



**READINESS FOR THE NETWORKED WORLD:  
A QUIET INFORMATION REVOLUTION IN TAMIL NADU**

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## EXECUTIVE SUMMARY

**Information technology (IT) offers great opportunities for economic and social development in Tamil Nadu; but in order to realize the full promise of these powerful new technologies, the government must leverage its initial successes in business environment and education while broadening the scope of IT benefits throughout society.** The numerous government-sponsored projects in process must be seen to fruition, and built upon with additional imaginative and integrated policies that cut across government, commerce, education, health and society at large. Business, academia and government all play essential roles in the state's success, but only by setting common goals and working together (in Internet Time, no less) will Tamil Nadu achieve the sort of growth of which it is capable.

**Current conditions are adequate for some activities but lack the necessary elements for others, but there are numerous initiatives designed to surmount those shortcomings.** Ranging from the partnership between ELCOT,<sup>1</sup> WorldTel and Reliance to create a statewide Internet backbone, to ELCOT and TIDCO's cooperation in creating the newly-opened TIDEL Park structure, infrastructure needs are in various stages of fulfillment. School children's access to computers has begun at over a thousand government higher secondary schools, which has allowed wide-scale computer science and computer literacy instruction to begin. The IT industry in Tamil Nadu is booming and reaching well outside Chennai, and the standardized Tamil character set is encouraging the appearance of local content. The Center has passed a cyber law enabling e-commerce to gain steam. Positive signs abound.

**There remains a long way to travel, however, in the journey towards a society that is ready for the Networked World.** The optical fiber WorldTel et al is laying needs to reach all around the state, connecting lucrative urban areas as well as the traditionally less appealing rural ones. Educational efforts using IT have been hampered by limited teacher training and poor machine to student ratio, and are a long way from effectively integrating information technology into regular coursework. IT success and its rewards are mostly limited to the largest urban areas, the educated and English speakers. Those in rural areas are largely not getting benefits from the IT revolution due to language barriers, lack of locally appropriate content and devices, and high cost of network access. Most local IT solution providers focus almost exclusively on export markets -- helping more to advance foreign economies than the Indian one, and are falling too low on the value chain overseas. The slow and lacking reform of DTS and VSNL significantly impedes network development and functioning. Planning and successful implementation are separated by strategy, effort, expense -- even luck -- and Tamil Nadu needs to continue pushing forward to achieve success.

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<sup>1</sup> All abbreviations are explained in the glossary.

**Comprehensive and holistic approaches to IT are essential to leveraging the value of IT because the types and goals of initiatives that support IT are interactive and self-reinforcing.** A cutting edge IT industry necessitates technology utilization not only within the IT community, but also throughout the larger society as appropriate. Extended use of IT through more of the social strata will produce a larger IT labor pool, greater local demand for IT products and services, more effective and locally appropriate uses of technology, and could ultimately help raise the standard of living for everyone. By thinking across sectors, considering the feedback loops that often characterize technology and merging public and private initiatives in imaginative ways, Tamil Nadu can create an environment for rapid IT development with lasting benefit not only for the select few, but for the society as a whole.

The **overarching guidelines** that should guide Tamil Nadu in its quest to benefit from new access and applications of information and communications technology are as follows:

- **Use IT as a tool:** All IT initiatives should be designed to support government's larger strategies and goals for economic and social development. Measures of success should be based upon outcomes and not outputs (i.e. not just a higher student-computer ratio, but a better education).
- **Think even bigger:** The government should make existing projects more innovative and aggressive, while creating effective new approaches to remaining challenges -- and leading to ubiquitous and effective access.
- **Work together:** Government, academia and business must all be mobilized to establish common goals for IT and work together to achieve them. Working alone, no one sector can marshal the amount and range of resources necessary to affect significant and lasting change.

Based on the Readiness Assessment and considering the aforementioned principles, there are certain areas where it has become clear that government should concentrate its efforts. These activities must be approached in an integrated and strategic fashion such that the government may take advantage of the synergies they create, while protecting its initiatives from political problems that might derail the implementation of effective policy. Government has already shown significant insight and dynamism in many of these areas, but has had varied success with implementation.

1. **Continue to build out telecommunications,** physical and business infrastructures. Infrastructure is necessary, although not sufficient to ensuring an IT growth in Tamil Nadu.
2. **Push for further telecoms reform** and more competition. Healthy competition is the key to affordable, appropriate, and accessible ICTs.

3. **Improve governance with IT:** Electronic governance empowers people with new tools to access government. By fostering improved transparency, service and information flow via use of IT, the government can set a powerful example of appropriate use of technology, while also attracting investment to the state.
4. **Focus on all levels of education:** Increase focus on primary and secondary education, and keep teaching English.
5. **Get more from higher education.** Greater interaction between academia and industry will promote better prepared students and context appropriate research.
6. **Prepare people (and organizations) to compete** in the local and global marketplaces. IT is becoming evermore important in and of itself and as a tool in many professions.
7. **Build a statewide database** of information relating to pervasiveness and maturity of technology use across sectors and society to inform decisions of business leaders and policymakers.
8. **Support the creation of locally appropriate content and interfaces.** Ease of use and utility are essential to making ICTs valuable and will also promote a local market for IT products and services. Rural and poor areas must not be left behind.
9. **Grow the domestic IT market** and IT firms. The IT industry needs to serve the domestic market, people and organizations need to understand how they can benefit from IT, and government needs to help expand that market and encourage entry.
10. **Market IT and success.** Share Tamil Nadu's success to date more widely and establish a vision for the future.

