. The Committee consists of representatives of the DoT, the DoE, the Planning Commission, the India Railways, and the Power Grid Corporation of India Ltd.
November	The DoT issues a draft Internet license guideline that envisions a license fee of Rs 600 per subscriber payable annually after five years of operations. City-wide licenses rather than national or state-wide are recommended. ISPs will have to provide deposits or financial guarantees. The Indian Railways and the Power Grid will share the Internet backbone business with the DoT and VSNL.
1998	
January	The DoT announces the ISP policy. The licenses will be issued immediately on receipt of the applications, and applications will not have to provide earnest money. Private ISPs will have to meet the technical requirements of Internet access providers, e.g. VSNL and the DoT. There will be no license fees for the first 5 years of operation. E-mail and Internet Service Providers Association (EISPA) petitions TRAI to interdict the DoT policy, which its members thought too restrictive.
February	The TRAI issues an order requiring the DoT to stop selling license applications and seek TRAI's concurrence before announcing a new Internet policy. The DoT then petitions the High Court in Delhi, seeking a reversal of the TRAI order.
March	The High Court declines to rule on the case, but issues an order allowing the DoT to sell applications "at risk" while the Court reviews the case.
July	The High Court clears the DoT's ISP policy. The National Taskforce on Information Technology and Software Development (IT Taskforce) submits its first Action Plan.
October	Prime Minister Vajpayee announces the government will issue licenses to private ISPs by November 7, 1998. There would be no restrictions on the number of licenses to be issued to an ISP; no license fee for the first 5 years and an annual fee of one rupee thereafter.
November	The New Internet Policy goes into effect.
1999	
January	The DoT issues a circular demanding e-mail and ISPs to pay Rs 15,000 ($353) for each of the Public switched telephone network (PSTN) access lines they use, retroactive to 1995 ["DoT Told not to," 1999].
March	The Union Cabinet approves the New Telecom Policy 1999 (NTP 1999). Among other provisions, the NTP 1999 opens national long distance service beyond service area to competition by private operators effective January 1, 2000; strengthens the TRAI; restructures the DoT to separate service provision from policy and licensing functions
April	IT Action Plan Part III: *Long Term National IT Policy* is issued. Some of the key elements affecting the Internet in India include the encouragement of the government's use of electronic means to improve the speed and accuracy of information-based service delivery; the development of a domain name registration system permitting the management Internet names and addresses in India; the creation of a high-bandwidth national backbone (Project Sankhya Vahini) linking research centers and institutions of higher learning [National Task Force on Information Technology & Software Development, 1999a].
June	TRAI issues restrictions to the DoT and MTNL preventing them from disconnecting the

	customer access lines of any e-mail and Internet service providers until the TRAI arrives at a decision on the DoT interconnection charge demand of Rs. 15,000 ($348) ["TRAI Restrains DoT, MTNL," 1999].
July	The Indian government formulates the implementation mechanism for security provisions and clearance for ISPs to set up their own international gateways for Internet traffic ["India Readies Mechanism for," 1999]. No permission is required for use of encryption up to 40-bit key length. ISPs are to provide monitoring equipment for security provisions.
August	The DoT formally invites ISPs to set up international gateways for Internet provisions. The department issues guidelines and application formats to enable ISPs to get the security clearances necessary ["ISP Watch: Round-up," 1999]. TRAI directs the DoT to withdraw its demand for Rs.15,000 ($345) per PSTN line from ISPs ["DoT Told not to," 1999].

Sources: [Goodman et. al., 1998b; "ISP history," 1998; "Indian ISP History," 1998]

IT ACTION PLAN

Perhaps the most encouraging sign of a changing government attitude was the creation of the National Task Force on Information Technology and Software Development (it-taskforce.nic.in/it-taskforce). The National Agenda for Governance issued in March 1998 by the BJP outlined India's goal of becoming a software superpower and announced the creation of a National Informatics Policy aimed at achieving this end. The Task Force was directed to produce an Action Plan within 30 days and a National Informatics Policy within 90 days. The Task Force was created on May 22, 1998 under the chairmanship of Jaswant Singh, Deputy Chairman of the Planning Commission and a Prime Minister's Office insider. The two co-chairmen were Dr. M.G.K. Menon, a former Minister of State for Science and Technology, and the Chief Minister of Andhra Pradesh, N. Chandrababu Naidu. The Member-Convener, essentially the executive director of the Task Force, was Dr. N. Seshagiri, Director General of the NIC and one of the country's leading authorities on IT. The other 13 members of the Task Force were all well-known names in the Indian IT community, half of whom were civil servants, while the others were drawn from academia and the public sector. The make-up of the Task Force was heavily oriented toward the software sector, which was reflected in the first two major documents issued by the group.

Less than three weeks after convening, the Task Force published a Background Report on the state of IT in India [IT Task Force, 1998a]. Comments on this document were solicited from experts worldwide. An Action Plan, outlining 108 recommendations, followed on July 4, 1998 [IT Task Force, 1998b]. The Prime Minister then appointed an inter-ministerial committee to examine the Plan and to report their findings. The Committee, comprising the Communications, Information, and Broadcasting Minister and the Ministers of Defense, Finance, and Human Resources Development [IT Task Force, 1998c], endorsed the Plan, which was then approved by the Cabinet. On July 25, 1998 President Narayanan ordered the document into effect [Seshagiri, 1998]. Publication of the draft National Informatics Policy and an implementation plan for the 108 recommendations were completed before the end of that year.

The Action Plan featured 108 recommendations for removing bottlenecks to IT development to "facilitate India's emergence as an Information Technology Superpower." Three general objectives were outlined, including:

- an "Info-Infrastructure Drive" to build world-class IT infrastructure;
- "Target ITEX-50" to increase software and IT service exports to $50 billion by 2008; and
- "IT for all by 2008" to make telecommunications, Internet, and IT-enhanced public services available to all Indians by 2008.

Highlights included recommendations that computers and the Internet be made available to all schools nationwide by 2003; that education centers be established to serve as models for IT-based education, helping rectify the low levels of development in several of the poorer states; and that the armed forces be tasked with increasing IT penetration in "far-flung and remote areas,"

notably those closed to foreigners. The 18 infrastructure recommendations included calls for open competition in backbone and access networks, local call rates for Internet users, and the establishment of public access and information centers.

The very short time frame allotted for the development of the Action Plan was not generally considered a handicap. Any combination of individuals from among the pool of senior Indian IT professionals and IT-savvy politicians from which the Task Force was drawn would probably come up with a similar list of recommendations. There was broad consensus regarding the causes of the economic stagnation at that time, and it is likely that most Task Force members, and those with whom they consulted, entered the process with a general idea of what needed to be done. The press release that announced the presentation of the Plan to the Prime Minister noted that a "significant feature of the 'IT Action Plan' is that most of its recommendations have already received prior concurrence of the ministries and departments concerned" [IT Task Force, 1998c]. The Action Plan was thus more a compendium of accumulated problems and suggested solutions rather than a document that broke new ground. The new ground that was broken was the emphasis placed on IT by the new government that resulted in the production of the Plan and the Plan's implementation.

The Task Force seemed to be inclined to operate in two "waves": The first was to go after the "low-hanging fruit" with a series of specific recommendations that address generally-recognized problems with relatively simple fixes. The most obvious examples were the complicated systems of taxes, customs duties, import and export regulations, and licensing requirements. This reform also provided a good opportunity to issue several blanket recommendations to implement privatization throughout most of the telecommunications sector. The second "wave" comprised longer-term issues, addressed with "vision" statements and statements of intention rather than specific recommendations. Examples included the improvement of the educational systems in the poorer states through the establishment of IT-enhanced model schools that would be emulated, and directives to the military to enhance IT penetration in areas under its control.

The Internet was featured prominently in the Action Plan, with no fewer than nine of the recommendations, including the very first, specifically addressing Internet development issues. The first recommendation directed the DoT "and authorized ISPs" to open Internet access nodes in all district headquarters by January 26, 2000, with toll calls to Internet access nodes to be charged at the local rate in the interim.

Subsequent recommendations designed to spur the development of a robust Internet infrastructure and proliferation of services included a ten-year relief from any significant licensing costs (#7); the authorization of independent international gateways to the Internet (#8) (announced by the Communications Minister a week earlier); the authorization of public sector companies and organizations that have geographic rights of way to develop and operate networks for public use (#9); the authorization for network operators to interconnect directly, rather than via VSNL (#10); permission for cable television operators to offer Internet access without needing an additional license (#11); the authorization of fiber optic and radio links for "last mile" connections by ISPs (#12), the reservation of a radio frequency range for such links (#13); and the stipulation that computers and the Internet shall be made available in every "school, polytechnic, college, university, and public hospital" by 2003 (#59).

Another recommendation that mentioned the Internet as a component was #15, which authorized the establishment of privately-owned Public TeleInfo Centres (PTIC) that are to offer Integrated Services Digital Network (ISDN) and Internet access, videoconferencing, remote database access, and access to government information sources. The recommendation stated that the DoT and unspecified other service providers were to make efforts to up-grade Public Call Offices (PCO) to PTICs, but did not specify the level of effort.

The IT Action Plan set the stage for a number of subsequent legislative measures designed to implement some of its recommendations and create a dramatically different regime for the provision of communications services.

NEW INTERNET POLICY 1998

The New Internet Policy [Department of Telecommunications, 1997] went into effect in November 1998, allowing any Indian company with a maximum foreign equity of 49% the possibility of providing Internet services. It established three categories of license:

- Category 'A' licenses apply to the entire country.
- Category 'B' licenses for one of the 20 territorial telecom circles (which roughly correspond to the boundaries of a state) or the large metropolises.
- Category 'C' licenses are for individual cities.

The Policy removed any restrictions on the number of licenses a single company could acquire, or the number of licenses that could be held by different companies in the same area. Licenses would be issued for 15 years and ISPs would be free to set their own tariffs. In addition, ISPs could lease transmission network capacity from private basic service operators, the railways, the state electricity boards, and the National Power Grid, thus ending the DoT's monopoly on domestic long distance data networks. ISPs could also build their own transmission networks, upon approval from the DoT. They could set up last-mile linkages, and use the networks of private cable TC operators.

NEW TELECOM POLICY 1999

The New Telecom Policy 1999 (NTP 1999) reflected not only a change in policy, but also a change in philosophy regarding the provision of communications services in India. Unlike the NTP 1994, which tentatively introduced the prospect of private companies' providing communications services as a supplement to the DoT, NTP 1999 established liberalized telecommunications as the norm, with the DoT being one of several competing service providers. NTP 1999 established the following specific objectives [Government of India, 1999]:

- Make available telephone on demand by the year 2002 and sustain it thereafter so as to achieve a teledensity of 7 fixed telephone lines per 100 individuals by the year 2005 and 15 by the year 2010
- Encourage the development of telecom in rural areas making it more affordable by suitable tariff structure and making rural communication mandatory for all fixed service providers
- Increase rural teledensity from the current level of 0.4 to 4 telephone lines per hundred individuals by the year 2010 and provide reliable transmission media in all rural areas
- Achieve telecom coverage of all villages in the country and provide reliable media to all exchanges by the year 2002
- Provide Internet access to all district headquarters by the year 2000
- Provide high speed data and multimedia capability using technologies including ISDN to all towns with a population greater than 2 lakhs (200,000) by the year 2002

To achieve these objectives, NTP 1999 presented a telecommunications regime in which nearly all services (except international telephony) would be provided by two or more competing providers, including, but not limited to the DoT. Furthermore, NTP 1999 explicitly addressed the need to separate licensing and policy-making functions from those of service provision, specifying that the DoT should be split into two parts. As a result, in October 1999, the DoT was split into two departments. The Department of Telecommunications Services (DTS) would be responsible for service provision, while the remaining portion of the DoT, still called the DoT, would be responsible for the licensing and policy-making functions. On October 1, 2000, DTS was transformed into a corporation, Bharat Sanchar Nigam Limited (BSNL), with an initial valuation of $14 billion [Government of India, 1999].

THE STRENGTHENING OF TRAI

In January 2000, the Government of India amended the TRAI Act, reconstituting this body to correct some of the shortcomings experienced since 1997 [Ministry of Law and Justice, 2000]. TRAI's initial years were marred by questions about the limits of its legal power. In particular, it was not clear whether TRAI had the power to settle disputes between the licensor and the licensees, or whether it could specify licensing conditions that would supercede those in the license [Verma, 2000]. In an effort to resolve such issues, TRAI was split, giving adjudicatory and dispute settling powers to the newly created Telecommunications Disputes Settlement and Appellate Tribunal. The decision of this tribunal could be overturned only by the Supreme Court, not by any civil court. In addition, the term of TRAI members was shortened to three years, ending the terms of the first members, none of whom were re-appointed.

INFORMATION TECHNOLOGY ACT 2000

A robust information economy must support the ability to carry out business transactions electronically. While the NTP 1999 and associated policies established a more liberal regime for providing telecommunications services, they did not address issues of electronic documents, electronic signatures, encryption, electronic payments, or other features that are an integral part of an electronic commerce economy. Established as law on June 9, 2000, the Information Technology Act, 2000 (IT Act 2000) was designed to provide a regulatory structure for electronic commerce activities [Ministry of Law Justice and Company Affairs, 2000]. The principal components of the Act are shown in Table 10.

Table 10. Principal Features of the IT Act, 2000

Digital signatures	Digital signatures may be used to authenticate electronic records. Digital signatures are created through a private key/public key encryption algorithm.
Electronic records	Electronic records and digital signatures will be equally valid as printed ones. This measure includes documents used in transactions with the government.
Certifying Authorities	The Central Government may appoint a Controller of Certifying Authorities who may: (a) exercise supervision over Certifying Authorities (CAs), (b) certify public keys of CAs, (c) establish standards for CAs, etc. The Controller will also maintain a database of public keys available to the public.
Digital signature certificates	Certifying Authorities may issue digital signature certificates
Penalties and Adjudication	It is illegal to access computer systems without permission, download or use data from such computers, or damage or disrupt such computers. Tampering with computer source documents, hacking, or publishing obscene material in electronic form is also illegal. The Central government may establish Cyber Appellate Tribunals.
When in the national interest…	The Controller may require that the person in charge of a computer resource assist in decrypting information, if in the interest of the sovereignty or integrity of India, the security of the state, public order, preventing a crime, or when ordered by any agency of the government. If he suspects a violation of the Act, the Controller has the right to access any computer system, apparatus, or data to search for any information. In addition, a police officer of rank Deputy Superintendent or above may enter any public place and arrest without warrant anyone suspected of committing or of being about to commit a violation of the Act.
Limits to network service providers' liability	The network service providers will not be liable for violations of the Act if they can demonstrate that the violation occurred without their knowledge and that they exercised due diligence.
Cyber Regulations Advisory Committee	The Central Government shall constitute a Cyber Regulations Advisory Committee to advise on any rules or regulations connected with this Act.

The IT Act 2000 established a number of important elements regarding the legitimacy, authenticity, and integrity of electronic documents and associated electronic transactions. Not surprisingly, the controversial points of the Act were those that touched on security and privacy issues. While one of the purposes of the Act was to clearly establish cyber crimes as such, punishable in a suitable manner, many within the Indian Internet community were concerned that the Act grants too much authority to the government to inquire or intrude into the affairs of the community. In addition, while the Act discussed the prohibitions against and penalties for illegal access and tampering of systems, it said nothing about if or how the privacy of citizens' data might be ensured. Even so, the Act in its final form was somewhat tamer than it might have been if certain members of the Parliamentary committee had their wishes. For example, one early recommendation that did not make it into the final bill was a requirement that visitors to Cybercafes leave their name, address, telephone number, and web sites visited with the café.

The first case of hacking brought before the court under the IT Act 2000 involved two individuals running a web hosting business who had been accused of hacking by a disgruntled company whose web site had been shut down because of non-payment. The two were granted bail, but their case was not resolved by Fall 2001 ["Court Grants Bail in," 2001].

THE COMMUNICATION CONVERGENCE BILL

With The Communication Convergence Bill 2000 ["Communication Convergence Bill 2000," 2000], the legal environment surrounding communications technologies and services continues to change significantly. A Group of Ministers on Convergence approved the bill in January 2001. In August 2001, the Union Cabinet approved the Convergence Bill for introduction to the Parliament where, at the time of this writing in early 2003 it remains under debate [Rattanani, 2001; "Cabinet Approves Enactment of," 2001; "Convergence Bill Introduced in," 2001; "Cabinet Okays Convergence Bill," 2001; "Mahajan For Fresh Look," 2002].

The principal thrust of the bill is the consolidation of the regulatory mechanisms governing the three principal communications areas – broadcast, telecommunications, and the Internet – to facilitate the convergence of these technologies and the services they provide. In the bill, "convergence" is given two meanings:

- “convergence of mediums or technologies facilitating the provision of all services by using a given facility or network and vice versa.”
- “convergence of services at the provider's end as well as at the consumer's end, meaning, thereby, a service provider should be able to provide a whole range of technologically feasible services and a consumer should be able to receive all services through a given terminal at any time and place of his or her choice.”

The bill recognizes that developments in technology blur the traditional boundaries between telecommunications, computing, and media and that future developments are difficult to predict. Rather than leave a regulatory regime in place that awkwardly distinguishes between the types of communication services, the bill proposes a centralized regulatory regime that stratifies communications vertically, rather than horizontally. That is, the licensing structure would break the provision of services into four different layers:

- Network infrastructure facility provider;
- Network service provider;
- Application service provider (ASP); and
- Content ASP

In this system the providers of network infrastructure would fall under one licensing structure. This arrangement would be true whether the networks were designed for broadcast, voice, data traffic, or all three; or whether they were based on fixed line or wireless technologies. Such an arrangement would significantly decrease the regulatory hurdles involved in providing services that cut across traditional communications boundaries.

If passed, the Convergence Bill would repeal the Indian Telegraph Act of 1885, The Indian Wireless Telegraphy Act 1933, The Cable Television Networks (Regulation) Act 1995, and The Telecom Regulatory Authority of India Act 1997, which governs the TRAI. In place of the multiple regulatory bodies currently governing these areas, a single Communications Commission of India (CCI) would be established. The Communications Commission would have the power to

- carry out spectrum management
- grant licenses and enforce license conditions
- determine appropriate tariffs and rates for licensed services
- ensure that granting licenses does not eliminate competition
- promote competition and the efficient operation of communications services
- formulate and determine conditions for fair and equitable access to network infrastructure
- protect consumer interests and enforce universal service obligations
- formulate program and advertising codes
- formulate commercial codes in respect of communication services and network infrastructure facilities
- take steps to regulate or curtail the harmful and illegal content on the Internet and other communications services
- formulate codes to establish the interoperability of services and infrastructures

The Bill grants the CCI rather broad powers to control the content and operation of communications facilities if it or the Central Government deems it in the national interests. Specifically, the following rights are among those granted:

- ensure that no programming is prejudicial to the interests, sovereignty and integrity of India, the security of the State, friendly relations with foreign countries, or public order
- ensure the promotion of Indian culture, values of national integration, religious and communal harmony, and a scientific temper
- ensure decency in the portrayal of women and restraint in the portrayal of violence and sexual conduct
- enhance general standards of good taste, decency, and morality
- direct any agency of the central or state governments to intercept any communication on any network facility or service
- direct any service provider to intercept, detain, disclose to the government, or refrain from transmitting any content brought to them for communication
- take control, for a limited period, of the control and management of any communication service or any network infrastructure facility in the event of war or any calamity of national magnitude.

The bill proved controversial. In particular, the concept of a super regulator troubled many, prompting the Minister for Information Technology, Communications and Parliamentary Affairs, Mr. Pramod Mahajan, to state that the concept needs "a fresh look" ["Mahajan For Fresh Look," 2002]. In early 2003, the bill was still languishing.

The policy and legislative measures outlined in this Section created an environment within which the Internet, for the most part, flourished. The new measures led to a major expansion of the number of organizations contributing to the Internet's growth, an increased rate of change, growth

in the amount of resources applied to Internet-related development, and a broadening impact on at least some of India's citizens and organizations.

In Section IV we examine in detail the manner in which the Internet evolved since the introduction of the New Internet Policy in 1998 and the factors that shaped its development.

IV. THE INTERNET IN INDIA: APPLYING THE GDI ANALYTIC FRAMEWORK

The passage of the New Internet Policy marked the beginning of a period of rapid expansion of the Internet and Internet services in India. During the two weeks following the DoT's announcement that applications for private ISP licenses were available, approximately 160 application forms were sold ["Norms for PVT Internet," 1998],[5] nearly half of which were from applicants seeking to offer services in New Delhi ["Internet Service Providers' Response," 1998]. The total number sold was not announced, but 47 companies completed the formalities, including establishing the required bank guarantee, by the end of October 1998 ["We Have Run Out," 1998]. The larger companies seeking to become ISPs joined together to form an E-mail and Internet Service Providers Association (EISPA) (Table 11). These companies include Global Telecom Services Ltd., which operated a 27-node nationwide private network; Satyam Infoway (P) Ltd., a division of Satyam Computers; and Sprint RPG.

Table 11. EISPA Membership, September 1998

CG Fax Services	HCL Comnet ISP Divison
Comsat Max ISP Division	Satyam Infoway
Datapro	Sprint RPG
GE Communications	Wipro Communications Division
Global Telesystems	

On November 4, 1998, the DoT invited the first ten of the 47 qualified ISP applicants to sign license agreements; three complied. Two of the three companies, however, were relatively unknown: Ortel Communications and Surevin Consultants, serving Bhubaneshwar and Ghaziabad, respectively. The third company, MTNL, received licenses to provide Internet service in Mumbai and New Delhi [Anand, 1998].