By most accounts, we are only now just beginning to capture the plethora of opportunities that information and communications technologies promise.<sup>2</sup> As we move forward, the only certainty we have is that these technologies will play a substantial role in the lives of much of the world's population -- in regions both rich and poor, urban and rural. Tamil Nadu is well poised to collect on that promise, and in so doing raise the living standard of its people to new heights. In order to achieve genuine and equitable success, however, Tamil Nadu must make a concerted strategic effort involving the diverse sectors and actors that comprise its society. It is that cooperation between business, government, academia, non-governmental organizations and society at large, which will allow the state to harvest its most valuable resource: its people.

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<sup>2</sup> Untangling e-economics, The Economist, Sep 21st 2000 at <http://www.economist.com/surveys/showsurvey.cfm?issue=20000923>

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## GOAL OF THIS PAPER

This assessment of Tamil Nadu's Readiness for the Networked World and the accompanying recommendations examine how Tamil Nadu can better exploit the benefits of the new economy for social development of all citizens, and foster the growth of current IT economies while developing new ones. The intention is to construct an image of Tamil Nadu's Readiness, for the purpose of identifying the challenges it faces and the opportunities upon which it can capitalize with respect to using information and communication technologies as a source of economic competitiveness. It is intended to set the stage for a cooperative approach to Tamil Nadu's future as it interacts broadly with IT.

Field research was conducted in January and February 2000, and included interviews with over 100 people in government, business, academia and non-governmental organizations. It is based on the Center for International Development's recent publication *Readiness for the Networked World: A Guide for Developing Countries*,<sup>3</sup> and covers 19 major readiness indicators in five broad areas. The document does not pretend to present a full picture of the situation, but rather to illustrate with both hard data and anecdotal evidence. Since the document was completed in July 2000, there have been numerous unforeseen changes and other developments that it was not feasible to include within the text of this document without a second round of research and major revisions. We tender our apologies for the inaccuracies present in the document.

The paper begins with briefly considering each of the major readiness indicators as suggested by the *Guide*, followed by discussing the overarching policy guidelines, and finally examining recommendations for specific government action.

We would like to offer sincere thanks to the many people who agreed to be interviewed, read earlier versions, and otherwise offered their irreplaceable contributions to the research and writing process.

## BACKGROUND ON TAMIL NADU<sup>4</sup>

The state of Tamil Nadu lies at the southern tip of India, occupying over 130,000 square kilometers, and bordering Kerala, Karnataka, Andhra Pradesh, and the Bay of Bengal and Indian Ocean. Its population is well over 60 million people, with about two-thirds of them resident in rural areas, and has about 18,000 official villages distributed in 29 administrative districts. The capital city of Chennai (formerly known as Madras) is the fourth largest in India, and Coimbatore and Madurai also find themselves within the top 20 largest cities in the nation. With an average density of almost 500 people per square km, the state is much more densely populated than the national average of about 300.

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<sup>3</sup> Published by the Center for International Development at Harvard University in 2000. Available online at [www.readinessguide.org](http://www.readinessguide.org).

<sup>4</sup> Figures and maps were adapted from [www.mapsofindia.com](http://www.mapsofindia.com) and [www.elcot.com](http://www.elcot.com), and largely based on 1991 census data.

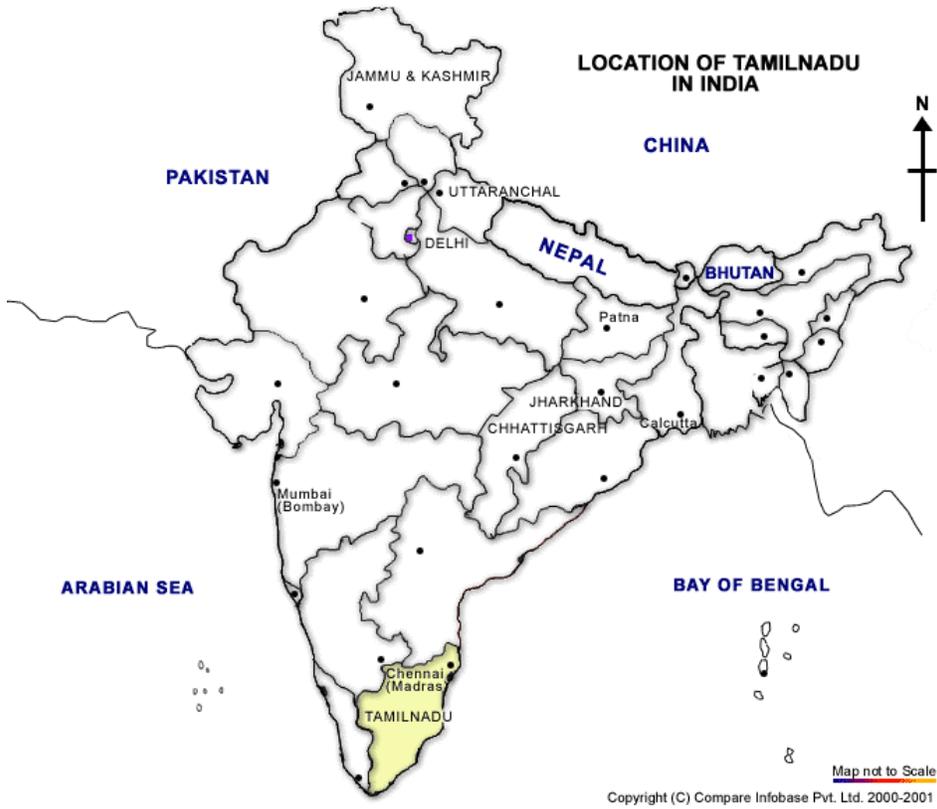
At around 60%, Tamil Nadu's literacy rate is among the highest in India and exhibits a moderate gap between men and women. Tamil is the principal language spoken, but other languages such as Malayalam, Telugu, Hindi and English (the latter by students, those who work in tourism and the more educated sectors) are also spoken. There are long and strong traditions involving arts, music, literature, film, culture and food.