PURPOSE AND ORGANIZATION OF THIS SECTION

The purpose of this Section is to analyze the Internet's growth in India by using the analytic framework developed as part of the Global Diffusion of the Internet (GDI) Project, discussed briefly in the Preface. Here we present, in quantitative terms, the evolution of the Internet in India, captured in six dimensions of the analytic framework:

- Organizational infrastructure
- Geographic dispersion
- Connectivity infrastructure

[5] An application form cost Rs 1,000 (US$25). A non-refundable deposit of Rs 5,000 (US$125) against the application processing fee was also required.

- Pervasiveness
- Sectoral absorption
- Sophistication of use

In each dimension, the state of the Internet may be captured by assigning it one of five possible levels (0-4). The details of these levels and the numeric values assigned are given in the discussion that follows.

ORGANIZATIONAL INFRASTRUCTURE

Organizational Infrastructure, derived from the number of ISPs and the competitive environment, assesses the robustness of the market for Internet services. It is a function of the three principal elements:

- the structure of the Internet service market,
- the structure of the market for basic domestic and international communications services, and
- the nature of the collaborative organizations and inter-organizational arrangements that work to promote the health of the industry.

Organizational Infrastructure is the dimension most directly influenced by government policy. In many countries, strides along this dimension were quickly followed or accompanied by substantial advances in the other dimensions of Internet diffusion. India is no exception. Table 12 shows the progress India made in recent years. In early 1998, India was classified as a Level 2 (*Controlled*) country. By early 2001, India was a strong Level 3 (*Competitive*), on the verge of becoming a Level 4 (*Robust*). With the de-monopolization of international long distance service in 2002, India reached Level 4.

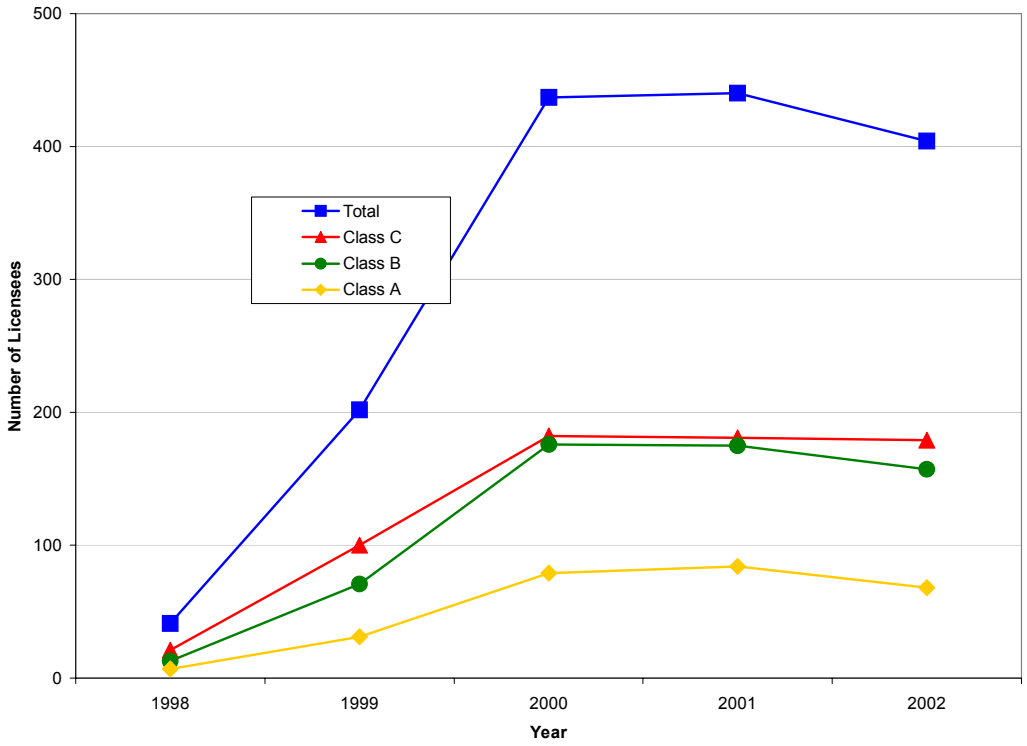
Table 12. Organizational Infrastructure of India

Level 0	None	The Internet is not present in this country.
Level 1	Single	A single ISP has a monopoly in the Internet service provision market. This ISP is generally owned or significantly controlled by the government.
Level 2	Controlled	Only a few ISPs operate because the market is closely controlled through maintenance of high barriers to entry. All ISPs are connected to the international Internet through a monopoly telecommunications service provider. The domestic infrastructure is also a monopoly.
Level 3	Competitive	The Internet market is competitive, with many ISPs and low barriers to market entry. The provision of international links is a monopoly, but the domestic infrastructure is open to competition, or vice versa.
Level 4	Robust	A rich service provision infrastructure exists. There are many ISPs and low barriers to market entry. The provision of international links and domestic infrastructure are open to competition. There are collaborative organizations and inter-organizational arrangements such as public exchanges, industry associations, and emergency response teams.

Internet Services

The provision of Internet services in India experienced dramatic growth through early 2001. By mid 2001, however, intense competition and a tapering off of venture capital led to slowing growth rates and in some areas an ISP shake-out. This dynamic is reflected in the number of Internet service licenses issued, the growth of ISP points of presence, and the degree of competition within individual cities, as shown below.

When the New Internet Policy went into effect on November 6, 1998, companies rushed to acquire licenses to provide Internet services. As shown in Figure 5, the growth in the number of licenses issued remained linear through the end of 2000, when the total exceeded 400. New license issuance came to a standstill in 2001, however, as India felt the effects of the global bursting of the dot-com bubble, and the incentives and support for new entrants into the Internet services market cooled considerably. The decline in 2002 reflects the issuance of an exit policy for license holders that would enable them to surrender their licenses by paying a surrender change of 5% of the Performance Bank Guarantee (PBG) [Department of Telecommunications, 2002a].



Source: ["Internet in India: A," 1999; "ISP Licence Holders as," 1999; "116 Internet Licences Issued," 1999; "DoT Issues 132 ISP," 1999; "ISP Licences Issued," 1999; "List of ISP Licences," 2001; Antonelli, 1986]

Figure 4. Number of ISP Licenses Issued.

While the number of companies with ISP licenses increased rapidly, the number of companies actually offering Internet service grew more slowly, reaching only 100-120 in early 2001, and holding steady or dropping later in the year [Goswami, 2001]. As shown below, in most cities with Internet service, competition remains minimal.

The gap between the number of companies licensed to provide Internet services and the number that are operational can be explained in a number of ways. One explanation is simply that it is relatively easy to acquire an ISP license, but considerably more difficult to offer Internet services [Mehta, 1999d].

One contributing factor appears to be the role played by VSNL. As the only commercial ISP from 1995 to 1998, VSNL was able to accumulate a great deal of experience, establish a rather extensive infrastructure for ISP services, and gain early and elite users as customers. In addition,

since VSNL was the monopoly provider of international Internet leased lines, it was able to hinder the growth of ISPs by delaying their applications for leased lines, and by offering them connectivity at rates that squeeze their profit margins [Mehta, 1999c]. VSNL's internal costs for connectivity are lower than what it charges ISPs. Consequently, if VSNL and the ISPs charged comparable rates to the end user, VSNL would have a wider profit margin and could thus tolerate lower prices than could the ISPs [Ganapati, 1999]. For example, in August 1999, VSNL received permission to reduce the rate it charged corporate customers for international Internet connections by 15 %, while leaving the rates for private ISPs unchanged [Mohan, 1999; Mani, 1999]. These lower rates would be made available to recognized educational institutions, government organizations, newspapers and news agencies, and corporations located in a business cluster, such as a software technology park.

A similar situation existed in Delhi and Mumbai, where MTNL was a monopoly provider of phone service. In July 1999, MTNL reduced its prices for certain institutional end users by 15% ["MTNL Cuts Net Tariffs," 1999], while the profit margins of competing ISPs in these cities were less than this amount. Consequently, MTNL was either subsidizing a service it was offering below cost, or its costs were lower than the ISPs. Either answer could be viewed as anti-competitive practice. In response to this imbalance, the Internet Service Providers Association of India filed a complaint with the TRAI [Ganapati, 1999].

On January 3, 2001, VSNL introduced a popular pricing package called "Monsoon" which reduced dial-up costs by 50% [Sengupta, 2001]. Subscribers could gain unlimited access for Rs. 2,400 per year, or purchase 100 hours of daytime access and unlimited nighttime usage for Rs. 750. This reduction came at a time when many ISPs were considering *increas*ing access rates to improve their financial footing. This price reduction and the resulting price-war among ISPs forced many to curtail their plans for expansion, or cease service altogether in certain cities [Goswami, 2001; "VSNL Pricing Puts ISPs," 2001]. In contrast, VSNL experienced steady increases in its subscriber base and acquired a reputation for high quality connections ["VSNL Revises Net Tariffs," 2001]. On August 31, 2001, VSNL ended the Monsoon package and increased access costs to Rs. 999 per 100 hours, only to drop them again a month later [Karkanis, 2001].

At a more basic level, many license holders found it difficult to obtain the leased, ISDN, or E1/R2 lines necessary to establish service, particularly in smaller cities where such services may not exist. In addition, according to some reports, the telecommunications officials in many cities are reluctant to permit the entrance of providers threatening the traditional monopoly status [Pai, 1999b].

While these factors may slow the growth of the Internet services market in India, they did not prove to be a show-stopper. One of the features of this market is the rapid rate at which private ISPs and VSNL/DoT rolled out new points of presence in the country's major cities.

One of the most striking features of the Internet in India is the growth of ISP points of presence and the resulting level of competition for Internet customers in many cities. As shown in Figure 5, by the end of 2002, nearly 1100 ISP points of presence were operational. In fact, this figure understates the total numbers of POPs, because if an ISP (e.g. Satyam Infoway) has multiple POPs within the same city (e.g. Mumbai), they are counted here only once.

The growth in POPs shows the very aggressive expansion of ISP activities since their licensing began in 1998 (Figure 5). What Figure 5 does not show, however, is that most of the growth of ISPs since 2001 came about as a result of BSNL efforts rather than that of private ISPs. The rapid expansion of private ISPs between 1998 and 2000 explain a substantial portion of the growth. The tapering off of growth during 2001 reflects the effects of the bursting of the global dot-com bubble. During this year, a number of Indian ISPs folded and most others curtailed expansion plans. During 2001 and 2002, however, multi-year efforts by BSNL to implement a national Internet backbone to provide Internet services in all districts finally began to bear fruit. Most of the expansion in POPs exhibited in Figure 5 is due to the rollout of Sanchar Net in districts nationwide [BSNL, 2003a].

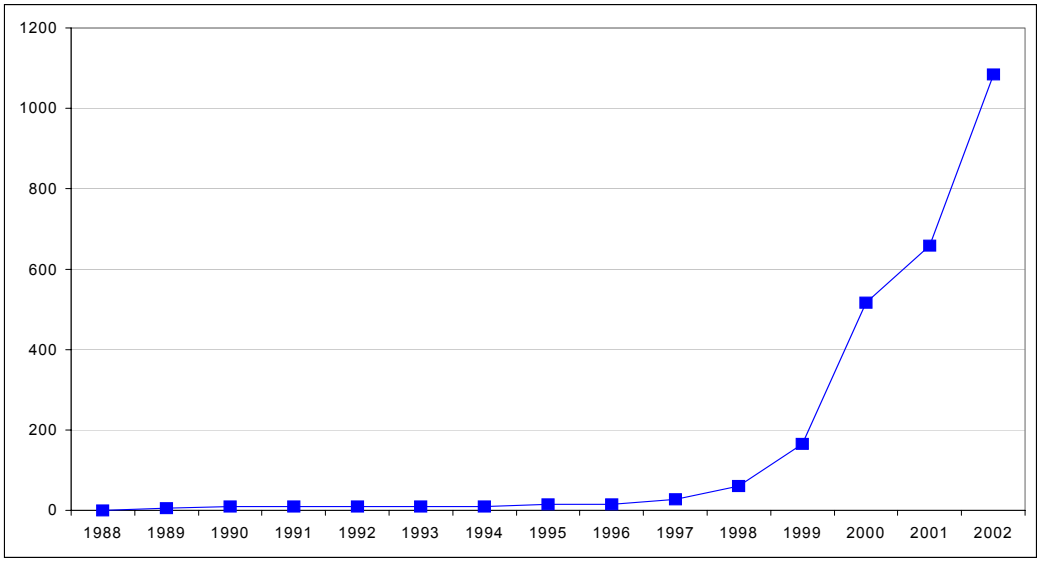


Figure 5 Number of ISP Points of Presence. Source: India ISPs.

The growth in city-POPs by ISPs resulted not only in an expansion of the numbers of cities with at least one POP, but also in the level of competition within cities with more than one POP. Figure 6 shows the grow in both these aspects. Markets with more than 10 competing ISPs emerged for the first time in 1999 (Hyderabad). By 2002, six cities were serviced by 25 or more ISPs: Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, and Mumbai, with the greatest concentration in Delhi (38).

At the same time, Figure 6 illustrates another interesting point about internet expansion in 2001-2002. While 2001 was a year in which private ISPs did little to expand service into previously un-served areas, nearly all of the growth in 2002 occurred through efforts (chiefly BSNL's) to expand the number of cities served.

The licensing of private ISPs was the first break in VSNL's extensive monopoly over Internet-related services. It is but one example of a broader effort to strip away VSNL's monopoly powers throughout the telecommunications industry. Since 1998, the government steadily, though not necessarily quickly or entirely willingly, chipped away at VSNL's remaining monopolies.

Regulatory Regime for Providing Basic Telecommunications Services

Until 2000, basic domestic long distance and international telecommunications services were provided by the monopoly providers Department of Telecommunications and VSNL, respectively. The Software Technology Parks of India (STPI) also provided international gateway services, but to a rather circumscribed set of user organizations and consequently did not offer true competition to VSNL. Meanwhile, local telecommunications service was only offered by the DoT, except in Mumbai and Delhi where MTNL was the monopoly provider.

Beginning in 1996, the Government of India began introducing a number of measures, which have slowly opened up India's market for ISP services, domestic long-distance, international satellite-based data communications, mobile service, and international terrestrial communications. In April 2002, VSNL lost its last monopoly, in international voice telephony.

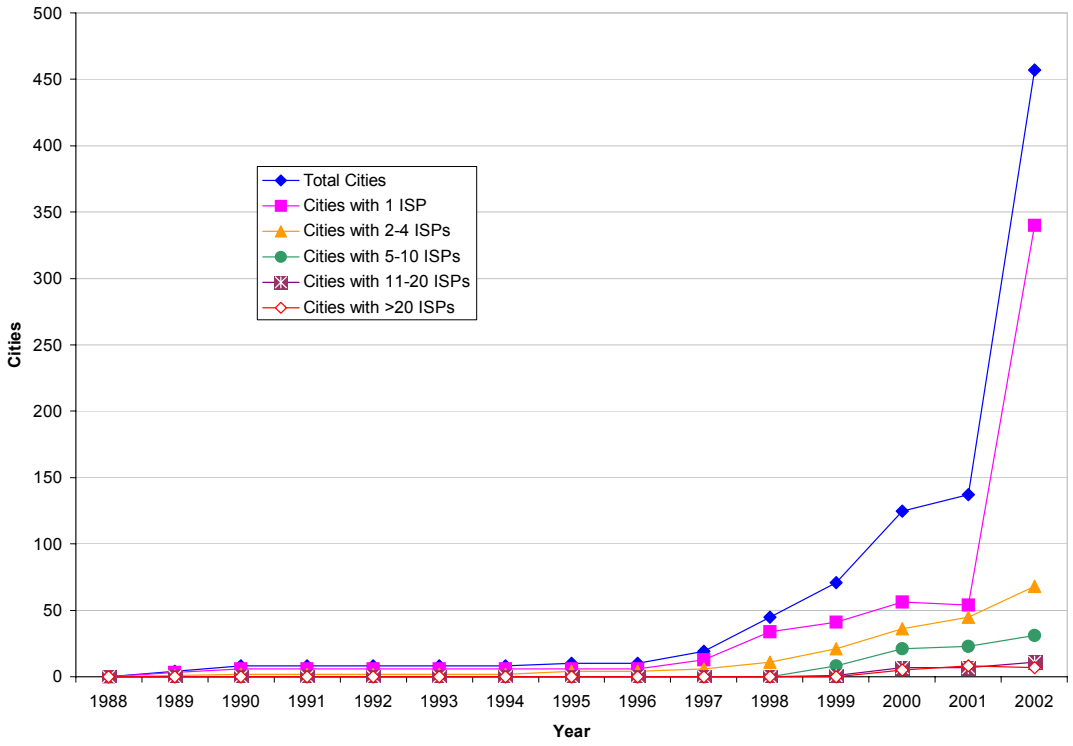


Figure 6. Level of ISP Competition within Indian Cities

Private International Gateways. The licensing of private ISPs, discussed in Section III, began in November 1998. Since then, government efforts to place ISPs on an equal footing with government-owned entities continued. In August 1999, the DoT formally invited ISPs to establish their own international Internet gateways, subject to a number of security and monitoring conditions. One of the main constraints, however, was that ISPs must agree to establish, at their expense, a monitoring facility that would be used by the government to make random inspections of the international traffic. The stated objective was to ensure that ISPs were not carrying Internet telephony traffic[6], in violation of explicit regulations preserving VSNL monopoly for this kind of traffic ["Independent Gateways for Internet," 1999]. By 2002, however, numerous ISPs including well known Sify, Tata, STPI, Bharti, and lesser-known Gujarat Narmada Valley Fertilisers Company Limited (GNFC) provided one or more international gateways. All in all, the Department of Telecommunications granted permission to 24 companies to establish gateways in 18 cities, as shown in Table 13.

Domestic Long-Distance Service. The New Telecom Policy 1999, approved in March of that year, permitted long distance domestic telecommunications services by private operators, as of January 1, 2000. The final decision to open up long-distance telephony to private carriers was finally announced in July 2000, with licensing to commence on August 15, 2000 [Pai, 2000n; "India To Open Up," 2000]. Actual competition began slowly but shows signs of becoming increasingly competitive over time. License restrictions and high capital requirements create rather high barriers to entry, but the major communications companies are lining up to provide service. Bharti Telesonic, ltd (BTL) and Reliance Infocom Ltd were the first private companies to

[6] Internet telephony involves using the Internet to carry telephone conversations via one's personal computer. The sound is digitized and transmitted via Internet packets to its destination, where it is regenerated. While Internet telephony does not always provide the same quality of sound as a conventional telephone connection, it can be a great deal cheaper, particularly for international long-distance conversations.

offer domestic long distance server. As part of the condition of privatization, VSNL also acquired a domestic long distance license. These three new entrants already put pressure on the cost of long distance services provided by BSNL ["Stiff Competition, Tariff Declines," 2002].

Table 13. Number of Licenses for International Gateways.

City	Licenses	City	Licenses	City	Licenses
Delhi	11	Pune	2	Channai	1
Chennai	7	Noida	2	Gurgaon	1
Bangalore	6	Kolkata	2	Secunderabad	1
Hyderabad	6	Bhopal	2	Kharagpur	1
Mumbai	4	Chandigarh	2	Lucknow	1
Ahmedabad	4	Bharauch	1	Cochin	1

Source: [Department of Telecommunications, 2002b]

International Long-Distance Service. On April 1, 2002, VSNL's monopoly on international long distance service ended. Under terms of the World Trade Organization, India was required to liberalize this sector by 2004, but the Indian government unilaterally pushed this date back to 2002 ["TRAI Seeks Comments on," 2001; "Govt. Accepts TRAI Recommendations," 2001]. From the perspective of the Internet, one of the most significant aspects of this decision was its coupling with a ruling permitting Internet telephony, which went into effect the same day [Raman, K., 2002].

Internet Telephony. Also on April 1, 2002, VSNL lost its monopoly in international telephony. The political battle over whether or not it should be permitted was intense. In favor of Internet telephony were the ISPs eager for the additional business this application would generate and citizens who paid high prices for telephone calls abroad. A government task force created to examine the issue made recommendations in favor of Internet telephony, with the restriction that it remain illegal until VSNL lost its monopoly in 2002 [Rambabu, 2001].

VSNL prohibited the use of the Internet for voice communications (Internet telephony or voice-over-IP) or facsimile transmission ["India's Phone Monopoly," 1998] for economic and legal reasons. Economically, VSNL's profits derived principally from international voice traffic. Any diminution of this toll traffic due to the use of flat-rate Internet communications would not only adversely affect VSNL's profits, but would reduce the amount of foreign exchange that VSNL earned for the Union treasury. VSNL was designed as the *Navratna* ("Jewel in the Crown") Public Service Enterprise because of its high profitability and its consequent value to the national treasury. Thus, on purely economic terms VSNL's ban on Internet voice and facsimile traffic was supported by the National government. VSNL officials estimated that if all international phone calls were placed over the Internet then even if VSNL provided the international connectivity for this traffic, revenues from this source would drop to one-eighth their then-current levels ["Net telephony robs VSNL," 2000]. These figures, however, assumed that the number of calls and average number of minutes would remain constant, a highly questionable assumption.

Under NTP 1999, VSNL was granted the license to be the exclusive provider of international telecommunications through 2004, a monopoly that was approved by the World Trade Organization (WTO). Given this monopoly, Internet voice or facsimile traffic, which bypasses VSNL's international toll network, was in violation of licensing terms and was thus illegal under Indian law.

Though VSNL realized that it could not prevent people from using Internet telephony if they really want to do so, it did block sites offering the required software and Internet telephony servers when it found them, under the assumption that these actions would deter the majority of would-be users. VSNL was not, however, concerned about the "hard core" Internet users who would most likely figure a way around the firewalls, assuming that their numbers would be too small to impact profits.