Traditionally Tamil Nadu is one of the most industrialized states of India, representing about 11% of India's GDP and about 15% of its exports. At present, the State Domestic Product (SDP) is about US\$ 25 billion and current exports are around US\$ 4 billion. While the services sector earns the most income (about 48% of SDP), more people are probably dependent on the agriculture component of the economy (about 24% of SDP). Industrial production (29% of SDP) is largely focused around Chennai and includes cotton, sugar, leather, textiles, engineering, petrochemicals, and the manufacture of vehicles, railway rolling stock, and precision tools.

Compared to the rest of India, the state is relatively well off in terms of energy, transportation, and educational infrastructure. Tamil Nadu counts on better and more power than most states, and a generally better transportation network, including highways, rail, airports and seaports. That is not to say that it fares well compared to the developed world or even most of the developing world, however. With 19 universities, almost 150 colleges and numerous polytechnics and industrial training institutes, Tamil Nadu is very well endowed in terms of higher education.

The government of Tamil Nadu is known as being relatively more effective than most other Indian state governments. It has taken proactive steps by designing its own policies for industry and information technology, for instance. It has actively encouraged new investment and largely welcomed outside collaborators. As always, there remains room for improvement.

The combination of these factors has pushed Tamil Nadu to the fore in the race for IT Indian IT leadership. Although less known, this component of the state's economy is comparable to its much better-publicized neighbors (Bangalore in Karnataka and Hyderabad in Andhra Pradesh). This document will examine many of the factors involved in its Readiness for the Networked world, which in turn affect Tamil Nadu's economic competitiveness in the Information Age.



• Source: [www.mapsofindia.com](http://www.mapsofindia.com)

## A SNAPSHOT OF TAMIL NADU: PREPARING FOR THE NETWORKED WORLD

### **NETWORK ACCESS**

Quality network infrastructure is the most apparent physical bottleneck facing Tamil Nadu (and India) today. While there has been significant progress in recent years, there remain significant challenges to implementation of policies that will lead to improved infrastructure and services. The progress thus far can be largely attributed to greater competition in the telecoms sector, due to government liberalization and increasing market for services. The telecoms sector reforms, however, have not been nearly as complete or as aggressive as they need to be in order to create the capacity to deliver the world class network essential for continued growth.

At present, infrastructure quality and consistency remain low, penetration is concentrated in urban areas, installation and repair times are varied, and access costs are high. Between these issues and the still-nascent concept of customer service, organizations that rely on the Internet must provide their own expensive backup systems (satellite) or be prepared to face the consequences.

Tamil Nadu is at the forefront of infrastructure development in India, however, thanks to its partnership with WorldTel and Reliance to lay a (mainly) optical fiber backbone throughout the state. Its goal is to have all district headquarters and most major cities (including Taluk, Block and other administrative headquarters) wired by the end of 2000. It remains to be seen whether this goal is feasible, but the strength of the partners suggests that it is.

The government (largely in the form of the ELCOT -- Electronics Corporation of Tamil Nadu) has taken steps at creating centers for IT-related businesses such as ELNET, the recently inaugurated TIDEL Park, and the Cyber Corridor in Chennai. While in other cities around the state, incubators associated with private business, Software Technology Parks of India (STPI), and universities have begun to sprout up.

One of the significant differences between Tamil Nadu and its South Indian neighbors is its relative decentralization, both in terms of IT and commerce in general. The state must take care to encourage this phenomenon and avoid neglecting regional infrastructure in its quest to further develop Chennai.

### ***Infrastructure***

Department of Telecom Services (DTS) runs Chennai Telephones and Tamil Nadu Telephones. VSNL provides international telephone service, including all non-satellite access to the international Internet gateway. There are stark contrasts between urban and rural areas, but the network in Tamil Nadu is better than much of India. Approximately 75% of all villages have at least a Public Call Office (PCO), although many do not count on national long distance service (STD). As would be expected, teledensity in cities is much higher than the rest of the country (about 20,000 PCOs and an average of 15 phones

per 100 people in Chennai). Chennai Telephones also reports the highest earning per line in India. The total number of telephone connections outside Chennai is over 2.1 million, with another approximately 18,000 connections in rural villages (about one connection per village).

The network, however, is built for voice and not data traffic. There are bottlenecks at every stage (local access, national backbone, international gateway), each of which must be resolved in order to allow adequate Internet access.

As the rest of the country, Tamil Nadu lacks fiber backbone and good access to the international gateway. The network itself is hybrid, using a mix of copper twisted pair, fiber, microwave transmission, and coaxial cable. It does have a VSNL node in Chennai, and DTS nodes in Coimbatore, Madurai and Trichy. CorDECT and wireless in local loop have been introduced in a limited fashion, and while other new technologies are under consideration, DTS would be well served to examine them further. All exchanges and trunks are digital, over half being CDOT.

There are a variety of initiatives aimed at creating a fiber backbone for the state. WorldTel, Reliance Industries and ELCOT have joined forces and are currently laying fiber around the entire state. DTS says that it is building a fiber backbone that will connect Chennai to three other metropolitan areas and nodes at the district level, and should be done this summer. RITES is supposedly laying fiber between Mumbai and Chennai in a joint venture with BPL. PowerGrid already has a substantial fiber network for its own use, and has plans to expand their capacity and offer service to the public. The government should receive 2 Mbps from Chennai to all district headquarters in exchange for rights of way on public property. Because these are pure IP networks and connectionless, the reflected bandwidth is a tremendous 60 Mbps (for 30 District HQ).