Although the principal reason for VSNL's tenacious grip on its monopoly was economic, security concerns were also cited [Ramani, 1998]. One of the functions attributed to VSNL is monitoring data networks for the use of encryption. It was suggested that without centralized control, separatist movements in India might make use of the Internet for propaganda to garner international support for their causes [Associated Press, 1995]. While the use of the Internet by such groups internally was dismissed by the government, concern was expressed about allowing them unrestricted access to international communications. Removing VSNL's monopoly would make monitoring of international communications more difficult.

In August 2000, the Minister of Communications, Ram Vilas Paswan, acknowledged that the monopoly on international telephony would have to be removed by 2002 rather than 2004, as originally planned [Pai, 2000b]. By early September, the Union Council formally made the decision to end VSNL's international telephony monopoly by April 1, 2002. In exchange, VSNL would receive a compensation package that would include waiving of the fee to become a national long-distance carrier, a five year waiver of the requirement that VSNL share revenue with the government, and held [Pai, 2000p]. The Department of Telecommunications issued guidelines limiting Internet telephony to IP-addressable devices, which specifically does not include public telephones and the public switched telephone network within India ["Guidelines Issued on Net," 2002; Kumar, A., 2002]

Following the opening up of competition in international telephony and the legalization of Internet telephony, nearly every ISP sought a license to offer some sort of Internet-based telephony service ["Net Telephony Players Figure," 2002]. In addition, numerous gray-market sites sprang up overnight to offer deeply discounted rates for international calls ["Net Telephony Thrives in," 2002]. Calls to the United States that previously cost Rs 48 per minute during peak hours could be made for Rs. 3-10 per hour ["Caltiger Enters Internet Telephony," 2002; "Just a Talking Point," 2002].

Access to and Construction of Terrestrial Cable. During the summer 2000, in response to a serious bandwidth shortage, the Indian government ended VSNL's monopoly on international cable capacity. In July of that year, Prime Minister Vajpayee stated that the monopoly on undersea fiber cable capacity had "hurt the growth of Internet services" in India, and announced that Indian ISPs were now permitted to set up their own landing stations anywhere within the country [Pai, 2000n, d]. The exception to this policy is security-sensitive areas, in which Internet nodes must be routed through VSNL. Such areas include: Andaman and Nicobar islands, Jammu and Kashmir, Punjab, north-eastern states, border areas of Rajasthan, and coastal areas of Tamil Nadu (excluding Chennai) ["Submarine Cable Landing Station," 2000]. At the same time, the government began deliberations on whether or not to permit private operators to construct terrestrial cables.

Resale of Private Gateway Capacity. In January 2001, following a recommendation by the group on Telecom and Information Technology Convergence, the DoT announced that ISPs with private international gateways could cede excess capacity to other ISPs [Pai, 2001d]. This decision enabled ISPs that are unable to afford their own gateways to acquire international bandwidth from someone other than VSNL.

Collaborative Organizations

With the growth of the Internet in India, a number of collaborative organizations were established, promoting the collective health of the industry.

The Internet Service Providers Association of India (ISPAI) seeks to provide a level playing field for the private ISPs, and to insure access to infrastructure and quality service for Internet users across the country. In this regard it is very active in lobbying policy-makers for measures that would benefit the country's ISPs. ISPAI is outspoken on reducing connectivity tariffs, and lowering customs duties for ISPs. On occasion, it launched formal protests against VSNL on behalf of ISPs for unfair business practices ["VSNL Rate Cut Ignites," 2001]. In addition, it played a role in promoting the creation of an Internet Exchange between its members [Pai, 2001c]. The ISPAI President is also a member of the bandwidth advisory committee set up by the Indian Telecom Commission [Pai, 2000g]. More recently, the ISPAI was instrumental in brokering a revenue-sharing deal between Internet telephony service provides who themselves own no infrastructure and the ISPs that carry telephony traffic [Saxena, 2002b].

In July 2000, seven Applications Service Providers (ASP) created the Forum of ASP of India (FASPIN). The objective of the organization, whose founding members included Intelligroup, Citrix India, Ideas2dotCom, Compaq India, Ariba, Hughes Escorts Communications Ltd, and Microsoft India, was to be ["Forum of ASPs Launched," 2000]:

> *"an advocacy group for customers, partners and solution providers whose mission is to articulate the ASP message, disseminate information and provide a central forum for the discussion of ASP issues, including the establishments of guidelines, standards and best practices for the industry in India*."

In light of the preceding discussion of the state of Internet services, telecommunications regulatory regime, and collaborative organizations, we rate India at a strong Level 4 (*competitive)* in the Organizational Infrastructure dimension of the analytic framework (Table 12). India took enormous steps since 1998 to create a market environment for Internet- and Internet-based services that is dynamic and vibrant.

GEOGRAPHIC DISPERSION

Geographic Dispersion (Table 14) describes the physical dispersion of the Internet within a country, there being benefits to multiple points-of-presence, redundant transmission paths, and multiple international access points. High geographic dispersion is a requirement for the Internet to transform the country as a whole and not just a few isolated cities. It often implies less of a "digital divide" between the rich and poor, and between urban and rural citizens.

Table 14 The Geographic Dispersion of the Internet in India

Level 0	Non-existent	The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country.
Level 1	Single location	Internet points-of-presence are confined to one major population center.
Level 2	Moderately dispersed	Internet points-of-presence are located in multiple first-tier political subdivisions of the country.
Level 3	Highly dispersed	Internet points-of-presence are located in at least 50% of the first-tier political subdivisions of the country.
Level 4	Nationwide	Internet points-of-presence are located in essentially all first-tier political sub-divisions of the country. Rural access is publicly and commonly available.

India is divided into 28 states and seven union territories, listed in Table 15. The states and union territories with at least one ISP point of presence in 2002 are shaded in gray.

Table 15 First-Tier Political Subdivisions of India

States			Union Territories
Andhra Pradesh	Arunachal Pradesh	Assam	Andaman and Nicobar Islands
Bihar	Chhatisgarh	Goa	Chandigarh
Gujarat	Haryana	Himachal Pradesh	Dadra and Nagar Haveli
Jammu and Kashmir	Jharkhand	Karnataka	Daman and Diu
Kerala	Madhya Pradesh	Maharashtra	Delhi
Manipur	Meghalaya	Mizoram	Lakshadweep
Nagaland	Orissa	Punjab	Pondicherry
Rajasthan	Sikkim	Tamil Nadu	
Tripura	Uttaranchal	Uttar Pradesh	
West Bengal			

With Internet point-of-presence in 27 out of 35 states and union territories, India falls well within Level 3 (*Highly Dispersed*) of the Geographic Dispersion dimension (Table 14). Examination of the growth of the number of states and union territories with POPs (Figure 7) shows five main phases of growth along the Geographic Dispersion dimension. During the first phase, from 1989 to 1990, India established points of presence in nine (25%) of its states and union territories.

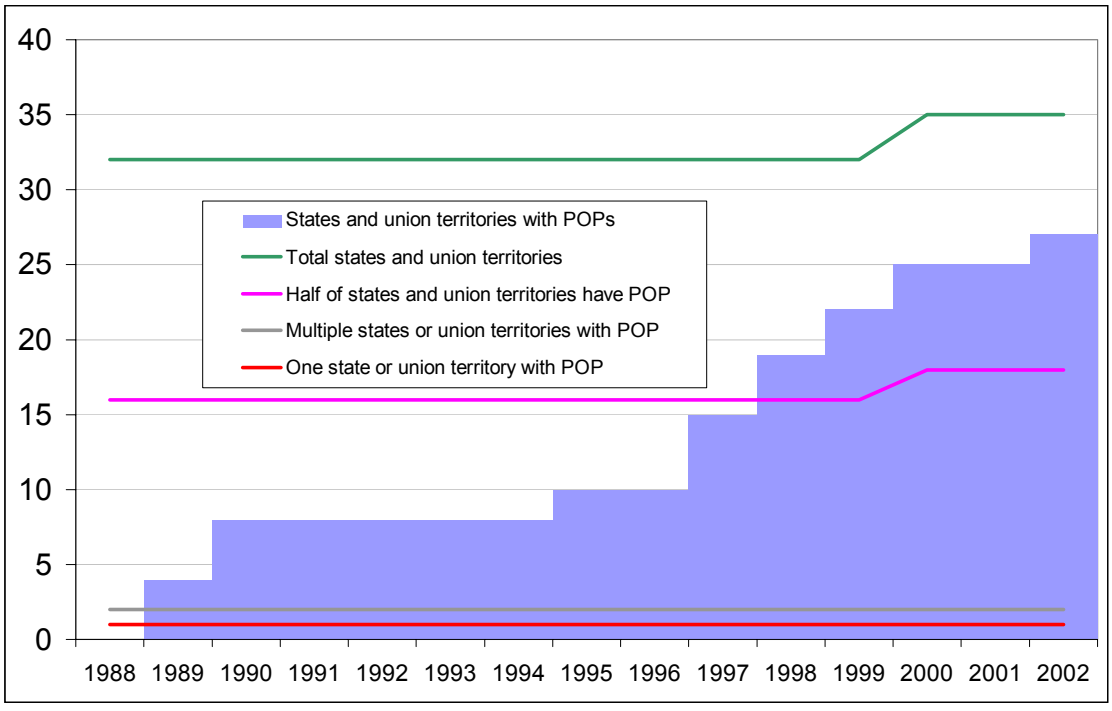


Figure 7. Growth in Number of States and Union Territories with POPs

Unlike many countries in which the Internet takes hold first within a single metropolitan area, India established points of presence in multiple states from the outset. This initial rapid expansion was driven in part by the desire to establish the Software Technology Parks of India and the associated infrastructure to enable Indian software companies to interact with foreign companies.

During the second phase, between 1991 and 1995, the Internet remained contained within these states and union territories. While additional cities were connected, they were all within the same states and union territories as the original points-of-presence. Having connected the software technology parks and other governmental institutions, there was no perceived need to expand beyond these first areas. The third phase began after VSNL began offering Internet service on a commercial basis. VSNL nearly doubled the number of states and union territories connected. Only in the fourth phase, which began in 1998 with the licensing of private commercial ISPs, did the number of states and union territories with points of presence rise above 50% of the total. During the fifth phase, 2000 to the present, growth slowed, with no new states or union territories added in 2001.

In some respects, however, Figure 7 understates the impact of the opening up of the ISP market. While new ISPs left nearly a quarter of India's states and union territories unconnected, the number of cities with an Internet POP increased significantly (Figure 8). In particular, BSNL's Sanchar Net added a large number of new cities in 2002, more than doubling the pre-2002 number.

India is likely to remain a Level 3 (*highly dispersed*) in the Geographic Dispersion dimension for some time. It is unclear how long it will take ISPs to establish points of presence in the remaining states and union territories. To date, the ISPs with nation-wide licenses focused their efforts on the largest population centers. The remaining states do not offer attractive markets. In principle, given legislation mandating that Internet access be available at local call rates from "anywhere" in India, the Internet should be accessible to anyone with a phone line and a modem. Because of the low quality of telephone lines, however, even access to a phone and modem does not guarantee access to the Internet.

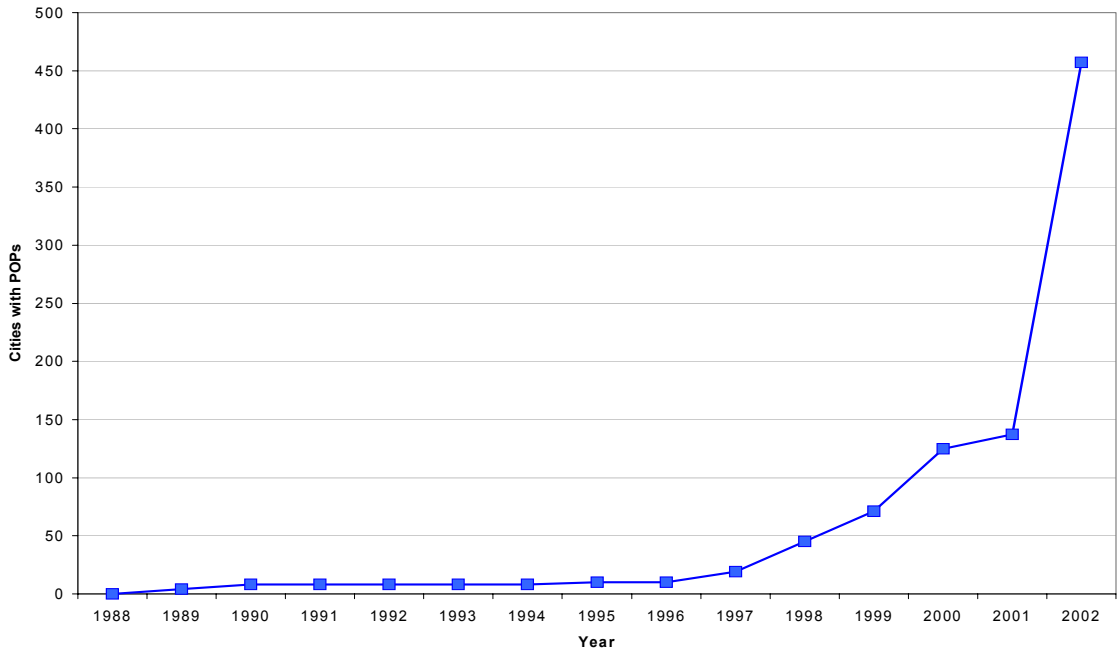


Figure 8. Number of Indian Cities with Internet

The state of the national telecommunications system remains a key barrier to India's achieving Level 4 geographic dispersion. A requirement for the latter is that "Rural access is commonly and publicly available." Such is not the case in India. First, not all villages have telephone connections. Tapan Sidkar, Minister of State for Communications, in November 2000 reported only 380,000 of India's 607,000 villages (63%) provided telephone connectivity ["USO Funds for Rural," 2000]. Second, India's teledensity in April 2001 was approximately 3.5 per hundred individuals, a significant improvement in recent years, but still a low number relative to developed countries. US$69 billion will be needed to raise teledensity to 15% by 2010 [Pai, 2001b]. Although the national telecommunications system is improving, the magnitude of the work yet to be done to provide basic connectivity throughout the nation is such that widespread rural access to the Internet is not likely to be available in the near future.

CONNECTIVITY INFRASTRUCTURE

Connectivity Infrastructure consists of four components:

- the aggregate bandwidth of the domestic backbone(s),
- the aggregate bandwidth of the international Internet Protocol (IP) links,
- the number and type of inter-connection exchanges, and
- the type and sophistication of local access methods employed.

Table 16 lists how these factors are related to the assessment of the infrastructure's level of development. In this table, Level 0 (*non-existent)* is assigned to a country with no Internet presence (and hence, no infrastructure) and Level 4 *(Immense)* is assigned to a country with a robust domestic infrastructure, multiple high-speed international links, and many bilateral ("peering") and open Internet exchanges.

India made rather rapid progress within the last few years in expanding its infrastructure. Government initiatives and efforts by VSNL and private organizations all contributed to building the infrastructure and expanding its capacity. The cumulative effect of these efforts was to bring India to a solid Level 3 *(Broad)* in the Connectivity Infrastructure dimension as of early 2001. As efforts to create new Internet exchange points underway since 2001 come to fruition, India will also move to a Level 3 in the Internet Exchange component.

Table 16. Connectivity Infrastructure of the Internet in India

		Domestic backbone	International Links	Internet Exchanges	Access Methods
Level 0	Non-existent	None	None	None	None
Level 1	Thin	≤ 2 Mbps	≤ 128 Kbps	None	Modem
Level 2	Expanded	>2 -- 200 Mbps	>128 Kbps -- 45 Mbps	1	Modem 64 Kbps leased lines
Level 3	Broad	>200 Mbps -- 100 Gbps	>45 Mbps - 10 Gbps	More than 1; Bilateral or Open	Modem > 64 Kbps leased lines
Level 4	Immense	> 100 Gbps	> 10 Gbps	Many; Both Bilateral and Open	< 90% modem > 64 Kbps leased lines

International Connectivity

Until 2002, the international connectivity available to commercial ISPs was provided through six international gateways, located in Bangalor, Calcutta, Chennai, Delhi, Mumbai, and Pune. All were managed by VSNL [Agarwal, 1999]. Through January 1999, the connections were those outlined in Table 17 ["Mumbai ISP Meet Takes," 1999].

Table 17 VSNL International Connectivity.

	Japan	MCI USA	Telecom Italia	Singa-pore	Tele-globe	Cable & Wireless	Total (Mbps)
Mumbai		2+8	6	2	8		26
Bangalore	8	2	2				12
Chennai		2.5			2+2	8	14.5
Pune		1			6+2		9
Calcutta	2+2	0.5			2		6.5
Delhi		2	2	2	8		14
Total (Mbps)	12	18	10	4	30	8	82

Source: [Mehta, 1999b]

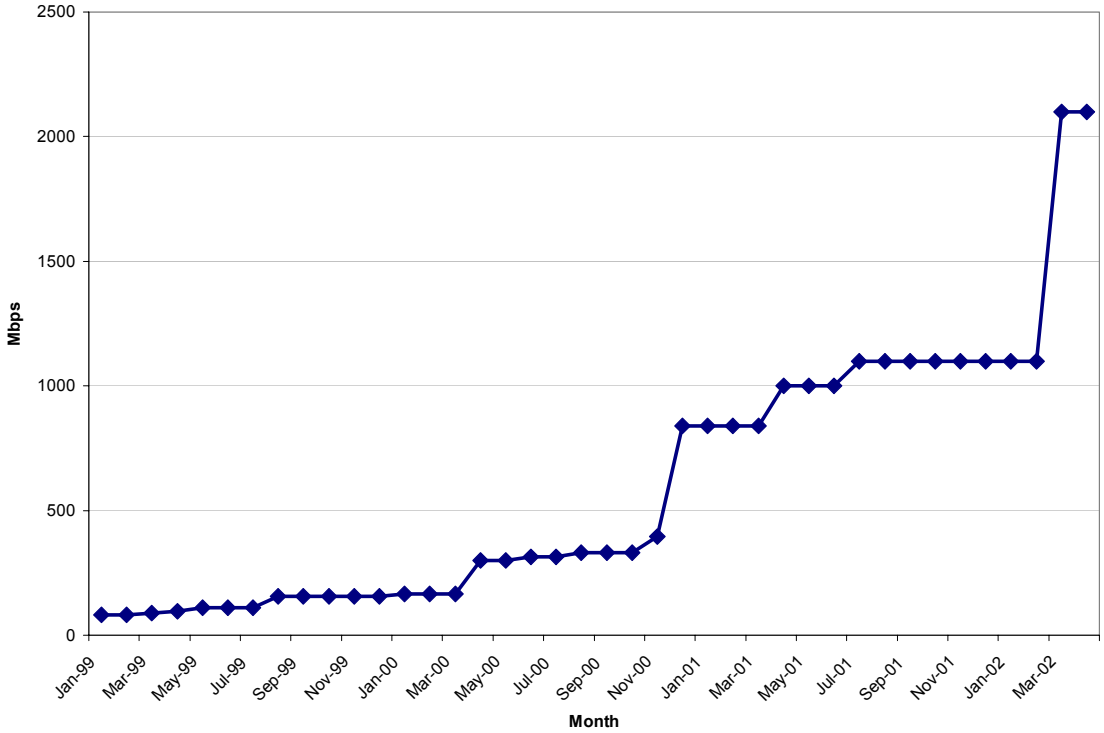
Indian demand for international capacity consistently exceeded supply, occasionally reaching crisis proportions. During the bandwidth crises in the spring and summer 2000 [Kumar, G.K., 2000], discussions of bandwidth were held at the cabinet level. In June 2000, a Bandwidth Advisory Committee consisting of leading individuals within the IT and telecommunications industries was set up to advise the DoT [Pai, 2000g; "Steps Taken to Make," 2000]. Shyamal Ghosh, chairman of the Telecom Commission and secretary of the Department of Telecommunications (DoT) headed the twelve-member Bandwidth Advisory Committee, which also included the Chairmen of the Securities and Exchange Board of India (SEBI) and All India Banking Association, and the Presidents of the Internet Service Provider Association of India (ISPAI) and NASSCOM.

The response to the widespread demand for increased international Internet capacity has taken two tracks: VSNL has embarked on a number of projects to increase its international bandwidth ("Operation Bandwidth"), and at the same time, the government introduced new measures to break VSNL's monopoly on such capacity. These efforts include the licensing of ISPs to establish their own international gateways, and permitting international undersea cable operators to sell capacity directly to ISPs rather than to VSNL alone [Gairola, 2000; Pai, 2000c; Kumar, N., 2000a].

Figure 10 shows the growth of VSNL's international capacity through the first quarter 2002. Until recently, VSNL consistently over-promised capacity. In September 1999, VSNL announced an agenda to increase its Internet bandwidth to 532 Mbps by March 2000, and to 40 Gbps by March 2001 ["India-VSNL to Expand," 1999; "VSNL to Triple Web," 1999]. In July 2000, VSNL projected that bandwidth would increase to 2.18 Gbps by the end of 2000 [Pai, 2000q]. Inspection of Figure 10 shows that these projections were far off target. Part of the explanation undoubtedly were delays in the construction of the undersea cables. Perhaps as a consequence, recent projections appear modest. In March 2001, VSNL signed a memorandum of understanding with the Department of Telecommunications committing itself to increasing international Internet capacity to 1475 Mbps by March 2002 ["India: VSNL to Raise," 2001].

In early 1999, in an attempt to ease the international bandwidth crisis, the government invited private ISPs to set up their own international gateways. As of November 1999, however, none

had been established. A major difficulty was the need for ISPs to gain security clearances from the government before doing so [Mehta, 1999a; "VSNL to Triple Web," 1999]. By April 2000, the DoT approved nine ISPs for the creation of 60 gateways throughout the country [Pai, 2000h]. A month later, 17 more ISPs were given clearance, increasing the total number of possible gateways to 101 [Department of Telecommunications, 2000a]. By the end of the year, the number of ISP with clearance nearly doubled to 50, while the total number of possible gateways increased by more than 100%, to 220 [Department of Telecommunications, 2000b].



Source: ["National Internet Exchange Planned," 1999; Noronha, 1999; "India - Free Upgrade to," 1999; "India Tops Internet Reliability," 1999; "India: VSNL to Raise," 2001; "Massive Bandwidth Procurement by," 2000; Chowdary, 2001; "VSNL Commissions more Bandwidth," 2001; Saxena, 2002a; Prashant, 2002]

Figure 9. International Internet Capacity Managed by VSNL.

The number of gateways grew much more slowly than planned due to the high cost and effort associated with establishing them, and the difficulty in realizing a profit from their operation. By the end of 2000, InTechNet, Dishnet, Mantra Online, Satyam Infoway (Sify), and Wilnetonline added perhaps 100 Mbps to the country's international bandwidth [Pai, 2000h; Seshadri, 2000; "Mantra to be the," 2000; Pai, 2000l, r]. The permitted capacity of the international gateways was limited by the government's ability to monitor traffic effectively. As a result of limited government-owned monitoring techniques, gateway capacity was not allowed to exceed 8 Mbps. Permission to increase gateway capacity beyond 8 Mbps (download) was given to Estel and Mantra Online in February 2001, only after government monitoring equipment was upgraded to the point where it could monitor higher bandwidths [Bhattacharya, 2001].

Two other measures were instituted by the government to increase international bandwidth. In July 2000, Prime Minister Vajpayee announced that private ISPs would be able to set up their own landing stations anywhere in the country in cooperation with submarine cable carriers, thus breaking VSNL's monopoly [Pai, 2000m; Kumar, N., 2000a]. In January 2001, the DoT

announced that ISPs with private international gateways could cede excess capacity to other ISPs [Pai, 2001d]. This decision followed a recommendation by the group on Telecom and Information Technology Convergence to allow such transfers.

At present, the future role of private international gateways is somewhat uncertain. There is no question that some will exist. However, VSNL pursued a strategy to drop costs for leased capacity to the point where establishing a private gateway separate from VSNL becomes more expensive for ISPs than purchasing capacity from VSNL. In 1999, VSNL argued that its capacity would be cheaper than that of private gateways ["India- VSNL Launches Control," 1999; Varadarajan, 2000b], and it appears to have continued this strategy in 2001 [Sengupta and Rajawat, 2001]. In addition, the policy that ISPs can purchase capacity directly from submarine cable operators, instituted in July 2000, enables ISPs to avoid the cost of installing earth stations [Seshadri, 2000]. In its annual report, VSNL reported that 90 Indian ISPs rely on VSNL gateways rather than their own [VSNL, 2002].

The one alternative provider of international connectivity is the Software Technology Parks of India (STPI). STPI operated international gateways from its own earth-to-satellite links via Intelsat since 1993. In 2001, they offered earth stations in 19 cities throughout India. STPI caters mainly to software exporters and a few other corporations but, for the most part, does not compete with VSNL ["STPI-Widening the Reach," 1999]. While a few ISPs use its international bandwidth, most do not have access to it.

In 2002, the international bandwidth landscape changed considerably. New submarine cables went operational, increasing the available bandwidth by an order of magnitude or more. In May, the South Africa Far East (SAFE) network was commissioned. This network's ultimate capacity is 120 Gbps. In July, Network i2i began carrying commercial traffic ["i2i Cable Network Begins," 2002]. The system capacity of this joint venture between Singapore Telecommunications Limited (SingTel) and Bharti Enterprises will be 8.4 Terabits per second (Tbps), and its initial capacity is 160 Gbps. In addition, DishnetDSL embarked on a project to lay an 8.63 Tbps undersea cable between Chennai and Guam ["Country's Intl Bandwidth," 2002]. Such capacity should provide sufficient bandwidth for a number of years and result in dropping prices for ISPs.

The addition of large amounts of international bandwidth, perhaps reaching 100 Gbps available for Internet connectivity, pushed India from a strong Level 3 (*broad)* in the international connectivity component of the Connectivity Infrastructure dimension to Level 4.

Domestic Backbone

In many countries, the national backbone falls into one of two categories:

- a single network to which all ISPs connect, often established or managed by the national telecommunications carrier (e.g. Turkey);
- multiple single-owner networks that may (Israel) or may not (Pakistan) provide Internet exchange points.

India's domestic backbone is a hybrid of these two categories, initially resembling the first and then, with the proliferation of ISPs, resembling the second, and more recently moving towards a combination of the two.

Before the opening of the Internet to private ISPs in November 1998, the entire backbone consisted of a VSNL/DoT network connecting the Internet nodes managed by these two organizations. Most of the Internet nodes connected to one or more of the international gateways via single 2 Mbps digital connections [Agarwal, 1999]. From 1998 through 2002, however, strong demand for domestic bandwidth has led to extensive private and public projects to lay fiber-optic cable across the country.

Private ISP Backbones. As private ISPs established their operations from 1999 on, they networked their points of presence through point-to-point leased line connections. Table 18 shows the backbone arrangements of several leading ISPs in late 1999.

Table 18 Backbones of Leading ISPs (1999)

ISP	Domestic backbone	International connectivity
Bharti BT	POPs in three cities: Dehli, Bangalore, Mumbai. 2 Mbps between each pair of cities	
Wipro Net	2 Mbps links between cities: Delhi – Calcutta Delhi – Bangalore Delhi – Mumbai Delhi – Ahmedabad Mumbai – Ahmedabad Mumbai – Pune Mumbai – Bangalore (2x2 Mbps) Bangalore – Hyderabad Bangalore – Calcutta Bangalore – Chennai Chennai – Calcutta	2 Mbps at each of three cities: Mumbai, Delhi, Bangalore
Satyam Infoway	Inter-city links of between 2 and 6 Mbps	Aggregate of 24 Mbps from VSNL
VSNL	Points of presence connected to international gateways via 2 Mbps digital trunks	Of the 110 Mbps aggregate capacity VSNL operated in Spring 1999, it used 40 Mbps itself. The remainder was used by other ISPs.
Dishnet	Relies on 4 Mbps connections to VSNL in each city	

The private ISP backbones expanded considerably in scope and capacity between 1999 and 2001. Figure 10 and Figure 11 show the backbone networks of two leading ISPs, Satyam Infoway and DishnetDSL in early 2001.

National Internet Backbone. In 1997, in response to frequent complaints about lack of access and low performance of the existing backbone, the Department of Telecommunications began planning the deployment of a large-scale, nationwide Internet backbone (NIB). The NIB would not only address the immediate access and performance concerns, but could also be scaled to accommodate future needs for capacity, coverage, and management.

Figure 10. DishnetDSL Backbone (March 2001)

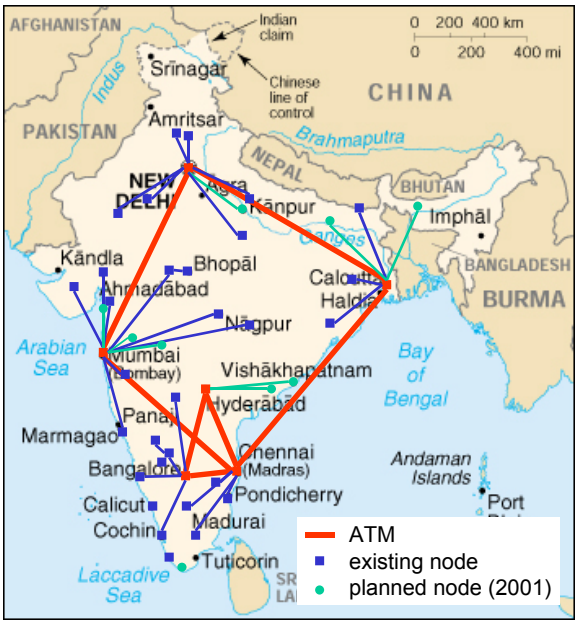


Figure 11. Satyam Infoway Backbone (March 2001)

The architecture of the NIB consists of a hierarchy of three tiers of nodes, including six core stations with international connectivity, a cloud of nodes in individual districts and, at the bottom, small towns. The first tier would consist of two sub-tiers. The six core stations with international connectivity, the so-called A1 stations, would be located in the cities with international gateways: Bangalore, Calcutta, Chennai, Delhi, Mumbai, and Pune. These six nodes would be connected in mesh via 34 E3 (34 Mbps) links, with each node connected to at least two other A1 stations. The

plans call for the backbone to be upgraded to 155 Mbps links in subsequent phases of development. The second sub-tier would consist of eight additional core stations, so-called A2 stations, located in Ahemdabad, Bhopal, Ernakulam, Hyderabad, Jaipur, Jallandar, Kanpur, and Patna. Each of these would connect to two A1 nodes via 8 Mbps links, to be upgraded to E3 (34 Mbps) links subsequently.

The second tier would consist of 31 Type B stations located in mid-sized cities. These stations would connect to A1 or A2 nodes through 8 Mbps links.

The third tier would consist of 504 Type C stations located in individual districts and small towns. Type C stations would be connected by 2 Mbps links to Type A or Type B stations, depending on geographic proximity.

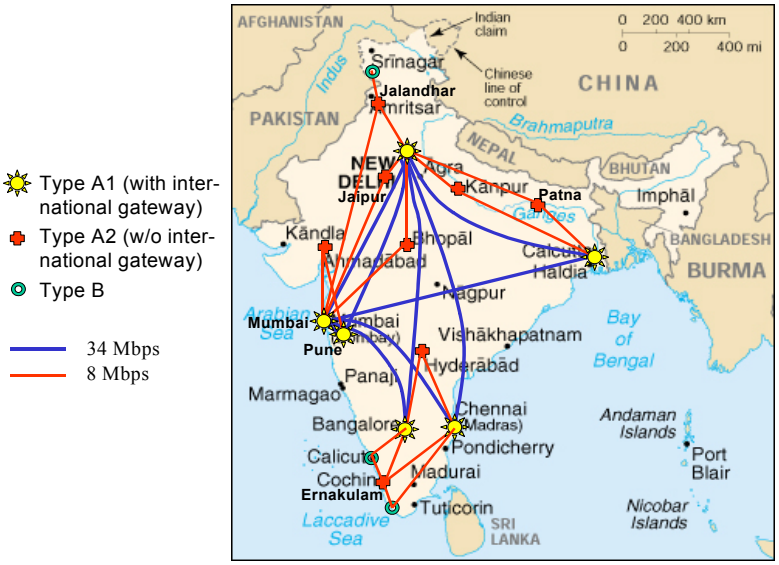
The cities hosting the 31 Type B nodes are listed in Table 19.

Table 19 Type B nodes of the National Internet Backbone.

Agar	Allahabad	Ambala	Amritsar
Baroda	Bhubaneshwar	Coimbatore	Calicut
Chandigarh	Faridabad	Guwahati	Indore
Jabalpur	Jammu	Lucknow	Ludhiana
Madurai	Meerut	Mysore	Nagpur
Noida	Panjim	Jodhpur	Rajkot
Ranchi	Shillong	Shimla	Surat
Trivandrum	Vijayawada	Vizag	

Source: [Agrawal, 1999]

A geographic representation of Type A stations and a sample of Type B stations is shown in Figure 12.



Source: Agarwal[1999]

Figure 12. India's National Internet Backbone

The total number of nodes of each type is shown in Table 20.

Table 20 National Internet Backbone Nodes.

Node	Description	Number
A1	Core nodes with international gateways	6
A2	Core nodes without international gateways, in cities and large towns	8
B	Mid-sized towns	31
C1	Government district offices and small towns	41
C2		87
C3		376
Total		549

Source: [Agarwal, 1999]

The NIB is being constructed in two phases. Phase I called for the creation of the NIB backbone consisting of 45 type A/B nodes. This phase was estimated to cost Rs. 86 crore[7] ($20 million), financed entirely from internal funds of the DoT [Chowdhary, 1999]. Creation of type C nodes was originally intended to take place during Phase II. As the project evolved, however, the creation of type C nodes in India's secondary switching areas was undertaken as part of Phase I. Phase II would then expand the capacity of the backbone and connect an additional 150 cities via high-capacity links. Phase II was expected to cost Rs. 225 crore ($52 million).

On September 9, 1999, Silicon Graphics, Inc (SGI) India announced that it received the Phase I order for 52 SGI Origin 200 servers and four Origin 2000 servers ["SGI India Bags Contract," 1999]. SGI India was part of a consortium led by Crompton Greaves, which also included Cisco, Netscape, Enlighten DSM (Distributed Systems Manager), Apache Stronghold, MRO-TEK and others [Chowdhary, 1999]. This consortium won out over a number of competing consortia: Wipro-Sun Microsystems-Cisco; Siemens-Sun Microsystems-Bay Networks; Ericsson-Sun Microsystems-Cisco; RPG Cable-Sun Microsystems-Cisco; Tata Lucent-Sun Microsystems-Cisco; and ITI-IBM-Cisco. The ITI-IBM consortium was originally awarded the order, but backed out when it realized the costs would be higher than estimated, and the DoT awarded it to the next bidder [Chowdhary, 1999].

The Telecom Commission of India initially specified January 26, 2000 as the date by which Internet nodes were to be established within every district in India [Pai, 1999b], however, the project lagged considerably behind schedule. By late summer 2000, only the first two of the 45 type A/B nodes were commissioned (New Delhi and Bangalore) [Pai, 2000f]. These two were cities were connected by an E3 (34 Mbps) link [VSNL, 2000b]. Furthermore, 245 type C nodes were commissioned in 215 secondary switching areas by September 1, 2000 [Pai, 2000f].

Bharat Sanchar Nigam Ltd. (BSNL) announced the start of service by the NIB in late 2000, but during early 2001, as service was switched from VSNL gateways to the NIB, the company experienced a substantial exodus of users to competing ISPs. Users complained of problems with authentication mechanisms, e-mail reliability, and slow on-line registration and renewal [Sakrak, 2001; Patole, 2001]. Phase I of the NIB was finally completed in July 2001 ["BSNL to Complete Phase," 2001]., By October 2001, BSNL claimed 418 switching nodes were commissioned in 326 secondary switching areas [BSNL, 2001a]. By 2002, however, BSNL was offering Internet service in all these locations through a service called Sanchar Net [BSNL, 2003a]. Difficulties in completing Phase I of the NIB, and questions about the capabilities of Crompton Greaves, led to

[7] One crore = 10 million

a more cautious approach to Phase II. By August 2001, Phase II was scaled back to Rs. 100 crore ($21 million), and Crompton Greaves' contract for Phase II was deferred ["Crompton Greaves Arm Sees," 2001].

As a result of the delays of type A and type B node rollouts, Indian ISPs were unable to take advantage of the bandwidth and exchange capabilities the NIB was to have provided. Unable to wait for the NIB, private ISPs established their own national networks. The capacity of many of these domestic links increased significantly between 1999 and 2002. In particular, VSNL deployed high-speed Internet nodes in Bangalore, Calcutta, Chennai, Cochin, Hyderabad Mumbai, New Delhi, and Pune.

Sanchar Sagar. The Sanchar Sagar project is the second major infrastructure project conceived in the late 1990s and undertaken by the Department of Telecommunications/BSNL to increase bandwidth throughout the country. Phase I of the project, completed in August, 2000, involved the creation of ten very high speed 2.5 Gbps capacity rings with an aggregate length of 17,000 km, connecting 33 major cities across the country [Kumar, N., 2000b]. Phase II involved the laying of 36,000 km of fiber optic cable to form 32 rings of 2.5 Gbps capacity, connecting 150 cities ["Carrier Infrastructure: What Slowdown," 2001]. This project led in 2002 to Phase III, a 20 Gbps dense wave division multiplexing (DWDM) system commissioned in June, 2002, connecting Chennai and Ernakulam, two landing points for submarine cables, and Bangalore. This 2400 km system also links the cities of Trichy, Madurai, Coimbatore, Thiruvananthapuram, Salem, and Vellore. On October 1, 2002, BSNL commissioned an 80 Gbps, DWDM system between New Delhi, Mumbai and Chennai, increasing bandwidth between these and other cities [BSNL, 2003b].

Other Infrastructure Build-out. While the DoT and VSNL continue to lay additional fiber-optic cable for their backbones, many other private and state-owned organizations are trying to capitalize on the growing demand for bandwidth by laying their own fiber-optic networks. One source reported that in mid-summer 2000 a total of $5 billion worth of plans for building infrastructure was announced by various organizations ["Bandwidth Feast Set to," 2000]. These efforts are being encouraged by the national and state governments through direct investment, and the passage of measures to resolve critical right-of-way issues.

The Tata companies, which acquired VSNL as part of the latter's privatization in February, 2002, have multi-year projects to lay thousands of kilometers of fiber-optic cable across the country in support of its nationwide services [Chaudhary and Kapoor, 2002; Carvalho, 2002];

One of the largest investments came from the Reliance Group, a petrochemicals conglomerate. In addition, ZeeTelefilms plans to link 26 cities through fiber optic cable to support video-on-demand, interactive games, and other entertainment applications [Pai, 2000s; "Bandwidth Feast Set to," 2000; Chowdhary and Srinivas, 2001]. Other major projects from BPL, Bharti Enterprises, and BSNL would add over 45,000 km of new fiber optic cable through 2002 [Chowdhary and Srinivas, 2001].

Possible alternatives to the domestic backbone are the fiber networks laid by Indian Railways, the National Power Grid Corporation, and State Electricity Boards. The existing fiber optic networks of each of these organizations provides them with excess capacity. They therefore plan to install fiber optic backbones for commercial purposes. Indian Railways' eight-fiber network is 1,528 km long (1998 data), of which 759km are in central India, 385 in the southeast, and 210 km in the east [Gairola, 1998]. In 2001, plans were being made for the adding 1500 km of network cable along five routes: Calcutta-Delhi, Calcutta-Mumbai, Chennai-Calcutta, Delhi-Jaipur-Ajmer-Mumbai, and Mumbai-Chennai. Also in 2001, the consulting firm McKinsey & Co. developed a business plan for the railway's new public sector unit, RailTel, which called for laying of fiber optic cable along 33,000 km of rail line [Padmapriya, 2001]. In early 2002, the newly formed telecommunications subsidiary of the Indian Railways, Railtel, awarded contracts for laying 1500 km of fiber optic cable, as part of a four-year plan to put fiber optic cable along 35,000 km of rail ["Railtel Awards Contracts for," 2002].

The Powergrid also plans to install 3,824km of fiber optics in the northern and southern regions along its transmission network [Gairola, 1998]. The first phase of the project, a 2,600 km link between Mumbai and Delhi, was launched in January 2001 ["Delhi-Mumbai Optical Fiber," 2001].

The Gas Authority of India (GAIL) is using its gas pipelines to build long distance communication links ["Bandwidth Feast Set to," 2000]. In 2002, GAIL announced plans for a three-stage project to lay 10,000 km of fiber optic cable that will cover 96 cities ["GAIL Lines Up Big," 2002].

While these cable-laying projects offer ISPs a number of alternatives for acquiring domestic bandwidth for their own backbones, until recently they were only permitted to build their own backbone within their service area and only for carrying traffic originated and terminated by its subscriber, and only when such capacity is not available from any other authorized agencies [Chowdhary, 1999]. In July 2000, however, at the first national conference of State IT ministers, the Union Government and the State Governments agree to allow free right of way for access providers to lay optical fiber networks along national highways ["Action Plan to Boost," 2000].

The National Association of Software and Services Companies (NASSCOM) reported the aggregate capacity of the domestic Internet backbones was 1.2 Gbps in 2000. Anticipating a future demand at least two orders of magnitude greater, NASSCOM announced it was undertaking "Operation Bandwidth" to increase the bandwidth to 100 Gbps by 2003 [Pai, 2000j].

The cooling of the Internet market in 2001 did lead to the scaling back, or canceling of a number of ambitious plans for laying new fiber [Chowdhary and Srinivas, 2001], though the projects announced in 2002 indicate that considerable build-out continues to take place. At the time of writing this article (2002), the bandwidth shortage has eased, and come commentators have even pointed to a bandwidth glut [Sengupta, 2002; Arora, 2002].

Internet exchanges

Although interconnections between ISPs are permitted under the ISP license, Internet exchange points are not well established, forcing most traffic between ISPs to travel to the United States before returning to India. At least three developments, however, are changing this picture:

- the VSNL Internet Central Control Facility (ICCF) ,
- the establishment of an Internet exchange by ISPs other than VSNL, and
- the National Internet Backbone (NIB).

In April 1999, VSNL launched an Internet Central Control Facility, a central hub connecting its international links and domestic backbone, and providing connections to private ISPs. The ICCF is located in the Lokmanya Videsh Sanchar Bhavan in Mumbai, where the Fiber Link Around the Globe (FLAG) and Southeast Asia Middle East Western Europe SEA-ME-WE2 cables terminate. The ICCF also serves as an exchange point between any ISPs connected here, enabling these ISPs to exchange network traffic directly [Noronha, 1999]. In December 2000, VSNL unveiled a Gigabit Routed Internet Exchange at this facility, which enables an exchange of traffic between the international cable in Mumbai, the ISPs, corporate leased lines, and the National Internet Backbone [VSNL, 2000b].