Some Internet providers (notably Sigma, Dishnet, Satyam Infoway) have been given clearance for a satellite uplink to the international backbone from Chennai, while STPI has one from Coimbatore, but this has not solved the bottleneck at the international gateway. Undersea fiber optic links are still reserved only for VSNL. Satellites are not preferred because they are expensive and better for one-way traffic (because of the latency period that occurs with geo-synchronous orbits), and are basically intended for back up only (except by STPI). Prices will remain high and service quality will remain low until access to the international gateway is improved by opening the undersea cables to private providers.

With approximately twice as many cable connects as phone lines (and to houses, rather than business), there is increasing interest in Internet access through coaxial cable. It seems to be gathering steam, with projects underway in Bangalore and Delhi, but will take significant time due the varied quality of the networks, their one way nature, and the high cost of cable modems.

Chennai Telephones is slated to begin offering mobile wireless service in September, and RPG (over 25k subscribers and about 50% of the market), Skycell and BPL (not in Chennai, though) already do. In all, over 50 cities covering virtually every district in Tamil Nadu enjoy mobile wireless service. WAP enabled phones are not yet available.

### ***Internet Availability***

Dial-up or other connections to the Internet are available in the largest cities in Tamil Nadu. Some non-urban areas currently require a long distance call, but the 176 exchange is only for Internet access, which means all calls -- regardless of location -- can theoretically be billed at local rates. Telecenters reportedly sprouted up in rural areas 2-3 days after the service was initiated and access calls became local.

ISPs are becoming more widely available, but that will probably depend on the backbone rollout. VSNL still dominates, although private sector challengers are proving competitive despite their higher costs.<sup>5</sup> There are numerous packages available from operators in the region including VSNL, DTS (in Madurai), Dishnet, Satyam Infoway, STPI and Global.

Since about seventy-five percent telephones in India are owned by business, and PC density is about three per thousand, a US-type model of Internet usage cannot be expected. Some mixture or access through the workplace or school, cyber cafes, and lesser access at home (possibly through set top boxes, not PCs) is most likely in the near term. In areas where there is tourism, there tend to be cyber cafes offering a variety of services ranging from access to the Web, to computer training, to IT services for local business.

Only the government offers leased lines, but the new lines laid by WorldTel and others in the coming year promise to make the market and basket of available services much more competitive. Currently cities have leased lines and ISDN ranging between 64Kbps (400-500 in Chennai, 2 in Madurai with others interested) up to 2Mbps (100-150 in Chennai, available soon in Madurai). Wireless solutions such as VSAT and radio are also available.

In Madurai, DTS has been experimenting with direct Internet access that does not require an ISP. By calling the DTS dial-up number, the caller is simply billed for any time spent on the Internet at a rate about 50% higher than a local phone call. The service ends up being about the same price as other ISPs, but does not require registration or an initial lump sum payment. The pilot has been a success, except for the fact that the phone number is constantly busy, and should be expanded to Chennai by summer 2000.

The vast majority of all Indian websites are hosted in the United States where there are more service options, prices are better, access is faster, and service is more reliable. This will likely remain the case at least until the national infrastructure has significantly more

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<sup>5</sup> ISPs and others noted that deep pockets and patience were the most important resources in competing with VSNL.

bandwidth, and possibly until VSNL is privatized or competitors gain access to international fiber gateways.

### ***Internet Affordability***

Effective dial-up Internet access rates have dropped significantly but Internet remains unaffordable for most Indians. The ISPs do not seem to be the primary cost barrier, rather the metered calling (which really adds up considering the slow data transfer rates), and the price of a personal computer. Although PCs are dropping in price<sup>6</sup> and lower cost alternatives like set top boxes are coming onto the market,<sup>7</sup> the US model for home Internet use (i.e. one computer and one connection per home) is unlikely to ever be very common in India.

Most Indians who access Internet will likely continue to do so in the workplace, through school, or via cyber cafes. Public Internet access varies in price and quality, but generally costs between US \$ 1 and US \$ 2 per hour. As the WorldTel and other backbones come on line, more ISPs are given permission for their own international gateways, and DTS begins to offer its dial-up service, we can expect service to become more widely available,<sup>8</sup> prices to continue to drop and service to improve.

Leased lines, while generally available in urban areas, continue to be somewhat expensive when their variable quality, installation time, and limitations of the network are considered. In Chennai, users are primarily limited to software and software services companies and ISPs, not traditional businesses.

Simultaneously, as more locally relevant content is developed and more essential goods, services and information are offered online, consumers' willingness to pay should increase. Who would make significant upfront and ongoing investments if the service quality and type of offerings were substandard? Some refer to the example of cable television, and the positive feedback loop between relevant channels and Indian subscribers that lead to Asian cable's ubiquitous Indian programming.

### ***Network Speed and Reliability***

The most fundamental problem with the network is that it was built for voice and not data transmission. With no national Internet backbone and limited access to the international backbone, there are a variety of bottlenecks that exacerbate one another. For instance, the absence of the national backbone, lack of peering, and capacity and cost limitations of satellite uplinks, in conjunction with the excess capacity in Europe and the US, makes it inefficient to host web sites in India.

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<sup>6</sup> Although it is possible to get an entire new system for under US \$ 1000, that is still unaffordable for the vast majority of potential personal users.