At the same time, Dishnet, Mantra Online, and Satyam Infoway announced a joint effort with Enron, the U.S. power and gas conglomerate, to establish their own Internet exchange in Mumbai ["India: Enron, 3 ISPs," 2000]. In January 2001, the Internet Service Providers Association of India (ISPAI) accepted the companies' proposal, and efforts began to enroll additional ISPs [Pai, 2001c].

Another effort to provide an Internet exchange was initiated in 2001 by Band-X, a British company providing bandwidth trading services to the communications industry. Called IN-IX, the exchange would be India's first neutral, not for profit, public peering point (http://in-ix.net/). By the second quarter of 2002, this exchange was still not operational ["It's High Time," 2002]. Estel Communications has also advertised Internet exchange services ["ESTEL Internet Exchange," 2002].

One of the purposes of the new National Internet Backbone is to provide connectivity between ISPs. In particular, the backbone is designed to partition the nation's traffic to avoid overloading any particular line or connection point. Thus, exchanges between ISPs located in the same region of the country should be carried out in that region, and, as a result, the effective number of Internet Exchanges will increase markedly.

Nevertheless, nearly four years after the first commercial ISPs licenses were issued in 1998, India still did not have an open (non-ISP owned) Internet exchange ["It's High Time," 2002]. In September, 2002, TRAI added its voice to that of the ISPAI and others, calling for the government to establish a public Internet exchange within India, dubbed the National Internet Exchange of India (NIXI) ["Set Up Internet Exchange," 2002].

Until the NIXI is built, ISPs must choose between a limited number of closed exchanges and the cost and latency of international round-trips for domestic traffic. As a result, India is rated as a weak Level 3 (*Broad*) for the Internet Exchange component of the Connectivity Infrastructure dimension.

Access Methods

The dominant form of access for end users will continue to be dial-up for several years. A U.S. market research firm, Frost & Sullivan, estimated that the fraction of bandwidth usage traveling over dial-up connections in March 2000, was 84.4% of the total, a figure which is expected to fall to 70% in the year 2005 [Pai, 2000e]. These figures, however, do not directly indicate the fraction of connections using dial-up access. If one assumes that high-speed connections (ISDN, DSL, cable) use 2 to 30 times more bandwidth than a dial-up connection and that such high-speed connections are more likely to be used for longer periods of time, the percentage of users on dial-up remains over 90%. Former chairman of VSNL, T. H. Chowdary, lends further support to this estimate [Chowdary, 2001].[8] How this figure will change in the near future is the subject of some speculation. According to a study done by industry observer Rediff on the Net, in 2002 an estimated 80% of users will be accessing the Internet via a dial-up connection [Kovoor, 1999]. An IDC study cited in December, 2002 indicated that the number of broadband users was 73,000, of which 28% were home users and the remainder were corporate users ["Broadband: Unravelling the Bandwidth," 2002]. The definition of user is unclear, but even if the figure refers to subscribers rather than users, fewer than 2% of India subscribers use broadband.

Nevertheless, high-speed access, in the form of ISDN, DSL, and cable modem connections is increasingly available in cities with ISP POPs. In 1999, ISDN access was available in forty or more cities, although the subscriber base was small. Nationally, the subscriber base was 3,487 in November 1998 ["DoT to Add 18," 1999]. The number of subscribers grew to 24,816 two years later [BSNL, 2000], of which the majority were commercial users ["Internet Subscribers Yet to," 1999]. BSNL claims ISDN access will be available in all 549 nodes of the National Internet Backbone, when they are completed [BSNL, 2001b]. The Frost & Sullivan study, however, predicts that the fraction of bandwidth usage traveling over ISDN connections will decrease from 7.8% in March 2000 to 1% in 2004-2005, as it loses competitiveness vis-à-vis other technologies [Pai, 2000e].

The availability of DSL currently is more limited than ISDN, although it is emerging as a popular access method for ISPs ["DSL Could Be Favorite," 2000]. DishnetDSL, the first company to offer DSL in India, offered this service in Bangalore, Chennai, Mumbai, New Delhi, and Pune [DishnetDSL, 2001]. DishnetDSL, and a growing list of ISPs also offering the service, are targeting primarily commercial users with this technology. The Frost & Sullivan study predicts that the fraction of bandwidth demand using DSL would rise from 2% in 2002 to 3% in 2005 [Pai, 2000e].

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[8] Of those who use something other than dial-up access, undoubtedly a substantial number are accessing the Internet through Internet cafes, which may have an ISDN or DSL connection. Thus, a statistic that fewer than 90% of users access the Internet through dial-up connections is more a reflection of the poor quality and access of the PSTN than of the availability and cost of high-bandwidth connections.

One of the more attractive possibilities, unrealized at present, is the provision of Internet service via the cable television infrastructure. First, more homes in India enjoy cable service (38 million) than telephone service (28 million) [Pai, 2001a]. Second, the quality of the cables is higher than the quality of the existing telephone connections. Third, there is a severe lack of leased line and high-speed dial-up access to the Internet in the country ["Internet over Cable: The," 1999]. Many of the major ISPs already begun offering Internet-over-cable service in selected cities, or are planning to do so [Pai, 2000i]. Frost & Sullivan predict that cable connections will carry 24% of Internet traffic by 2005 [Pai, 2000e]. The broad penetration of Internet access via cable modems faces major barriers, including the high cost of cable modems and service [Chatterjee, 2001]. Cable modems cost between Rs. 16,000 ($370) and Rs.20,000 ($460) in 1999, leveling off at Rs. 10,000-14,000 ($220-310) by mid-2000. By some estimates, cable modem costs would have to come down to Rs. 5,000-6,000 ($110-130) before demand would increase substantially [Chatterjee, 2001]. Nevertheless, for high-usage customers like small businesses and cyber cafes, cable-based Internet access is an attractive option [Chatterjee, 2001; Varadarajan, 2000a].

Dial-up access will continue to dominate in India in the near future; however, major increases may be seen in access through cable modems and DSL, particularly for organizational users, who will use these methods in place of leased lines. Within this component of Connectivity Infrastructure, India rates a strong Level 3 (*Broad*).

Resources

Efforts to expand the Internet through the construction of infrastructure, the development of companies, and the provision of products and services require an abundance of human and financial resources. A great deal of money was poured into the IT sector from both government and private sources; however, meeting stated goals will require many times more investment than was provided to date. Similarly, although India benefits from a growing number of technologically savvy individuals, demand exceeds supply here as well.

Financial Resources. Having made development of the IT sector a high priority, the government invested a great deal of money in the expansion of telecommunications and Internet infrastructure. The public sector has invested between $2.48 billion and $3.39 billion per year between 1995 and 2000 [Ghosh, 2000]. Although this amount is substantial, it is small compared with the amount needed to achieve the stated goal of 15% teledensity (15 phone lines per hundred people) by 2010. JM Morgan Stanley Vice-Chairperson Naina Lal Kidwai estimates that bringing India's fixed-line telephone penetration to 10.3% by 2010 would require an annual investment of Rs 27,020 crore ($5.7 billion) ["Morgan Stanley Upbeat on," 2001]. This amount is more than the Rs 23,000 crore ($4.9 billion) of combined capital outlay of the three public telecommunications companies, VSNL, BSNL, and MTNL in fiscal 2001 [Chowdhary, 2001]. Nevertheless, the latter figure represents a considerable increase over the years 1995 to 2000.

As India privatizes its telecommunications industry, private investment in infrastructure and services will constitute an increasingly significant percentage of overall investment. In 2000, the Indian telecommunications industry received a huge increase in foreign investment. In 1999-2000, the total amount of foreign direct investment in India was $2.1 billion. However, in August 2000 alone, $1.5 billion of foreign capital was invested in Indian telecommunications projects [Barman, 2001].

India benefits from a sizable community of non-resident Indians (NRIs) who grew wealthy (for a time) riding the dot-com bubble in the United States. NRIs were the driving or controlling forces behind many ISPs, venture capital firms, and E-Commerce companies ["Team of 4 Gives," 2000; "Money to Talk at," 2000; "Did You Dot-Com," 1999].

Overall, however, foreign direct investment (FDI) is well below what some observers feel it should be, given India's geography, labor pool, democratic system of government, and English-speaking population [Bajpai and Sachs, 2000a]. Bajpai and Sachs list several reasons why FDI remains low [Bajpai and Sachs, 2000b]:

- high corporate tax rates
- a restrictive FDI regime in which foreign ownership of more than 50% involves long, cumbersome, and uncertain procedures
- exit barriers that make it difficult for foreign investors to pull out of markets
- stringent labor laws that prevent large firms from laying off or firing workers without government approval
- land laws that prevent corporations from selling surplus land in major cities without government approval
- lack of clear-cut and transparent sectoral policies for foreign direct investment, which slow the transaction of approved FDI into actual investment

As a result, FDI into India lagged behind many of its neighbors. In 1997, while India experienced $3.2 billion of actual FDI, China received $45.3 billion [Bajpai and Sachs, 2000a]. Figures for subsequent years followed a downward trend, with FDI falling to $2.6 billion in 1998, and $2.2 billion in 1999. At the same time, global FDI nearly doubled during these years from approximately $460 billion in 1997 to $865 billion in 1999 [Naik, 2000]. However, FDI increased during 2001, reaching $3.6 billion during the first 9 months ["FDI Inflows up 40," 2001].

To attract foreign direct investment (FDI), India made a number of policy changes to create more favorable investment conditions. In July 2000, the government decided to raise the FDI ceiling from 49% to 100% in E-commerce, radio paging, e-mail and voice mail, and, on the infrastructure side, dark fibre[9] and end-to-end bandwith [Raman, S., 2000]. Curiously, however, the policy change affected E-commerce ventures, but not ISPs, which often exhibit high need for capital [Chowdary, 2000]. To foster the growth of venture capital funds, the government introduced a number of initiatives including the introduction of sweat equity, government-facilitated venture capital funds, and liberalized treatment of taxes on venture capital funds [Butani, 2001]. The increase in investment in the telecommunications sector in the middle of 2000, reflected a combination of favorable changes in the investment climate stemming from the NTP 1999 legislation, including efforts to demonopolize basic services and improved licensing arrangements in cellular telephony [Barman, 2001]. Most of the new investment went towards cellular phone projects.

By early 2001, however, foreign investment in the telecommunications and Internet areas dried up considerably. While a great deal of the decline was undoubtedly the result of a decline in the availability of venture capital for Internet-related projects world-wide, investment in India itself became less attractive as a result of some government flip-flops and delays on policy affecting cellular phone service, and overly optimistic estimates of the value of many projects that were under consideration [Barman, 2001].

In September, 2002, the government was considering raising the foreign direct investment cap in telecommunications from 49% to 74% ["Govt Considering Hiking FDI," 2002].

The bursting of this bubble in 2001 certainly reduced the amount of capital available to Internet companies, but without this investment over the last few years, India's Internet would undoubtedly have grown at a much more modest pace.

*Human Resources.*The availability of skilled human resources is a factor that strongly affects the rate at which expansion of the Internet can occur. Though shortages of such personnel remain a problem in India, the government and the private sector took a number of steps to mitigate the shortage ["IT NAC to Focus," 2001; "NASSCOM Moots 5-Year," 2001]. A ubiquitous feature of the Indian landscape, featured prominently in the newspapers, is advertising for computer training centers and courses. Earlier government efforts to boost IT, especially software exports, resulted

[9] Dark fiber is fiber optic cable that has been laid in the ground for reserve, but is not yet being used. When companies lay fiber they usually lay more than is needed at present in order to accommodate future demands for capacity.

in the creation of a vast computer- training sector. Government certification ensures that the many schools, from one-room store fronts in remote villages to large urban campuses, conform generally to a recognized curriculum. Competition for students is fierce.

One weapon in this competition is Internet access. The larger schools are buying Internet accounts from VSNL in bulk and providing them to their students free of charge. One of the pioneers of this trend, NIIT, also owns the largest network of computer schools in the country. In March 1998, NIIT announced that students at centers in Ahmedabad, Bangalore, Calcutta, Chennai, Mumbai, and New Delhi would receive free Internet accounts ["NIIT Internet Facility for," 1998]. NIIT requested a total of 20,000 GIAS accounts from VSNL to support this program. Coinciding with the NIIT announcement, the Indira Gandhi National Open University opened negotiations with VSNL for 10,000-15,000 Internet accounts for its students ["VSNL's Net Set," 1998]. Internet access is now a differentiator used by the higher-end schools and training programs to attract students. If prices come down in the near term, more schools are likely to lease bulk Internet access for their students.

Courses being offered via the Internet are another academic spur to Internet development. In January 1998, another major computer school system, Aptec, announced that its Master Software Engineering course would be offered in part over the Internet ["Aptech Launches Online Course," 1998]. That same month, the University of Illinois at Urbana-Champaign began offering its Masters-level computer science program over the Internet in India in conjunction with a local partner, Quantum Enterprises ["MCS Programme in India," 1998]. In addition, the BITS Pilani School in Rajasthan announced that it was launching a “virtual university.”

Public-private sector joint ventures have long been used by the Indian government to spur development in targeted regions and sectors. One of the more successful examples of such a partnership is the West Bengal Electronics Industry Development Corporation Limited (Webel), headquartered in Calcutta and sponsored by the government of the state of West Bengal. Webel created several wholly-owned companies in the communications, electrical power, entertainment, and electronic component equipment industries, and provided seed funds (usually as an equity investment) for regional start-ups. Although Webel concentrates on electronic hardware projects, it invested in six joint-venture software companies, including the Indian subsidiary of SEMA Group Telecom, developers of telecommunications management systems.

PERVASIVENESS

One of the most common metrics to measure the state of the Internet is Pervasiveness, the fraction of the total population that uses the Internet regularly. Our usage of the term differs from commonly used Internet growth metrics in that the final measure of pervasiveness is not an absolute number, but a ranking of that number in one of five levels, shown in Table 21. An accurate determination of the number of users is, however, always problematic. A basic difficulty is the confusion between Internet users and Internet subscribers. The latter are those who maintain an account with an Internet Service Provider. While individual ISPs know precisely the number of their accounts, they may not publish accurate figures. Furthermore, in some contexts, such as at Universities and at Internet Cafes, the concept of a "subscriber" may have little direct correspondence with the number of individuals accessing the Internet through the provider. Even in the case where an identifiable individual subscribes to an ISP's service, that individual may share his or her account with a number of family members or friends. Nevertheless, tracking the numbers available over time provides an indication of trends.

Table 21, which is based on the data in Table 22, indicates that India was at a very high Level 2 (Established) by March 2002, and likely crossed to a Level 3 (Common) by the end of the year.

Table 21. Pervasiveness of the Internet

Level 0	Non-existent	The Internet does not exist in a viable form in this country. No computers with international IP connections are available. There may be some Internet users in the country, however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1	Embryonic	The ratio of users to total population is on the order of magnitude of less than one in a thousand (less than 0.1%).
Level 2	Established	The ratio of Internet users to total population is on the order of magnitude of at least one in a thousand (0.1% or greater).
Level 3	Common	The ratio of Internet users to total population is on the order of magnitude of at least one in a hundred (1% or greater).
Level 4	Pervasive	The Internet is pervasive. The ratio of Internet users to total population is on the order of magnitude of at least one in 10 (10% or greater).

Table 22 Estimated Number of Internet Subscribers and Users in India

Date	Number of subscribers	Number of users (% population)	Source
August 1995	2,000	10,000	[NASSCOM, 2001]
1995-6	4,000		[Mehta, 1999c]
March 1996	50,000	250,000	[NASSCOM, 2001]
1996	4,000		["Manipal Group Launches Net," 1999]
March 1997	90,000	450,000	[NASSCOM, 2001]
1997	29,000		[Mehta, 1999c]
September 1997	50,000		[Kovoor, 1999]
1997		300,000 (.03%)	[Haridas, 1999]
March 1998	140,000	700,000	[NASSCOM, 2001]
1998	90,000		[Mehta, 1999c]
November 1998	130,000		[Nicholson, 1999a]
November 1998	175,000		["Competition gives fresh impetus," 1999]
December 1998		500,000 (.05%)	["Indian givers to boost," 1998]
Fall 1998	150,000		[Kovoor, 1999]
1998		750,000 (.08%)	[Haridas, 1999]
March 1999	280,000	1.4 million	[NASSCOM, 2001]
April 1999	250,000	800,000 (.08%)	[Agarwal, 1999; Nicholson, 1999b; "Net Numbers are Rising," 1999]
May 1999	280,000	800,000 (.08)	[Thampi and Basu, 1999]
June 1999		1 million (.10%)	[Nicholson, 1999a]

June 1999		1.5 million (.15%)	[Pai, 1999a; "Competition gives fresh impetus," 1999]
September 1999		1.9 million (.19%)	[Haridas, 1999]
October 1999	350,000		["Competition Gives Fresh Impetus," 1999]
December 1999		2.6 million (.25%)	["India - Pioneer Online Launches," 1999]
March 2000	900,000	2.8 million	[NASSCOM, 2001]
July 2000	1 million	3.1 million	["India Casts Biggest Net," 2000]
July 2000	1.14 million	2.13 million	["Net Users To Touch," 2000]
August 2000	1.6 million	4.8 million (.48%)	[NASSCOM, 2001]
January 2001	1.8 million	5.5 million (.55%)	[Pai, 2001a]
March 2001	3.0 million		[ISPAI, 2002]
August 2001		6.0 million (.6 %)	["India Fastest Growing Internet," 2001]
December 2001	3.8 million		["ISPs Report Fewer Netizens," 2002]
February 2002		9 million (.9%)	["Enhance PC, Tele Density," 2002]
March 2002		9.8 million (.98%)	[Nair, 2002; "China Leads in Domestic," 2002]
March 2002	3.2 million		[ISPAI, 2002]
September 2002	3.8 million		[ISPAI, 2002]

In the context of the entire country, usage of the Internet remains low. However growth rates remained impressive, at least through the start of 2001. While they are neither entirely accurate nor fully consistent, the figures in Table 22 unquestionably underscore the very rapid growth of Internet usage in India since the start of commercial Internet service by VSNL in 1995. The largest year-to-year relative increase occurred in 1995-1996, when VSNL's subscriber base increased 25-fold, according to NASSCOM [NASSCOM, 2001]. By some estimates, the next greatest year-to-year increase (300-400%) occurred in 1998-1999, after the government began issuing licenses to private ISPs. NASSCOM data, however, shows a more modest, though still impressive, doubling of the Internet usage base during these years [NASSCOM, 2001].

Usage crossed the .1% mark sometime between late 1998 and mid-1999. Projections through 2000 estimated that India would cross the 1% threshold in mid-2001. More recent figures appear to indicate that the rate of growth leveled off considerably. The Gartner Group estimated 6 million regular Internet users in July 2001, only 8% greater than in January, but numbers were projected to reach 7.5 million by December, a 36% growth rate for 2001. In a country with a population as large as India's, such growth over a short period of time reflects a considerable change in the technological basis for communications, and an extensive investment of resources and effort by the Internet community.

What would explain the growth of the number of Internet users? Fundamentally, the number of Internet users is a function of each individual's decision to use, or not use, the Internet. A decision to use the Internet depends on the existence of four basic conditions:

- First, an individual must have the opportunity to use the Internet. This condition implies the existence of basic telecommunications and Internet services, and of access to user technology such as a PC and modem.
- Second, the cost of access must be acceptable to the individual.
- Third, the value an individual perceives to derive from the Internet must justify the cost.
- Fourth, the Internet must be sufficiently easy to use that the individual can climb the learning curve given the time and effort that the individual is willing to invest.

If any of these four conditions is lacking, an individual will not use the Internet. Moreover, improvements in any or all of these four conditions are likely to result in increases in usage throughout the population, as is evidenced by India's experience.

Access. Individuals and organizations cannot use the Internet unless they have access to it. Access depends on the availability of personal computers or other end-user devices, Internet service, and the basic leased and dial-up telecommunications services. India experienced substantial growth in each area, with the largest growth taking place in providing Internet services.

By August 2000, more than 4 million personal computers in India provided sufficient processing power to access the Internet. By 2002, this number reached 6.4 million [Nair, 2002]. Eighty-one percent of PC sales were driven by the desire to access the Internet [NASSCOM, 2001].

In just under four years following the introduction of the New Internet Policy in November 1998, the number of points of presence increased by an order of magnitude, to nearly 1100 POPs in over 450 cities. While Internet service is now available in all major cities, rural access remains extremely limited. The geographic coverage of the telecommunications network, still does not reach hundreds of thousands of villages. India's telephone density only reached 3.8 lines per 100 people in 2001 ["Ministry Seeks Sales Tax," 2001;]. Furthermore, the quality of many lines is low. As a result, long-distance dial-up from outside major cities is subject to frequent dropped connections.

Cost of Internet Access. Costs to end users dropped considerably in recent years, helping to fuel the rapid growth in the subscriber base. VSNL, for example, dropped end-user prices by 80% between November 1998 and January 2003 (Figure 13). Subscribers for 250 or 500 hours of service may use these hours at any time over a ten-month or one-year period, respectively. Unlike many plans in the United States, they are not tied to a particular month. The rate changes reflect a determination on the part of VSNL to compete aggressively, particularly for new subscribers. In December 1998, shortly after the first private ISPs began offering service, VSNL dropped prices by 30% ["India's VSNL Cuts," 1998]. It reduced prices twice more in 1999. Other ISPs, such as Dishnet and MTNL at times undercut VSNL's prices, but only in individual cities.

In 2000, a vicious price war broke out among ISPs driving VSNL to drop rates in January, and again in May. Other ISPs began a torrent of price reduction announcements, and companies began introducing a spectrum of incentives to attract users. Caltiger.com pioneered a free Internet service in Calcutta. Jain Studios Limited followed with free service in Delhi. Meanwhile, VSNL and others began offering free service at night, between 11pm and 8am. Other ISPs offered "freebies" such as music cassettes, carry bags, watches, pens, and encyclopedias. For Rs. 250 ($ 5.60), DishnetDSL offered one hour of Internet usage per day for five days, but only for women [Raval, 2000].