<sup>7</sup> In February 2000 VSNL started offering a free set top box to anyone purchasing 500 hours of dial-up access. Aiwa has also expressed its intentions to begin offering the boxes (priced at around US \$ 300) in 2000.

<sup>8</sup> When DTS introduced its metered Internet services, numerous cyber cafes sprung up virtually overnight.

That causes virtually all interactions with hosts to occupy international bandwidth, thus congesting the whole system. Web queries from Chennai to Coimbatore commonly travel to the US and back before reaching their destination (unless the queried site is hosted on the VSNL server or co-located at its gateway). This requires ISPs to lease more bandwidth from VSNL than they would otherwise need. But more importantly, it means that users get much slower service than they should, and that fewer people use the Internet because of it.

The result is that even in cities where equipment is good, dial-up connections regularly yield rates as low as 4.8Kbps. Cyber cafes vary widely in connectivity, but often have slow enough connections to render web-surfing effectively impossible. The leased lines they use commonly vary from 9.6Kbps to 64Kbps, and these may be shared between many machines. Some rural areas have consistently slower connections due to equipment limitations,<sup>9</sup> making email difficult and anything more impossible.

Leased lines can also run into trouble. The 64 bps lines in Madurai have been particularly slow due to bottlenecks upstream in Chennai. DTS currently offers no service guarantee, a constant frustration for ISPs and others who depend on the Internet.

If there is no problem with local access, however, it is likely to arise at the international gateway. Downtime ranges from 0.9 - 2%, compared with the international standard of less than 0.3%. Due to over-subscription, a 2 Mbps pipe at VSNL's international gateway regularly slows to 64 Kbps (which is, of course, shared between numerous users) and sometimes even single digits. VSNL makes no service guarantee to its wholesale customers (ISPs, software companies), forcing them to buy excess capacity in the hopes of meeting a higher minimum level of connectivity. Those approved for access to the international gateway are setting up satellite links as a redundant system because they think so little of VSNL's service.

The local network has problems, but is serviceable. Across India, downtime on local circuits varies from 3-15%, compared with international standards of less than 0.1%. Mainline faults are high. Chennai Telephones reports about 14 per hundred mainlines, but predicts the number will fall to single digits in 2001, and ultimately reach 4 or 5. The area around Madurai averages around 8 monthly faults per one hundred mainlines.

Repair times are faster in urban areas, but are varied. In Chennai and Madurai, they are often less than 24 hours. There are reports, however, of phones being out for much longer; rural areas often take days and may even take weeks, depending on the type of problem and its location.

### ***Hardware and Software***

Hardware and software are available, but are too expensive for many consumers or small businesses. A complete new computer system costs over US \$ 1,000, more than the

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<sup>9</sup> Kodaikanal, for instance.

annual income for most Indians. Software piracy is fairly common,<sup>10</sup> which reduces the price to the consumer, but deters local software design. Most software products are not effectively adapted to local needs, particularly in the areas of language and user interface. There is supposedly a Tamil version of the Windows operating, but it is reported to be much more trouble than it is worth.

One very significant gain has been the standardization of the Tamil character set and keyboard layout organized by the state government. It has allowed the Tamil community around the world to choose one common means of communication, thus helping culture to survive while enabling improved communication with the Diaspora.

### ***Service and Support***

There is a great difference in telephone installation time and attitude towards customer service depending on which city you are in, or how rural your location is. Generally speaking, DTS still operates as a monopoly provider (with high prices and poor service relative to the private sector), although some branches take their need to be competitive quite seriously. Problems arise for the latter since they are controlled from Delhi, and do not enjoy the freedom to make themselves more competitive (and better serve the public).

The customer service mentality is beginning to arise, but the public sector units seem to be least sophisticated (probably lead even by politicians, who must at least answer to voters).<sup>11</sup> Customer service centers do exist, and while the big customers generally receive more attention, inattention and lack of service guarantees frustrate even them.

In Madurai, DTS is aggressively striving to offer new and better services (Internet service, discounted sign up fees, and possibly phone cards in future), but has little control over its budget and business plan. DTS in Chennai outfitted its repair staff with pagers so that they might respond more rapidly, but generally seems to be lagging in its customer orientation.

Depending on the location, phones in Chennai take between one and four weeks to install. The wait can be much greater in rural areas. There is a waiting list in Madurai, but they report that it is due to the success of recent reduced cost promotions and should be eliminated by year's end. The waiting list in the part of Tamil Nadu outside Chennai is almost 500,000. ISPs offer customer support online and via telephone, but quality of assistance and wait-time are quite variable.

### **NETWORKED LEARNING**

Adequate access to a quality IT-enabled education at a variety of levels of study is essential for the Networked World. Much of the achievement that Tamil Nadu already enjoys stems from its educational system. Needs are growing and changing, however,

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<sup>10</sup> Copyright is sometimes defined as “the right to copy.”

<sup>11</sup> When asked about considerations of improving customer service in a competitive environment, one DTS executive replied that he would open up a marketing department

and the focus is expanding from engineering and computer science to general IT literacy. Because in addition to having some people skilled at designing hardware or writing code, it is essential that others be able to conceive of how to wield information technologies as a tool, and use them accordingly. Similarly, those people specializing in IT-related fields need real experience to be considered competitive in the infotech sector.

Tamil Nadu is the only state in the country to offer its government higher secondary school students access to computers. The Schools Program was initiated at 666 government higher secondary schools in 1999, and expanded to 1198 schools in 2000. The schools should be wired to the Internet over the next two years as part of the ELCOT/WorldTel/Reliance project.

The state created an innovative public-private partnership by contracting out the services to provide hardware, software and teaching. The partnership benefits the government, contractors, students and citizens. The state didn't have to actually purchase the equipment and will not be saddled with out of date technology or hiring additional instructors. The contractors can boost their earnings by using the computer labs to offer public classes in the evenings, thus serving the neighboring community when the equipment would otherwise go unused. By awarding contracts to dozens of separate companies, the government also took an important step in seeding business by offering a guaranteed revenue stream. Students get trained and experienced instructors with the new equipment (as specified in the contract).

The program began with students in the last two years of high school (plus one and plus two), by offering a basic computer science course. The course is part theory and part practice, with most classes having two students per computer in the practice sessions. Beginning in the 2000 school year, computer literacy classes (covering basic use and the MS Office package) will also be offered to ninth and tenth standard students as well as teachers. Many schools have between 1,500 and 2,500 students and access is constrained with only ten computers, even with the labs operating all day. About 50% of the 50,000 students enrolling in the computer science course are women, and about half the covered schools are in rural areas. When the program is fully running, about 300,000 students per year will be covered by the system.

The current curriculum is a solid first step at introducing high school students and teachers to computers. As the teachers in other disciplines develop basic computer literacy, they will also need to learn how to integrate the machines with their teaching. Computers in schools need to find balance between being the ends (as for a programmer) and being the means (as in a group research project).

While there are multiple private partners, there is only one state-designed curriculum, which inhibits local solutions, experimentation and diversity in education. For instance, within the realm of computer science, instructors are limited to teaching MS Windows-based material, rather than creating a regime which allows students to develop a range of

expertise in different platforms. Just as no institution wants technology lock in hardware and software, likewise in education.

One particular area that the Schools Program might wish to explore is that of using Linux as a platform. Open-source software is cheap or free to use, allows for groups to work together to build new software and improve existing programs, is more reliable than Windows, and is capable on running on older computers. All of which would be of great use if the Schools Program is to expand its number of machines and make them available at lower grades. Government proposals for text editors in Tamil and keyboard interface for the Linux platform is a noteworthy initiative and should be aggressively followed through. To be sure, Linux has its down sides, too, and any decision should be carefully researched.<sup>12</sup>

There is a similar computer literacy initiative at the college level, which is leading to computer and Internet access at 60 government arts and science colleges, and all medical, dental and law colleges across the state. While it will also involve outsourcing to private providers, it will not be subsidized and students enrolling in the program will pay the entire cost. The government expects that the cost will be much lower than market rates for similar programs due to the aggregated demand.

### ***Schools' Access to Information Technology***

As it stands now, there are 1198 government higher secondary schools with computer labs in Tamil Nadu. Each lab is networked with one multi-media server and nine other Pentium II PCs running Windows. All the software is currently in English (which has not been a problem), although Tamil software should be arriving in some labs this year. The labs have adequate power and air conditioning. They currently do not have Internet connections, but use a CD-ROM simulation to teach about the WWW. Schools should have full connections within the next two years, but some will come sooner.

Access to the labs is limited to class time. In 2000, they should be occupied by classes during most of the day, and by classes open to the public in the evenings, leaving little or no unstructured access time. Schools do not have CD-ROM libraries yet. Computers for administration purposes or dedicated teacher access are available at few or no schools.

Most colleges and universities have a paucity of computer resources, although the necessary investments in hardware and connectivity are becoming more common. IIT -- Madras and some engineering colleges have good access, and PSG in Coimbatore even has advanced CAD/CAM facilities, but less technical fields of study tend to be limited. Poor Internet access at most colleges and universities generally makes WWW-based research difficult or impossible.

### ***Enhancing Education with IT***

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<sup>12</sup> There are many resources on this topic. Of particular interest is the Scholar Net program in Mexico, which has set the goal of creating 140,000 computer labs with Linux over the next four years.

Classes at the government higher secondary level currently (and in the near term) do not integrate IT meaningfully in the lesson plan. The first step, which is underway, is to help teachers become computer literate -- this should be a top priority. The teachers must “buy into” the technology, understanding both its benefits and limitations, so they are able to use it effectively in their lessons. To date, teaching teachers to use new technologies effectively has been the biggest challenge for IT in education in most countries -- developed and developing alike. As schools gain Internet access, a whole host of new opportunities will arise for WWW research, collaborative projects with other schools in Tamil Nadu and elsewhere.

It is also important to allow for unstructured access to the computers, outside of regular class time for both teachers and students.<sup>13</sup> Programs in the United States have successfully used “fun” applications capable of manipulating graphics and sound in conjunction with office applications.<sup>14</sup> The effectiveness of the curriculum in use has not yet been evaluated, but it is important to develop new curricula that promote group work via computers, WWW research, and so on.

### ***Developing the IT Workforce***

In addition to the numerous traditional college and university programs available, there are many other opportunities for study in fields related to information technology. The Indira Gandhi National Open University (IGNOU) is a distance learning program that uses a combination of videoconference and Internet-based courses, in cooperation with cyber cafes and training institutes to offer degree programs. These include Bachelor and Master in Computer Applications, Certificate in Computing, and Bachelor and Advanced Diploma in Information Technology. American universities are also beginning to offer accredited long distance degree programs.

Professional training institutes like Aptech and NIIT are in the larger areas, and smaller towns often have some combination learning center and cyber cafe. As the Schools Program begins to offer service at night, there should be a host of low cost options in previously un-served or under-served areas. There are a variety of certification programs offered though the training institutes.