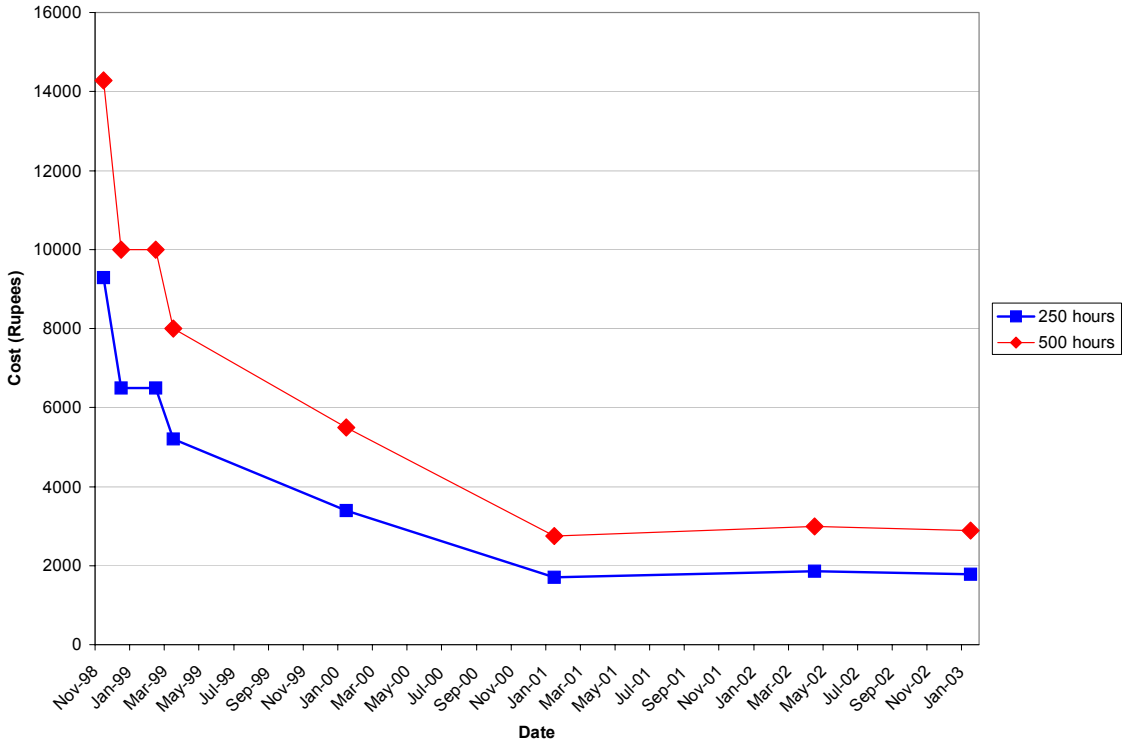

Figure 13 VSNL End-User Dial-up Rates

On January 3, 2001, VSNL introduced a popular pricing package called "Monsoon" which reduced dial-up costs by 50% [Sengupta, 2001]. Subscribers could obtain unlimited access for Rs. 2,400 ($52) per year, or purchase 100 daytime hours and unlimited nighttime access for Rs. 750 ($16). This price reduction further fueled an intense price war among ISPs that lasted throughout 2001. By 2002, however, prices had stablized, as shown in Figure 13.

The stabilization of prices was accompanied by the failure of a number of "free Internet" services. Caltiger ended its free service in 2001 and saw its subscriber base drop from 750,000 to 10,000. Jain Internet also abandoned its free Internet model and closed down ["Internet Subscriber Base Shrinks," 2002; "Market Not Good for," 2002]

Even though prices remain much lower than they were before 2000, the fraction of Indian households that could afford to spend even $30 a month is very limited. Jhunjhunwala claims that while 90% of American households can afford to spend $30/month on communications services, only 1.6% of India households can afford to do so, assuming that they are willing to spend 7% of their income (Table 23) [Jhunjhunwala, 2000].

The cost to end users is in part a function of the costs ISPs incur for connecting to the global Internet. The trend in these costs is shown in Figure 14. The 1997 data reflects the rates VSNL was charging corporate customers, not ISPs, since no private ISPs existed at the time. The 1998 data reflect rates VSNL charged ISPs at the end of that year. In April 1999, the TRAI announced new tariffs for leased lines that were 40% lower than previous tariffs. During the same month, VSNL dropped the price of a 64 Kbps international leased line by nearly 40%, to Rs. 500,000 ($11,700) a year, down from Rs. 800,000 ($18,700).

Table 23. Percentage of Indian Households that can Afford a Given Yearly Expense on Communications.

Household Income (yearly)	Percent of households	Affordable expenditure on Communications (Yearly)
>$5000	1.6%	>$350.
$2500-$5000	6.3%	$174-$350
$1000-$2500	23.3%	$70-$175
$500-$1000	31.8%	$35-$70
<$500	37.0%	<$35

Source: [Jhunjhunwala, 2000].

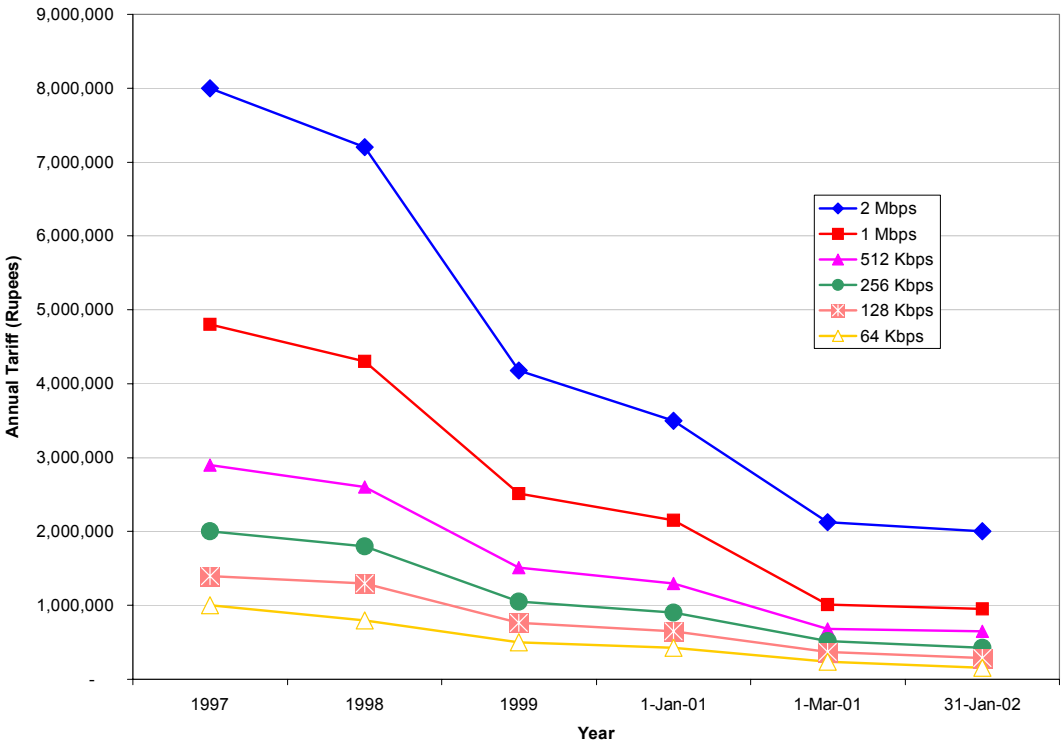

Figure 14. Cost of VSNL Internet Leased Lines

In Cochin and Mumbai, cities in which submarine cables used by VSNL land, rates were even lower than in other cities. For example, a 2 Mbps leased line in one of these two cities cost Rs. 1,250,000 ($26,800) per year (March 2001), compared with Rs. 2,130,000 ($45,700) per year in other cities [VSNL, 2001]. This difference, which other ISPs claimed reflected VSNL efforts to sell bandwidth below cost in unfair competition, prompted the ISPAI to file a formal protest ["VSNL Rate Cut Ignites," 2001].

In October 1999, in an effort to promote faster and deeper penetration of the Internet, the Government of India asked VSNL to halve the service charges for allocating bandwidth to companies providing Internet services ["Independent Gateways for Internet," 1999].

According to some sources, VSNL's price drops in January and March 2001, were motivated, in part, by projected drops in bandwidth costs as other ISPs acquired additional capacity. A number of ISPs were establishing their own gateways, acquiring their bandwidth directly from submarine cable carriers, or even laying their own submarine cable [Pai, 2000o]. As the new international cables come on line, the prospects are good that international bandwidth prices will drop considerably.

Ease of Use. The easier it is to use a technology such as the Internet, the more accessible it is to users. The invention of the Web browser greatly simplified the Internet and enhanced the interface through which it is used, fostering the Internet explosion of the mid-1990s.

For the most part, however, a person must be literate to use the Internet. The 1991 Census, India shows India's literacy rate is 52% ["India at a Glance," 1991], though India has an advantage over many countries in that it includes a very large English-speaking community. English, the most common language on the Internet, is the *lingua franca* of commerce, government, and the court system. It is not, however, widely understood beyond the middle class and those who can afford formal foreign-language education.

Although the un-served English-speaking market for Internet services is still large, for the Internet to spread beyond the urban core, local language content will be required [Kochhar and Anwar, 1998]. Recommendation 78 of the IT Action Plan aims to make the Internet more widely accessible in India. It calls for intensive development of applications in local Indian languages. In 1998, the DoE announced that two Indian-language word processing programs were available, free of charge, on the Internet at the Web site of the Center for Development of Advanced Computing (C-DAC). Hypertext mark-up languages (HTML), Internet browsers, and e-mail programs were targeted by the DoE for early indigenization ["DOE Launches Free Indian," 1998]. To date, the focus of the development of local-language software is Hindi and the Devanagari script, on which many Indian languages are based.

A number of commercial vendors introduced products with native language support. Rediff.com introduced Rediff Bol, an instant messenger in English and four Indian languages - Hindi, Gujarati, Tamil and Telugu - targeting approximately 60 per cent of Indians ["Rediff.com Launches Instant," 2000]. Mithi.com offers e-mail, chat, and browser service in 11 Indian language plus English ["Mithi.com Seeks Next," 2000].

Usage of non-English sites appears to be small. The Gartner Group estimated only 11% of Indian users visited an Indian language site [Rao, 2000]. Mithi.com served approximately 50,000 users of its multilingual technology ["Mithi.com Seeks Next," 2000]. Such percentages will have to grow, however, if the Internet is to become accessible to the broader population. In fact, the existence of Indian language technologies and compelling Web sites is a prerequisite for broad Internet usage in India.

Perceived value of the Internet. The proportion of Internet users in India, having just reached the 1% mark nationally, is greatest among the large middle-class. In 1999, the Internet moved from an exotic technical accessory to a relatively commonplace component of middle class day-to-day life. India, however, remains in the early phases of popularization of the Internet, and many middle-class Indians with personal computers are not connected to the Internet. Others are still either unaware of the Internet, or worry about its security. The Internet, however, is 'fashionable' across a broad segment of the middle class, and the potential for growth in the user base is enormous, even if the Internet does not reach rural areas.

The principal driving force behind Internet diffusion at present is the large pent-up demand. A large market is not only waiting to be served, but demanding more and better service. Besides demand, however, there is broad recognition that Internet development is a key component of a larger program to boost Indian IT exports, principally in software. In addition, the government believes that national development is being held hostage to basic infrastructure improvements,

and that those improvements, including the Internet, should receive more emphasis than market demand alone.

The large number of Indian expatriates, those employed overseas and students studying abroad, (the NRIs, that is, non-resident Indians), is also likely to spur further diffusion of the Internet in India. Students in foreign institutions generally gain Internet access making them familiar with the technology, and somewhat reliant upon it. While studying, they seek to communicate with their families and other NRI students via the Internet, and once home, they bring their needs, expectations, and expertise with them. Though significant percentages of non-student NRIs are laborers, and probably do not have the means to access the Internet, most others are professionals with the means and know-how to communicate with their families and friends online. In addition, many use the fruits of their successes overseas to fund investments in new businesses in India.

The demand for Internet service in India is high. Part of the reason for this high demand is the general awareness of the Internet on the part of the educated middle class and their desire for improved access to information and communications. The government is also a demand driver, in that many officials see the future of Indian economic development relying on the benefits of wide-area networking, especially in the educational, commercial, agricultural, and health sectors. One of the major reasons for the demand for Internet access across the board is the desire and often critical need, for information. As is typical of developing countries, technical, scientific, and medical information is hard to come by and expensive when available. A researcher at the Indian Institute of Technology in Chennai estimated that the typical Indian educational institution receives only a small fraction— less than 3 percent— of the professional journals routinely available in the West, and that many doctors “are happy with the free pamphlets that drug companies give them” [Arunachalam, 1998]. The Internet is viewed as a means to acquire the latest professional information rapidly and inexpensively, as well as to put Indian practitioners in closer contact with their Western counterparts. The legalization of Internet telephony in 2002 provided a new reason to use the Internet. ISPs moved quickly to acquire licenses to offer this service, while many cyber cafes offered the service illegally, without the appropriate license [Saxena, 2002b]. In either case, each of these organizations anticipated an opportunity for increased Internet usage.

While still in its infancy in India, Internet gaming may be an important application attracting users to the Internet. Low access bandwidth, modest PC penetration, the cost of games, and social mores, are among the reasons that Internet gaming did not flourish in India in the past. However, gaming stations are becoming mainstream and Internet gaming is likely to follow as some of the technical barriers are removed [Singh, 2002].

Cyber Cafes. One of the most significant enablers of personal Internet usage in India is the Cyber Café, affecting Pervasiveness by making the Internet affordable and accessible in a setting that increases perceived value by encouraging socialization. By April 2001, according to one estimate, over 8,000 cyber cafes were in operation in India, of which fewer than 10% were owned by major ISPs. By June, 2002, the number reached 12,200 [ISPAI, 2002]. International Data Corporation (IDC) India estimated that approximately 60% of Indian Internet users access the Internet from Cyber Cafes ["Like This Only (Indya," 2001; "Indian Netizens Prefer Cyber," 2001]. With prices dropping in 2001 to approximately Rs. 20-25 ($0.43-$0.53) per hour, users could access free e-mail accounts hosted by Yahoo, Hotmail, or several Indian providers from numerous locations within a city, often with better connectivity than could be obtained through dial-up connections from home [Mendonca, 2001].

In general, growth in Pervasiveness of the Internet remained positive, with a slowing of growth during 2001-2002. A number of ISPs reported drops in the number of subscribers during this time ["Internet Subscriber Base Shrinks," 2002; Thiagarajan and Raman, 2001]. A number of factors played contributing roles [Thiagarajan and Raman, 2001]: A certain degree of saturation of the market in large cities, the deletion of dormant accounts, the shift of some intensive dial-up users to high-speed DSL or cable connections, the termination of services offering free Internet access, and a stabilization of end-user prices at the end of 2001.

SECTORAL ABSORPTION

Sectoral absorption assesses the degree to which four major sectors of society took up the technology:

- the academic,
- commercial,
- health, and
- public (government) sectors.

While the sectors describe the major social and economic divisions in society, none are homogeneous, (Table 24). (Personal use is not considered in this metric.)

Table 24. Internet-Using Sectors of the Economy

Sector	Subsectors	
Academic	Primary and secondary education	University education
Commercial	Distribution, Finance, Manufacturing	Retail, service
Health	Hospitals, Clinics	Research centers Physicians/practitioners
Public	Central Government Regional and Local Governments	Public companies Military

The Sectoral Absorption of the Internet in a country is determined by first evaluating the absorption of the Internet within the individual sectors, as shown in Table 25. One point is assigned for each sector that rates at *rare*, two points for each *moderate* sector, and three points for each *common* sector. These points are then aggregated to determine the overall level of Sectoral Absorption (Table 26). The ratings shown indicate that India recently reached a Level 2 (Moderate). Reaching a Level 3 (Common) would require moderate absorption into the education and healthcare sectors, or nearly complete penetration (90%) in the commercial or public sectors.

Table 25 Absorption of the Internet in Sectors of the Indian Economy

Sector	Rare	Moderate	Common
Academic - primary and secondary schools, universities	>0-10% leased-line Internet connectivity	10-90% leased-line Internet connectivity	>90% leased-line Internet connectivity
Commercial-businesses with more than 100 employees	>0-10% Internet servers	10-90% Internet servers	>90% Internet servers
Health-hospitals and clinics	>0-10% leased-line Internet connectivity	10-90% leased-line Internet connectivity	>90% leased-line Internet connectivity
Public-top and second tier government entities	>0-10% Internet servers	10-90% Internet servers	>90% Internet servers

Table 26 Sectoral Absorption of the Internet in India

Sectoral point total	Absorption dimension rating	
0	Level 0	Non-existent
1-4	Level 1	Rare
5-7	Level 2	Moderate
8-9	Level 3	Common
10-12	Level 4	Widely used

Academic

As in many countries, access to the Internet by educational institutions varies considerably among regions and types of institutions. The Department of Education presents the statistics in Table 27 that indicate number of schools in India broken down by level and specialty.

Table 27 Numbers of Educational Institutions in India (1998).

Type of Institution	Number of institutions (1997-1998)
Pre-Primary Schools	41,788
Primary Schools	610,763
Middle Schools	185,506
High Schools	76,230
Hr. Secondary Schools	26,491
Inter/Jr./Pre Degree Colleges	4,379
Arts, Science, and Commerce Colleges	7,199
Eng./Tech. Colleges (Degree & above level)	458
Medical Colleges	769
Teacher Training Colleges	848
Polytechnics	1,051
Universities	229

Source: ["Ministry of Education - Elementary," 2001]

Not surprisingly, the leading universities are the best connected of all educational institutions. An unofficial list of 1006 colleges, universities, and institutes in India, most recently updated in 1998, lists 202 institutions with homepages [Mukherjee and Sodani, 1998]. This number undoubtedly increased significantly since. VSNL's page of links to Indian universities, dated 2000, shows 65 of 253 institutions with Web pages ["Indian Universities Link Page," 2000]. Yahoo's listing of Indian colleges and universities contains links to 114 institutions ["Yahoo Listing of India," 2001].

One high profile development of the Internet in the Academic sector was the plan to create a high speed, inter-university data network, called "Sankhya Vahini" [National Task Force on Information Technology & Software Development, 1999b; "National High Speed Inter," 1998]. The Sankhya

Vahini evolved as a Technology Mission of the National Task Force on Information Technology and Software Development. The objective of the project is to establish a high speed data network for the benefit of educational institutions, public and private corporations, service providers, and individuals for learning, training, research, and other multi-media activities [Paswan, 2000]. Under a Memorandum of Understanding dated October 16, 1998 between the DoT and IUNet, a US based educational institute, the High Speed Data Network would operate in the range of 2.5 to 10 Gbps. It would connect over 100 institutions of higher learning and research centers to an international university network established by Carnegie Mellon University. The $150 million program would build a network topology of approximately 16,000 kilometers with 8 to 10 nodes located in major cities and 25 high bandwidth POPs, extendable to 100.

Sankhya Vahini generated a great deal of controversy. Charges included those of personal gain for the principal proponents and threats to national security. In July 2000, the High Court in New Dehli asked for details from the government on the Sakhya Vahini project after a watchdog group filed suit alleging that the project was initiated in the interests of private gain by interested parties without a global tender, and was to be built using old technologies acquired from U.S. universities ["HC Asks Govt to," 2000; "TC May Approach Cabinet," 2000]. In April, 2002, the project was abandoned amidst a good deal of finger-pointing on all sides ["Sankhya Vahini Project Abandoned," 2002].

In October, 2001, the Ministry of Communications and Information Technology announced a plan to link universities, schools, and colleges with 2 Mbps connectivity ["Project to Link Colleges," 2001]. The first phase of the project, Gyan Vahini, would link 257 universities, 800 engineering colleges and 250 medical colleges. A second project, Vidya Vahini, envisaged a 128 kbps link across 60,000 secondary schools in the country. A pilot project involving 140 schools was initiated in October, 2002 ["Dept of IT Goes," 2002].

Private sector entities are also working to improve connectivity for education. Dishnet, Ltd. initiated an "education to home" (ETH) service aimed at making the Internet accessible to everyone. ETH will be free for schools.

In short, while over half of India's universities are connected to the Internet, this is perhaps the only category of educational institutions in which more than 10% of the institutions can access the Internet.

Health Care

The fraction of health care facilities using the Internet in India is "vanishingly small" [Mehta, 1999c]. Yahoo! India contains links to only a handful of medical institutes and no hospitals (http://in.dir.yahoo.com/Regional/Countries/India/Health/). WebIndia.com hosts the MedInfo service, offering "comprehensive information on healthcare in India" ["What is MedInfo," 2001]. While this site lists 21 hospitals and medical centers, all of these links are to pages hosted on WebIndia.com's site, not to sites hosted by the institutions themselves.

While they are not likely to change India's ranking in the health care component of Sectoral Absorption, a number of telemedicine projects were undertaken in India. Doctoranywhere.com is an Indian web site that offers doctors access to specialists. The site provides the ability for doctors to do remote medical consultation and real-time chat with specialists. The service provides 36 hour turn-around on doctors' questions.[10] The Online Telemedicine Research Institute (OTRI) (http://www.onlinetelemedicine.com) is a major driver of telemedicine in India and south-east Asia. Its mission is to mentor rural and remote areas with international telemedicine initiatives. In partnership with organizations such as has the Ministry of Information Technology and the Indian Space Research Organization (ISRO) it developed nearly 50 telemedicine products [OTRI, 2002]. OTRI used the technology to link Udaipur, a tribal area in Tripura, to Rabindranath Tagore Hospital in Kolkata ["Doctors at Large (OTRI," 2002]. The Public Health

[10] In April 2003, the web site http://www.doctoranywhere.com appeared active, but the "New and Updates" portion of the site contained posting from November, 2000 through July, 2001 only.