Approximately 15,000 people graduate in fields related to IT every year in Tamil Nadu, and while very highly regarded, the higher education system faces significant constraints that reduce its effectiveness. There are centrally imposed constraints in terms of quotas and controls on spending. There are traditional strategies which, when faced with the fast-changing world of information technology, have become liabilities -- like triennial syllabus review (often characterized as reactive even when it is more frequent). And

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<sup>13</sup> NIIT's Research Director Sugata Mitra has had great success simply allowing children with no computer training whatsoever access to computers and the Internet. His experiences suggest children's innate ability and hunger to learn even (especially?) without teacher support.

<sup>14</sup> Thaddeus Miles' work with Massachusetts Housing Finance Corporation, for instance, has been successful in teaching inner city youth computer skills through this mixture.

there are resource problems that leave technology fields ill equipped for research and experience necessary to succeed in the labor marketplace.

Significant gains in many of these areas could be created through increased partnership with the private sector. There is little systematic input on curriculum by private sector firms in the infotech sector. Private sector sponsorship of academic research is basically limited to IIT-Madras, and required internship programs seem to generally be a disappointment for both sides. The situation is in sharp contrast to the United States' model in which industry and academia cooperate extensively on research & development.

Potential benefits of research include increased funding for colleges and universities, development of locally appropriate solutions, hands-on experience for students and faculty, increased input from industry regarding its needs, increased effectiveness in industry research (letting higher education do the basic work), and increased generation of new technologies.

More research into locally appropriate technologies would be an academic, economic and social boon for India. India faces some of the greatest challenges of the developing world (environmental stress, governance, poverty, literacy) and has the technical capacity to play an active role in addressing these problems. It also has an incentive, since if India doesn't solve them it is unlikely that anyone else will. Practical examples of this are present in Dr. Jhunjhunwala's research with TeNet (Telecommunications Networking Group at IIT-Madras). Current common computer science research agendas at present are largely theoretical (since infrastructure is lacking), and not focused on addressing local needs.

Higher education institutions are not capitalizing on the interest in IT in their volunteer activities. Rather than limiting teaching to areas like literacy, these organizations could teach computer literacy or at least offer opportunities to use computers.<sup>15</sup> Whether by using computers with games, Internet connections, or CD-ROMs containing health, agricultural or traditional educational information, technology could be both demystified and made useful.

### **NETWORKED SOCIETY**

It is essential for government to recognize domestic Internet and IT penetration as top priorities for growth, sustainability and distribution of benefits in the long term. In order to realize the benefits associated with infotech, people must make use of it, for the more they use it the better they can understand its potential -- and realize it.

True with society as well as business, as people understand the opportunities presented to them, they will push government, business and education to make information and

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<sup>15</sup> As noted, Infosys regularly takes computers to poor areas to offer people the opportunity to use computers as part of its Reach the Rural program. It also offers Train the Trainers, concentrating on college science and engineering professors, and Catch Them Young, which teaches youth problem solving skills. Many universities perform some sort of periodic community service.

communication technologies increasingly available to the masses. Thus, can the vote bank play a positive role in combating the power of entrenched gatekeepers.

As the access barriers begin to be addressed, use of the Internet is on the rise. Increasing numbers of web portals, interest in NRI (non-resident Indians) and domestic e-commerce are increasing. There is still much work to be done in the area of generating locally directed content, presenting it in a culturally appropriate manner, and helping people to comprehend how to use the new technologies available to them.

### ***People and Organizations Online***

There is significant awareness of the Internet as a phenomenon, but much more limited real understanding, let alone direct experience. There is extensive English language advertising for businesses including WWW addresses, training, and other Internet-related services. This suggests there exists awareness that the Internet is important, but does not tell us how many really use it, or the value of the advertised sites. Last reported, the assignment of domain names by NIC (via VSNL) was paper-based and could take up to a month to complete, a notable deterrent to registration.

Within Tamil Nadu, there are some local commercial websites, some higher education sites, and a fair number of state government offices. Their number and quality (currently erratic) is increasing. Some larger cities have their own (privately run) portals (Chennai, Madurai, Coimbatore), as does the state itself. Most sites are in Tamil and English. Small and medium size businesses may be listed online, but rarely have their own websites. There is a much wider body of organizations online with national relevance. Many people have email addresses through the various ISPs or Hotmail.

### ***Locally Relevant Content***

Portal sites like Chennai Online provide relevant links and information on a wide variety of topics of local, regional, national and international concern. With everything from railway schedules to wedding planners, the public is apparently receptive as evidenced (by their own account) by the one million page views in March. Interest is growing, as shown by the increase from about 5,000 daily visitors at the beginning of 2000, to over 10,000 in April (and about 40,000 page views).

The Government of Tamil Nadu has made significant progress in putting valuable material on the WWW, but still has a ways to go. Currently all of its over 70 forms on line (in English and Tamil), although they cannot be submitted via the Web. Tenders are listed on the government site, but are not organized to be searched easily (the organization is better on Chennai Online), and proposals cannot be submitted online. Other information on the site is static, not terribly detailed, and does not reflect the government's actual awareness of IT as a tool for effective governance. The Chennai Corporation is not yet up and running, although its URL has been reserved. ELCOT has a useful and extensive list of the many sites related to Tamil, Tamil Nadu and Chennai. In general government sites are more clunky than they should be given its IT savvy.

There are numerous other portals, magazines and nationally targeted sites primarily in English. They offer news, information, e-commerce, entertainment, etc. Most Union government agencies have some sort of site, although the quality is greatly varied. They are typically in English and Hindi.