Centre at Sargur (Karnataka) was also linked with Narayana Hridyalaya in Bangalore using the technology.

Commercial

The commercial sector experienced a great deal of growth in Internet usage since the introduction of commercial ISPs in 1998. The Confederation of Indian Industry (CII) is a trade organization with about 4,000 members promoting the interests of Indian companies (http://www.ciionline.org/). In February 2001, CII published the results of a survey of IT usage by small and medium enterprises (SMEs) from across the country, covering a broad spectrum of industry groups and activities [Confederation of Indian Industries, 2001]. According to this survey, 66% of respondent SMEs have their own website or homepage, while 34% do not have an Internet presence. Among large enterprises, the fraction with an Internet presence is undoubtedly significantly greater.

In the analytic framework used in this study, the key question is whether the fraction of companies with more than 100 employees (medium-sized enterprises) is more or less than 10% of the total. In spite of some methodological uncertainties, the CII survey seems to support the conclusion that in the commercial sector, Internet usage falls within the 10-90% bracket. The CII survey does not indicate the methodology behind the survey, leaving open the question of how well the survey reflects all Indian SMEs. If the survey population consisted of only members of the CII, the results could be biased towards those organizations that are more likely to be involved in industry organizations. It is not inconceivable that there would be some correlation between an organization's involvement in promoting industry interests and its use of the Internet. However, even if the 66% figure is six times higher than a truly random survey might yield, the results are still above the 10% threshold. Moreover, since many of the respondents were likely to be small enterprises with fewer than 100 employees, and since the likelihood of an organization's using the Internet increases with size, the fraction of medium sized enterprises who use the Internet could be higher than 66%.

The figure remains high, even if we discount enterprises using the Internet solely for advertising (Table 28), which may not reflect a serious commitment to Internet usage. The CII survey also examined the purpose of enterprise websites/homepages. The results for the year 2000 are shown in Table 28. This table indicates that 73% of respondents using the Internet (48% of all respondents) do so in a manner than involves either substantial information content (Product catalog) or some manner of data transfer with users.

Table 28 Purpose of Website/Homepage of SMEs.

Purpose of website/homepage	Percentage of respondents
Product catalog	28%
Selling products and services	28%
Advertising	27%
Data collection	7%
Data transfer	6%
Training	3%
Other	1%

Source: [Confederation of Indian Industries, 2001]

Of the corporate web sites, 91% are physically hosted overseas, according to a survey done by the National Association of Software and Service Companies (NASSCOM) [NASSCOM, 2001]. The intent of the Sectoral Absorption dimension of the analytic framework is to identify companies that made a strong commitment to the Internet. Using an overseas host for a web site does not in any way diminish a company's commitment to using the Internet. In fact, it may be an indication of an enhanced commitment. One of the primary reasons for hosting a web site abroad is performance. In the absence of Internet exchanges that permit one ISP to exchange traffic with another, traffic between two ISPs must first travel to Europe or the United States, then back to India. If an individual were to visit a corporate web site hosted in India by an ISP different from the users', both the HTTP request and the web server's response would make round-trip connections through Internet exchanges located outside of the country. If, however, the web server is located in the United States rather than India, for example, the travel distance for packets is cut in half, easing the demand on international bandwidth and improving response time. A second reason, associated with the first, is that is that the bandwidth available in the United States is greater. A third reason is that the cost of establishing and operating a host in the United States is lower than in India ["Indian Websites Losing Country," 2000].

That so many corporate sites are located abroad would help explain why, in surveys such as that conducted by CII, the number of corporations using the Internet seems relatively high, while by some accounts the number of corporate leased lines in India is rather low. According to one report, the number of corporate leased lines for Internet use in India at the end of 2000 was over 1000 ["VSNL 'Unveils' Internet Exchange," 2000]. Corporations may operate 24x7 web sites hosted abroad, but appear to conduct day-to-day access over non-leased line connections, such as ISDN, DSL, or dial-up.

Overall, the estimate that more than 10% of medium-large enterprises use the Internet would seem justified.

Public Sector

Use of the Internet in the public sector is mixed. The New Telecom Policy 1999 called for Internet access to all district headquarters by the year 2000 ["Objectives and Targets of," 1999]. In 1999, all central ministries and departments were instructed to prepare a five-year plan on information technology with a provision of up to three percent of their budget outlay ["Ministries Asked to Prepare," 1999].

By the end of 2002, the e-Goverance picture in India was mixed. According to the NASSCOM Strategic Review 2003, In 2001-2002, the national government spent Rs. 2,500 crore ($520 million) on E-governance initatives, with 2002 spending reflecting an 18% increase over the previous year ["E-Governance to Usher in," 2003]. By the end of 2002, 19 of the 28 Indian states had created e-governance blueprints and begun implementing e-governance projects. The NASSCOM study lists a number of examples of current e-governance initiatives, including:

- Computer aided registration of deeds (Andhra Pradesh)
- Smart cards for drivers' licenses (Gujarat)
- Plan for total e-governance by 2005 (Haryana)
- Computer-based registration and stamp duty, sales tax, transportation, and treasuries (Maharashtra)
- Geographic Information System for transportation, waterways and others (Punjab)

In spite of the existence of successful projects in individual states, overall progress has been slower than originally anticipated. The outlay of three percent of the budget to IT recommended in 1999 was never implemented by the state or federal governments. NASSCOM further identified a number of hurdles slowing e-governance progress ["E-Governance in India Accelerating", 2003]:

- Lack of coherent government policies
- Governments unwilling to commit funding
- Lack of an e-Governance champion at the highest levels
- Focus on hardware procurement with inadequate attention to software and services
- Unclear revenue stream for private sector seeking involvement with e-Governance initiatives

SOPHISTICATION OF USE

To truly understand the Internet capability of a country, it is necessary to understand not only how many people use the services and where, but also how the Internet is employed. Of particular interest is the point at which the service is mature enough to attract interest and use outside the narrow community of technicians. A second major milestone is reached when the user community transitions from simply using the Internet to creating new applications, sometimes even impacting Internet use elsewhere. Based on the data presented below, the Sophistication of Use of leading segments of the Internet user community is at Level 3 (*transforming)*, while the majority of individual users and organizations are at Level 2 (*conventional)* (Table 29).

Table 29 Sophistication of Use of the Internet

Level 0	Non-existent	The Internet is not used, except by a very small fraction of the population that logs into foreign services.
Level 1	Minimal	The small user community struggles to employ the Internet in conventional, mainstream applications.
Level 2	Conventional	The user community changes established practices in response to or in order to accommodate the technology, but few established processes are changed dramatically. The Internet is used as a substitute or straight-forward enhancement for an existing process (e.g. e-mail vs. post). This is the first level at which we can say that the Internet has "taken hold" in a country.
Level 3	Transforming	The use of the Internet by certain segments of users results in new applications, or significant changes in existing processes and practices, although these innovations may not necessarily stretch the boundaries of the technology's capabilities.
Level 4	Innovating	Segments of the user community are discriminating and highly demanding. These segments are regularly applying, or seeking to apply the Internet in innovative ways that push the capabilities of the technology. They play a significant role in driving the state-of-the-art and have a mutually beneficial and synergistic relationship with developers.

Sophistication of Use Among Organizations

A number of surveys tried to assess Indian organizations' use of the Internet. According to one survey of Indian businesses with Internet access, over 90% use it for e-mail, 30-70% use it for downloading information, FTP and Website monitoring, and less than 20% use it for E-commerce ["ISPs' Opportunity," 1999]. According to another survey, 20% of the brick-and-mortar companies[11] are using E-commerce to some extent, while only 16% have the top executives' involved in the process.

[11] The survey results were obtained from 318 chief information officers found in 4,000 top Indian companies, 36 chief executives, and over 2,000 households, representing the higher socio-economic segments of

An assessment of the Sophistication of Use by Indian organizations was undertaken by the authors in February 2001 with a follow-up study during Fall 2002. We examined a random sample of 300 of the 1069 organizations listed on valuenotes.com, India's premier web site dedicated to Indian financial and corporate research. The same organizations were examined in both studies, enabling a measure of longitudinal analysis. For each organization, we examined the organization's web site to estimate the Sophistication of Use, identified as lying within one of five levels defined by our analytic framework. To determine each level, we use the web-site specific guidelines shown in Table 30

Table 30. Sophistication of Use of Corporate Web Sites

Level 0	None	The organization has no Internet connectivity
Level 1	Minimalist	The organization has a web site, but only minimal content and no interactivity.
Level 2	Conventional	The organization uses the web site primarily for information dissemination. Minimal feedback or guestbook functions may be present.
Level 3	Transforming	At this level customers may conduct transactions with the organization via the web site, or may interactively check on the status of a transaction, etc.
Level 4	Innovating	Organizations at Level 4 are pioneering new and distinctive applications, pushing the boundaries of existing Web functions.

The results of the analysis are shown in Figure 15. Since the sample pool consists of Indian companies whose stock is publicly traded, it probably contains a disproportionate number of Internet-savvy organizations. If this is the case, then the data here suggests an upper bound on sophistication of use among Indian Internet-using organizations as a whole.

Of the organizations sampled, nearly one third lacked a web site, or had an invalid URL. This number actually increased somewhat in 2002, due to the fact that a number of companies, such as dot-coms, had gone out of business. The results for the other levels indicate a shift towards web sites of increasing sophistication. The number of web sites that did little more than provide an electronic brochure for their companies declined by nearly two-thirds. The number of firms that provided rich content about the firm and its products and services, but did not support transactions (e.g. buying products), increased by nearly 20%. Such web sites offered extensive product catalogs, detailed contact information, and other information about the company. The number of firms supporting true electronic commerce transactions more than doubled. Among the sample, no Level 4 organizations were found in 2001, but one, UTI Bank (http://www.utibank.com) was found in 2002. While all Level 3 banks provide a set of on-line services, such as balance checking, bill payment, and funds transfer, UTI bank serves as a clearinghouse, providing a central bill-paying center for customers. Here the customer not only pays bills, but receives bills electronically from firms with which he did business. While such functionality is not unique globally, neither is it widespread among banks. It represents innovation not only in technology, but also in inter-organizational banking processes.

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society in 16 cities. Clearly the fractions should not be interpreted as fractions of all Indian companies or households.

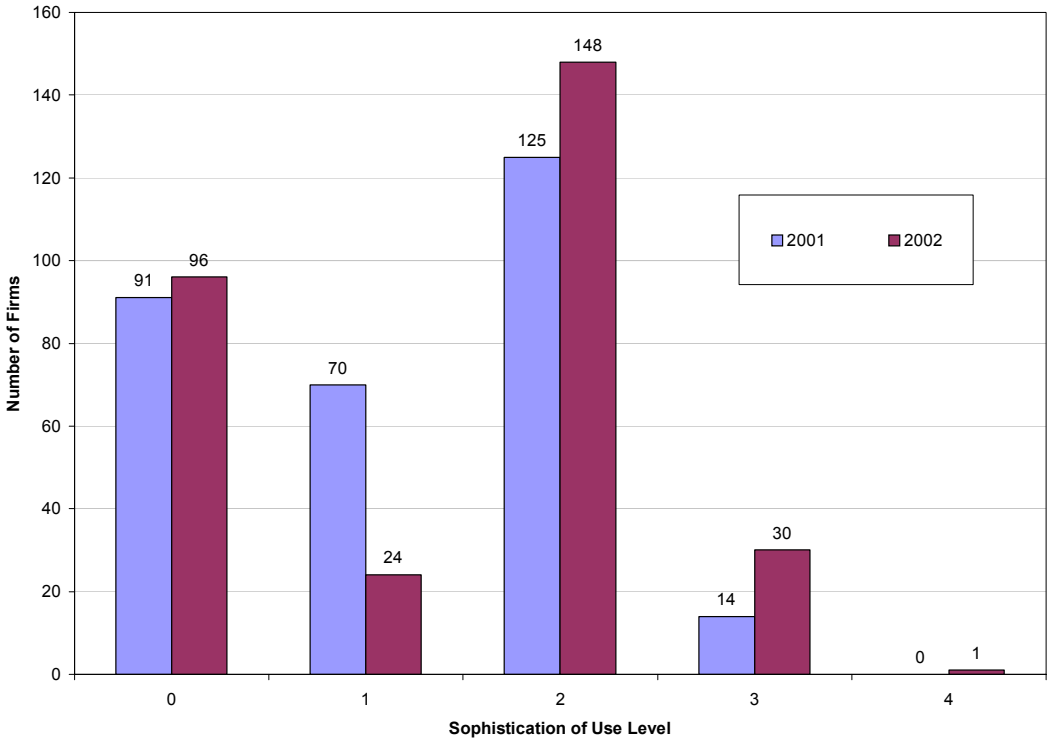


Figure 15. Sophistication of Indian B2C Web Sites

Other examples of innovative Internet activities carried out by Indian organizations were found. For example, in December 2000, Satyam Infoway (Sify) launched a multi-portal "web exchange," in effect a portal into portals. This web exchange provides, among other features, a multiparametric search enabling users to find the right supplies, the right procurement engine, and the right catalog functionality [Pai, 2000k]. BPL Mobile introduced a mobile Internet portal that can accommodate both wireless access protocol (WAP) and short message service (SMS) communications, eliminating the need for customer to upgrade their telephones [Pai, 2000a].

Sophistication of Use Among Individuals

A number of surveys examined Indian on-line user habits. According to web research firm Indiameter.com, the average Indian user spends 58% of his or her time on e-mail, 12% using search engines, 10% using news sources, 7% on entertainment, and 5% on activities such as paying bills ["Feeling the Pulse of," 2001].

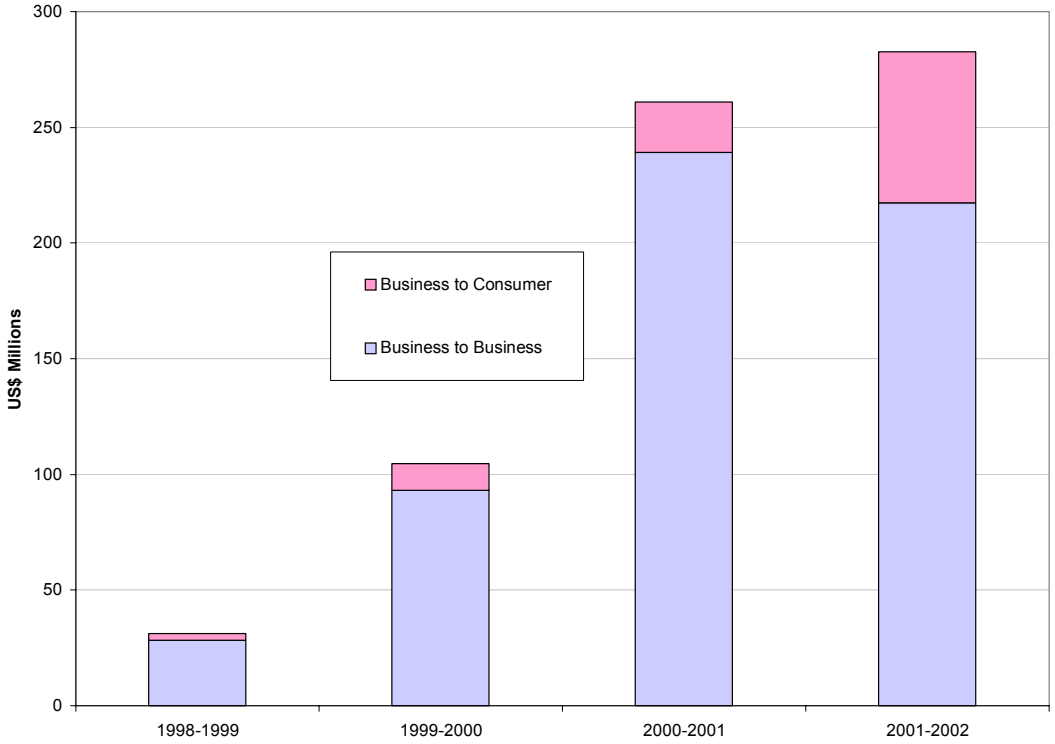
Electronic Commerce

One of the indictors of sophistication of use is the extent to which E-commerce is an accepted and used means of conducting commercial transactions. A substantial E-commerce survey conducted jointly by the Computer Society of India**,** the Madras Consultancy Group, and Scope Marketing & Information Solutions [Computer Society of India et. al., 2002b] provides some insight into the E-commerce environment in India in 2001. Of the 463 companies surveyed, only 13% implemented e-Commerce functionality, although 95% indicated that they were unlikely to do so eventually.

While relatively small in absolute terms, the volume of E-Commerce activity grew quickly in recent years, and expectations are for this growth to continue. The volume of E-Commerce grew by

nearly an order of magnitude between 1998-1999 and 1999-2001 in both business-to-business and business-to-consumer segments [NASSCOM, 2001].

Figure 16 shows these data, with the 2001-2002 figures obtained from [Computer Society of India et. al., 2002a].



Source: [NASSCOM, 2001; Computer Society of India et. al., 2002a]

Figure 16. Growth of B2B and B2C E-Commerce

A study released in May 2001 estimated that by 2005 the volume of Business-to-Business E-Commerce would reach Rs. 252 Billion ($5.3 billion); and the volume of Business-to-Consumer E-Commerce, Rs. 18.8 Billion ($390 million) [Confederation of Indian Industry, 2001]. Other analysts believe Business-to-Consumer volumes could reach over $210 million in 2005 [Computer Society of India et. al., 2002a].

A number of changes are needed for electronic commerce to become widely used in India.

- One of the barriers most commonly mentioned is the lack of bandwidth and connectivity throughout the country [Computer Society of India et. al., 2002a]. This barrier affects both for end users and commercial organizations. As discussed in the section on Connectivity Infrastructure, projects currently underway should increase the bandwidth substantially, eventually.
- Second, greater numbers of Indians must use the Internet. As discussed earlier in the section on "Pervasiveness," the trends here are quite positive.
- Third, a greater fraction of those users must use the Internet to conduct transactions. According to some analysts, fewer than 5% of on-line users ever conducted an E-commerce transaction [Computer Society of India et. al., 2002a]. Part of the explanation for this small penetration is that overall, credit card usage remains low. By some estimates, only 3.5 million credit cards were in use in India in 1998. Some

commentators claim that for E-commerce to become well established in India credit card penetration would need to reach 15 million ["Telematics '99. Global Information," 1999]. "There is no dearth of money among the omnipresent Indian middle class, but what matters is that most of them do not have credit cards" [Thampi and Basu, 1999]. People that do have credit cards are often reluctant to give out such information on-line [Computer Society of India et. al., 2002a].

- Fourth, E-commerce infrastructure related to payment clearing is inadequate [Computer Society of India et. al., 2002b].
- Fifth, changes are needed in Indian laws to clearly support E-commerce transactions. The Information Technology Act, 2000 was a positive step in this direction. Approved on June 9, 2000, the act (described in Section 3) established the legal recognition of electronic documents and digital signatures, and created the legal infrastructure to support the creation and regulation of Certificate Authorities (CA) to issue digital certificates for use in electronic commerce transactions [Ministry of Law Justice and Company Affairs, 2000]. However, this act does not cover Indian contract law and provides insufficient clarity on such matters as the taxation of electronic transactions and the protection of intellectual property rights on the Internet [Computer Society of India et. al., 2002b].

V. PROSPECTS AND CONCLUSIONS

THE STATE OF THE INTERNET IN INDIA

The discussion of the framework dimensions in Section IV is summarized in Figure 17. This figure underscores the extensive growth of the Internet in India, most evident after the government began issuing licenses for private ISPs in 1998. Sophistication of Use, Geographic Dispersion, and Connectivity Infrastructure, all reached a very solid Level 3, with Pervasiveness barely reaching a Level 3 in 2002, and Organizational Infrastructure reaching Level 4 in the same year. As in many countries, Sectoral Absorption is likely to lag behind the other dimensions due to the large number of organizations, many in rural areas, which need to "come on-line" for a country to reach Levels 3 and 4.

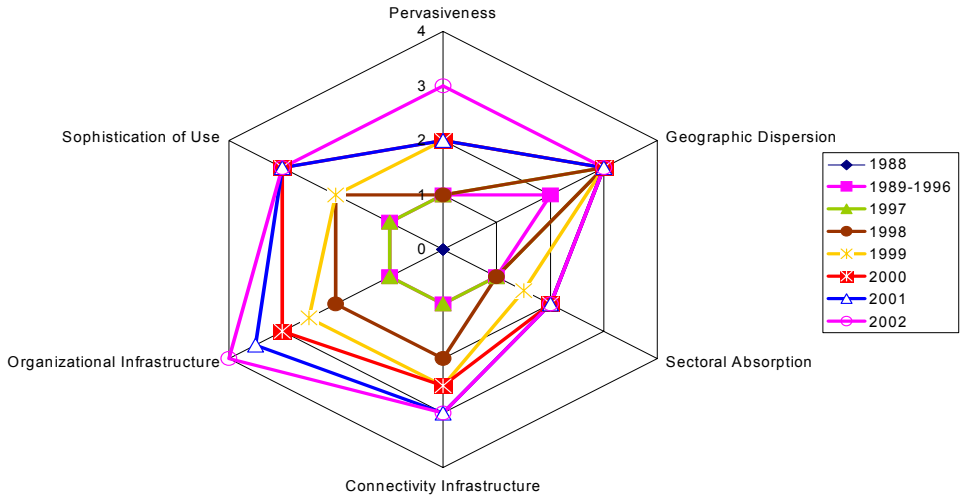


Figure 17. Diffusion of the Internet in India

In April 2000, the Ministry of Information Technology (MIT) released a report assessing the progress made on the 108 recommendation of the IT Action Plan. The report found that 56 were implemented, 27 were not implemented, 22 were on-going, while 3 were not accepted. Of the 11

recommendations dealing with the Internet and IT Planning, seven were implemented, three were not implemented, and one was on-going. These recommendations and what was accomplished are shown in Table 31. Clearly, a great deal of work was done by the DoT and other ministries to comply with the recommendations. The recommendation to establish independent international gateways, listed in Table 31 as "not implemented," was actually implemented after the report was issued. The other major recommendation not implemented, the creation of the National Internet Backbone (NIB), is one of the more difficult to implement, since it deals not with policy issues but with a large-scale roll-out of a high-capacity network. The DoT's failure to implement this recommendation on the original timetable may be attributed to insufficient ability to execute such a large project on the desired timetable, or, more cynically, to foot-dragging on the part of the DoT ["DOT 'Hampers' Spread of," 2000]. An undated BSNL web page, accessed October 3, 2001 indicates that 418 nodes were commissioned in 28 telecommunications circles [BSNL, 2001a] and Phase I of the NIB was finally completed in July 2001 ["BSNL to Complete Phase," 2001]. A major achievement of 2002 was BSNL's offering Internet service into these areas via Sanchar Net, greatly increasing the number of Indian cities served [BSNL, 2003a].

Table 31 Implementation of IT Action Plan recommendations (2000).

Recommendation	**Imple-mented? (2000)**	**Ministry of Information Technology Comments**
1. INTERNET access nodes will be opened by DoT and authorised ISPs at all District Headquarters and local charging areas by 26th January 2000. As an interim measure, and till nodes are provided in all local charging areas, access to nearest INTERNET access nodes will be on local call rates, progressively with effect from 15th August 1998. ISPs will be responsible for ensuring that this facility is not misused for telephone traffic.	No	This recommendation contains two parts. One relates to providing internet access nodes at all District Headquarters by DOT and authorised ISPs and the second relates to nearest internet nodes on local call rates. The second part has been implemented vide order no.64-10/97-NS dt. 14.8.98. As far as part-I is concerned , DOT is planning to establish a National Internet Backbone(NIB) to cover the whole country by 2003 and to facilitate high-speed data transmission. Initially, DOT planned to provide 5 nodes in 5 telecom districts by 30.4.2000 as against 322 telecom districts or 592 District Headquarters.
7. For setting up ISP operations by companies, there shall be no license fee for the first five years and after five years a nominal fee of one rupee will be charged.	Yes	ISP POLICY announced by DOT.
8. The monopoly of the VSNL on International Gateway for INTERNET shall be withdrawn and authorised public/government organisations will be allowed to provide INTERNET Gateway access including international leased circuits directly without going through VSNL Gateways. Private ISPs are allowed to provide such Gateways after obtaining Security clearances for which the Interface of Private ISPs shall only be with DOT, which will set up a mechanism for obtaining security clearance from different security agencies.	No	As per the ISP policy, Private ISPs are permitted for setting up of international gateways for internet. The necessary guidelines for setting up of international gateways for internet by the ISPs were issued. However, authorised Gateways were not permitted to provide international leased circuits. Therefore, this recommendation may be treated as Not Implemented.
9. It should be made free for the Railways, State Electricity Boards and National Power Grid Corporation, to lease the excess/spare capacity for data transmission to DOT or licenses of DOT for the basic as well as value added services or to any other users including	Yes	National Telecom Policy ' 99 permits leasing of excess/spare capacity for data transmission by Railways,State Electricity Boards, National Power Grid Corporation.

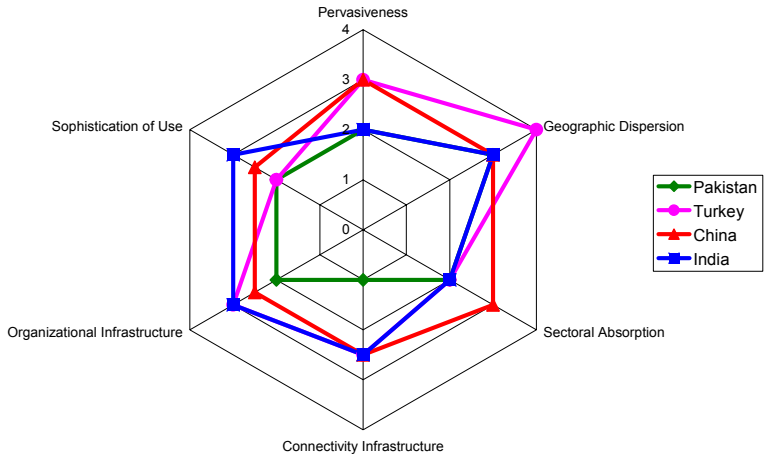
Internet Service Providers in conformity with the license conditions, where applicable		
10. DOT shall allow interconnectivity of the Government Data Networks and Closed User Group(CUG) Networks for data transmission. For other networks, inter-connectivity policy shall be worked out by DOT and the Task Force within one month.	Yes	Inter-connectivity of networks for data transmission was permitted vide order No.212-4/92-PHC (Vol.V) PT. dt.02.9.1999.
11. Providing access to INTERNET through authorised Cable TV shall be permitted to any service provider without additional licensing subject to applicable Cable Laws.	Yes	Necessary provision was made in the new ISP licence agreement.
12. The 'last mile' linkages shall be freely permitted either by fibre optic or radio communication for IT application enterprises, IT promotional organisations and ISPs. In case of radio linkages, coordination by the Wireless Adviser will be observed to avoid frequency interference.	Yes	Order No.220-1/98-PHC (Pt) dated 11th August, 1998 and amendment vide order No.220-1/98-PHC(Pt) dated 4th January, 99 issued.
17. To enhance the pace of PC and INTERNET penetration in remote and far flung areas in the country, the policy should enable the Defence Services to provide connectivity to their communication systems for civilian applications after due examination.	No	Not implemented
59. Computers and Internet shall be made accessible to schools, polytechnics, colleges, and public hospitals in the country by the year 2003.	On-going	Internet access nodes will be provided by DOT in all districts (Secondary Switching Areas) by December-2000 with the implementation of NIB 1 connectivity. With the implementation of NIB 2 by the end of 2003 by DOT, connectivity will be available at block levels. In view of the above , the recommendation may be treated as 'ON-GOING'.
Each Department/Agency in the Central Government and State Governments shall be required to prepare a five year IT plan.	Yes	NIC assisted many state govts/ Departments in this regard.
88. 1-3% of the budget of every Ministry/Department shall be earmarked for applying IT in the Department/sector; this investment will include not only the purchase of IT products, IT Software, but also for training and IT services; Reappropriation of the Department's budget for the IT sub-budget head shall be within the delegated powers of the Head of the Department.	Yes	Planning Commission wrote to all Central Ministries/ Departments and state governments in this regard and is also monitoring it.

Numbers in first column refer to recommendation number
Source: [Ministry of Information Technology, 2000]

COMPARISON WITH OTHER COUNTRIES

Clearly, the Internet has been expanding rapidly in other developing countries as well. How does India's experience compare with theirs? A detailed answer to this question is beyond the scope

of this study, but a comparison of India with three other countries- Pakistan, Turkey, and China- during 2000 highlights some interesting points, shown in Figure 18. Turkey and Pakistan represent two developing countries which, like India, have in recent years undertaken a variety of economic and political measures to promote telecommunications-based services. China is included in this diagram because it is the only country whose population exceeds India's.



Source: [Wolcott and Goodman, 2000; Foster and Goodman, 2000]

Figure 18. The Internet in Pakistan, Turkey, China, and India (2000).

Relative to these other countries, India did as well or better in the Organizational Connectivity component, measured by the presence of regulatory and market mechanisms to support a robust Internet services market. At the same time, India developed a vibrant community of entrepreneurs who are actively engaged in creating new Internet companies, products, and services. While the other countries are not without such qualities, India exceeds the others in its sophistication of Internet usage. Where India lags behind the others (except Pakistan), is in the dimensions that reflect the extent of use of the Internet. While the argument might be made that it is easier for a country like Turkey with only 6% of India's population to achieve higher levels of Pervasiveness and Sectoral Absorption, the same cannot be said for China. China is considerably more successful in enabling its citizens to access at least its domestic Internet. While there are a number of reasons for India's lag relative to China's, one of the dominant factors is certainly China's ability to roll out extensive high-capacity nation-wide backbones and telecommunications infrastructure [Foster and Goodman, 2000]. Though making progress, India suffers from an under-developed telecommunications infrastructure and a government bureaucracy that does not have nearly the same "ability to execute" as China's.

DISTINCTIVE FEATURES OF THE INTERNET IN INDIA

Though India's experience with the Internet and the telecommunications sector shares many similarities with the experiences of other countries, its unique history, size, and demographics give it distinctive qualities which offer insights into Internet diffusion.

First, government policy makes an enormous difference in Cyberspace. In spite of those who claim that the Internet transcends national boundaries, the Indian experience provides an

excellent illustration of how fundamental, focused changes in policy and legislation can unleash forces that can accelerate Internet diffusion.

Second, the nature of the relationship between the government, the state-owned telecommunications service provider(s), and the private sector is a critical variable. While many variations on this three-way relationship exist, India offers an example of one in which the relationships have a tension that ultimately helped the Internet grow. To begin with, the government is not overly protective of its national service providers, VSNL in particular. While VSNL was granted monopoly rights over many aspects of communications vital to the provision of Internet services, these rights were peeled away over time. The result has not been the devastation of VSNL, such as might have occurred had all of its rights been taken away. Rather, VSNL remained sufficiently healthy financially that it was able to launch vigorous responses to the competitive threat of new ISPs. VSNL aggressively pursued the acquisition of bandwidth, competitively lowered prices, and established quality Internet services such that it is the ISP of choice for a large percentage of users. A major motivation for such efforts was the desire to keep VSNL attractive to investors who will have to acquire a 25% strategic ownership in the company as part of India's privatization efforts ["VSNL Divestment by Dec," 2001]. The divestment process was lengthy and arduous, reflecting sometimes conflicting desires to get a good price for a stake in the company, while at the same time opening up the telecommunications and Internet sectors to greater competition ["VSNL Divestment by Dec," 2001; "India; 'Cut Overseas Call," 2001; Adhikari, 2001; "Divestment of 25 PC," 2001; "Decision to Break VSNL," 2001; Luce, 2001; "VSNL Sell-Off to," 2001; "Govt. Inconsistency May Impact," 2001; "Govt Approves VSNL Divestment," 2001; "Videsh Sanchar Nigam: A," 2001]. The end of this process occurred in February, 2002, when the Tata Group acquired a 25% share in VSNL ["VSNL Enters Tata Family," 2002]. Where VSNL's monopoly powers proved to be a hindrance to the expansion of the Internet, however, policy makers enabled ISPs to acquire needed services from alternative providers.

Third, Indian policymakers try to strike a balance between the interests of the society and the interests of the individual, formulating a set of policies that will promote both simultaneously. While nearly the entire communications sector was opened up to competition, the dedication to achieving universal service remains a prominent part of policies, reflected in the establishment of a National Internet Backbone and BSNL's Sanchar Net Internet service, and efforts to provide connectivity to state-run schools. While the government encourages individual companies to find their own economic niches, there are boundaries of propriety and national security that, at least on paper, may not be crossed. Among these boundaries are the inappropriate treatment or presentation of national culture, women, or national sovereignty. Pending legislation gives the government broad, though not unlimited, powers to take corrective action. At the same time, legislation protecting the privacy of individuals is underdeveloped.

> *The urgency for [a Right to Privacy statute] is augmented by the absence of any existing regulation which monitors the handling of customer information databases, or safeguards the Right to Privacy of individuals who have disclosed personal information under specific customer contracts viz. contracts of insurance, credit card companies or the like. The need for a globally compatible Indian privacy law cannot be understated, given that trans-national businesses in the services sector, who find it strategically advantageous to position their establishments in India and across Asia* [Awasthi, 2002].

The measures to protect national security weave a thread through Government policies and legislation. Internal security is an important issue for the Indian government, which needs to manage hundreds of fractious ethnic groups, a sizable number of which turned to violence within in the past decade to attain their goals. If it is true that “[t]he most serious threats to the states of South Asia are internal conflict and the potential for state disintegration” [Thomas, 1996], the potential uses of the Internet by the government’s adversaries needs to be considered.

Internationally, ongoing political and military conflicts are a constant reminder of the precarious regional balance. India and Pakistan fought over Kashmir, a predominately Muslim Indian State, since they were granted independence in 1947. Though the majority of the Indian-Pakistani conflicts were on a small scale, the situation was exacerbated by the detonation of nuclear devices by both countries in 1998. In addition, India never officially acknowledged the People's Republic of China's right to the territory the latter still occupies east of Karakoram (China's "Aksai Chin" province) and in the Mishmi Hills of eastern Assam.

To date, the Internet has not played a great role in India's struggles with opposition forces. The use of the Internet as a tool in the Indian-Pakistani conflict involved the defacement of web-sites, efforts by the Indian government to block domestic access to The Dawn, the leading Pakistani newspaper [Sreenivasan and Ganapati, 1999], and denial of service attacks ["Pak Claims Indian Hackers," 2002; Rambabu, 2002]. Perhaps the greater impact on the Indian government comes from more legitimate uses. In 2001, a major arms trade corruption scandal was unearthed by journalists working for the Internet publication Tehelka, meaning "sensation" in Hindi (www.tehelka.com) ["More Scandal From Indian," 2001]. The details of the case were widely disseminated via the Internet and, ultimately, brought down several high-ranking government officials.

PROSPECTS FOR CHANGE

What can we expect to see of the Internet in India in the coming years? Many positive steps have been taken both by the public and private sectors. These measures, as they affect some determinants of Internet diffusion of the GDI model, are shown in Table 32. Also shown in this table are some elements that may restrict the growth of the Internet by negatively impacting one determinant or another. These hindrances suggest issues that, if addressed through policy or other mechanisms, may spur the growth of the Internet in years to come.

Table 32. Government Policy and the Determinants of Internet Diffusion

Determinant	***Measures Taken by Government promoting Internet***	***Measures taken by private sector***	***Elements inhibiting Internet growth***
Access	Opening of Internet service to private companies; expansion of telecom infrastructure; National Internet Backbone; public Internet kiosks; efforts to bring computing into schools	Offering of Internet services in growing number of cities; cybercafes; numerous national and international cable laying projects.	Dial-up and leased-line infrastructure limited in extent and quality; national security concerns hindered or slowed ISP efforts to provide access in some parts of the country or establish international gateways
Perceived Value	Measures promoting the IT sector; Gov't mandates on IT spending and planning within State governments; legalization of Internet telephony.	Intensive promotion of Internet & E-Commerce; Creation of desirable content for domestic & non-resident Indians	Restrictions on content; questions regarding security and privacy; limited use of credit cards and other prerequisites for E-Commerce
Ease of Use of the Internet	Support of non-English Internet initiatives.	Multilingual web products	Offerings relatively limited
Cost of Internet Access	Reduction of leased line tariffs; Internet access at local call rates; reduction of tariffs on technology-related imports	Price reductions fueled by competition and reductions in cost of basic services	Relatively high tariffs on leased-line and dial-up communications; low per capita GDP makes Internet unaffordable to many; metered tariffs on local telephone calls increase access costs substantially.

Determinant	*Measures Taken by Government promoting Internet*	*Measures taken by private sector*	*Elements inhibiting Internet growth*
Adequacy and Fluidity of Resources	IT education initiatives; investment in telecom infrastructure, Internet infrastructure. Liberalizing of investment policies in IT sector; software technology parks	NRI investment; domestic investment in ISP expansion; infrastructure investment; software industry providing skilled human resources; companies traded on international stock markets	Conditions for foreign direct investment worse than in other countries competing for foreign capital; downward trend in FDI. Human resources inadequate to support desired growth in IT sector. The bursting of the dot-com bubble has dried up venture capital, but increased the availability of skilled workers.
Regulatory and Legal Framework	NTP 1994, NTP 1999, TRAI Act, New Internet Policy, IT Bill 2000.;Communications Convergence Bill; Opening of international cables & gateways to private sector; granting right-of-way on public land	Intensive lobbying by private sector and industry groups; private sector involvement on national policy-making committees	Lack of adequate safeguards for privacy of personal data; incomplete legislation regarding electronic transactions, copyrights.
Ability to Execute	VSNL responds aggressively to competition & need to remain attractive to potential investors.	Aggressive and focused leadership of many ISPs; NRIs bring experience gained abroad.	Long and bureaucratic processes delay projects, such as NIB; limited efforts for intra-country Internet exchanges
Geography	NIB has nodes in each district	ISP expansion in major Indian cities	Most ISP activity limited to most populous urban areas; limited telecommunications infrastructure
Demand for Capacity	State and national IT programs	Vigorous expansion of customer base.	Hosting of web sites abroad relieves some pressure on bandwidth
Culture of Entrepreneurship	Encouragement of private sector in provision of basic & value-added communications services	Encouragement of private initiative and start-up formation	Foot-dragging by bureaucrats opposed to or threatened by private sector activities.
Forces for Change	Strong support for IT-promoting policies at highest levels of government	Intensive competition & flamboyant industry champions	Bureaucrats & actual and perceived corruption
Enablers of Change	Indian Institutes of Technology; emphasis on English within official circles	Promotion of culture valuing high technology and change	Extensive poverty and inadequate physical infrastructure

What are the prospects for India reaching the highest level, Level 4, in each of the six dimensions of Internet diffusion? India already reached Level 4 in the *Organizational Infrastructure* aspect of Internet diffusion. What remains is for the private sector to grow into the market niches opened by recent or pending changes in policy. If current levels of investment in domestic and international capacity continue, India may reach a Level 4 in *Connectivity Infrastructure* within a year or two.

For India to reach a Level 4 in *Pervasiveness*, however, its user community would have to grow by an order of magnitude, to 100 million users. In the foreseeable future, *Geographic Dispersion* is likely to stall at Level 3. Making the Internet widely available within rural areas will only come about when a much more pervasive telecommunications infrastructure is built, and the economic and educational well-being of hundreds of millions of Indians improves. The great unevenness in connectivity throughout India may present one area in which India, with the right encouragement, focus, and support, could develop innovative solutions. Enabling large numbers of individuals without telephone lines or money to access the Internet could be one area in which Level 4 (*innovative)* work in the *Sophistication of Use* might emerge. One route to Level 4 in *Sectoral Absorption* would be to follow through on expressed desires to bring the Internet to nearly every school and government organization. While the magnitude of these efforts is such that we are unlikely to see them accomplished in the timeframe promised by policy-makers, it is possible.

In conclusion, is the Indian elephant learning to dance? While it may not be able to pirouette, it did learn a step or two. The basic elements for continued dynamic growth of the Internet are largely in place. The Internet in India simply needs time to expand.

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LIST OF ACRONYMS

B2C	Business to Consumer electronic commerce
BJP	Bharatiya Janata Party
BSNL	Bharat Sanchar Nigam Ltd.
CDAC	Center for Development of Advanced Computing
CII	Confederation of Indian Industries
DoE	Department of Electronics
DoT	Department of Telecommunications
DWDM	Dense Wave Division Multiplexing
EDI	Electronic Data Interchange
EISPA	E-mail and Internet Service Providers Association. Now known as ISPAI.
ERNET	Education and Research Network
ETH	Education to Home
FLAG	Fiber Link Around the Globe
FTP	File Transfer Protocol
GDP	Gross Domestic Product
GEMS	Gateway Electronic Mail Service
GIAS	Gateway Internet Access Service
GNFC	Gujarat Narmada Valley Fertilisers Company Limited
GPSS	Global Packet-Switched Service
ICCF	Internet Central Control Facility
IDC	International Data Corporation
IIS	Indian Institute of Science
IIT	Indian Institute of Technology
IITM	Indian Institute of Technology Madras
INTERNIC	Internet Network Information Center
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet service provider
ISPAI	Internet Service Providers Association of India
ISRO	the Indian Space Research Organization
IT	Information technology
ITU	International Telecommunications Union
IUCAA	Inter-University Centre for Astronomy and Astrophysics
LAN	Local Area Network
MIT	Ministry of Information Technology
MTNL	Mahanagar Telephone Nigam Ltd.
NASSCOM	National Association of Software and Service Companies
NCST	National Centre for Software Technology

NIB	National Internet Backbone
NIC	National Informatics Centre
NICNET	National Informatics Center Network
NIP	New Industrial Policy
NRI	Non-Resident Indian
NTP 1999	New Telecom Policy 1999
OTRI	Online Telemedicine Research Institute
PCO	Public Call Office
POP	Point of Presence
PSTN	Public Switched Telephone Network
PTIC	Public TeleInfo Centres
SAFE	South Africa Far East cable system
SEA-ME-WE	Southeast Asia Middle East Western Europe cable system
SDH	Synchronous Digital Hierarchy
SGI	Silicon Graphics, Inc.
SITA	Société International de Télécommunications Aéronautique
SMS	Short Message Service
STM	Synchronous Transport Module
STPI	Software Technology Parks of India
TCP/IP	Transmission Control Protocol/Internet Protocol
TLD	Top-Level Domain
TRAI	Telecommunications Regulatory Authority of India
VECC	Variable Energy Cyclotron Center
VSAT	Very Small Aperture Terminal
VSNL	Videsh Sanchar Nigam Limited
VSSL	VSNL Seamless Services Ltd.
WAP	Wireless Access Protocol
WTO	World Trade Organization

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