“TamilNet 99” has been successful in creating a standardized coding for mono and bilingual glyphs and keyboard for the Tamil language, thus allowing the approximately 70 million Tamil speakers located in Tamil Nadu and all around the world to communicate more effectively. It has resulted in initiatives like the Tamil E-Zine ‘Aaramthinai’, which recently completed its first year of publication.

### ***Information Technology in Everyday Life***

Cost, availability and local conditions (like electricity problems) currently limit use of ICTs. Local and national service phones are now available in all official villages (leaving thousands of smaller villages uncovered, but within reach). Very few people have phones in their homes, and mobile phones are limited to wealthier groups. Across India most communities have access to television (75%) and radio (95%), with Tamil Nadu’s numbers possibly even higher.

There are relatively few personal computers in India, and though the number is growing, they (and Internet access) will remain a rarity in the vast majority of all homes because of cost and infrastructure impediments. Email is available publicly in many urban areas, but is principally used by businesspeople and students. People do not generally turn to the Internet for shopping needs, but may do so for information gathering, chat and certainly for email communication.

### ***Information Technology in the Workplace***

Small and medium enterprises led the movement to adopt IT until mid-1999, when larger corporations started late but with resolve. The small and medium enterprises had no legacy systems, a shorter business cycle and smaller hierarchies (and therefore better access to decision-makers) -- allowing them an easier path to information technologies. Businesses related to the IT field are at the fore in terms of IT use, with others beginning to invest in new technologies.

Use is widely varied, and is not yet causing widespread efficiency gains. Many smaller businesses have at least a PC or two, but outside of businesses with an IT-focus, it is unlikely to find a computer or a phone on every desk. Relatively few government officials outside the upper levels have access to computers, and they are not networked.

## **NETWORKED ECONOMY**

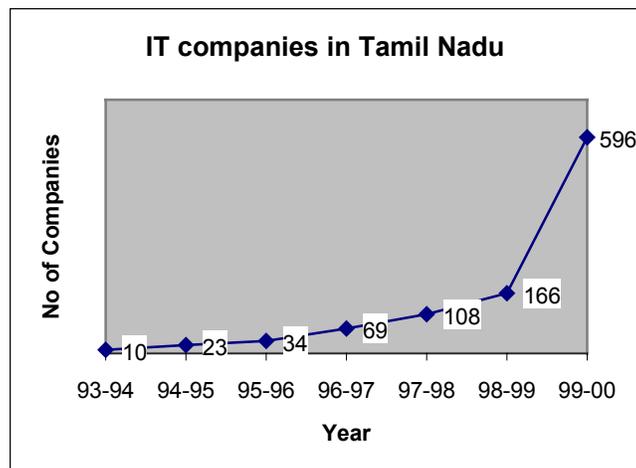
The IT industry is a driving force in Chennai. Most of its efforts, however, are directed at export markets, and thus many of the benefits this sector offers go unexplored. By also looking to national businesses, the industry would garner diverse experience while helping generate efficiency in India. The NASSCOM-McKinsey Study suggests the

banking and financial services sector, utilities, manufacturing industry, and government as obvious and important starting points.

IT and the Internet in particular could also play a huge role in increasing general price transparency and creating competition, which would lead to greater economic efficiency.<sup>16</sup> The thinking goes that this will generate both lower prices for everyone, and consumers and industries capable of competing in India and abroad. Some Indian IT executives offered that India's non-incumbency, lack of bricks and mortar and distribution channels is to its advantage, much like the Silicon Valley Dot Coms -- no legacy systems.

### ***Employment Opportunities***

The source of Tamil Nadu's great success in the IT sector has without a doubt been largely related to the presence of its highly trained and effective labor force. Between IIT-Madras, Anna University and the over 150 other colleges and universities in Tamil Nadu, the state has among the greatest number of technically trained students in the nation. It continues to attract new business based on this resource, while other cities in Tamil Nadu remain less exploited, despite their significant talent base. Coimbatore, Madurai and Trichy, however, all present real opportunity as their infrastructure improves. The number of IT companies in Tamil Nadu has increased dramatically within the past years.



source: ELCOT home page

Currently there is significant increasing opportunity in the urban areas, particularly for those with technical training (especially college in computer science, electronics, or engineering) and work experience (at least two years preferred). More than 30,000 professionals are employed in this industry according to the Tamil Nadu government. However, it can still be difficult to find people with a significant amount of work experience. Many of those with more experience choose to work overseas, either under

<sup>16</sup> As argued in article, "Untangling e-economics" in Sept. 21 issue of The Economist

the auspices of an Indian company or a multinational. The number of H-1B visas issued by the US government has been increasing and is under constant negotiation. Other countries have similar technical needs, and often look to India to fulfill them.

If the infotech sector continues to grow as it has been forecasted, there may well come a manpower crunch in which there are simply not enough graduates for the job. There is a turnover rate of around 17%, and manpower costs at one successful infotech consultancy have reportedly increased 20% in the last year. At present, firms are being forced to fight harder to retain employees by addressing needs for salary increases, improved work environment, better continuing educational opportunities and ESOPs.

### ***Business-to-Consumer Electronic Commerce***

Currently there seems to be fairly little e-commerce, with a lot directed at non-resident Indians (NRIs). The limited number of international credit cards contributes to the problem, as does the fact that the banking system is not yet on line. Suspicion of giving credit card numbers over Internet is exacerbated by the unlimited liability that cardholders face (unlike US limits of US \$ 50). The Post Office presents opportunities as a potential distributor (via VPP) due to its relative efficiency and great reach. Most initial e-commerce might well be limited to cities where income and connectivity are much higher.

On the other hand, Chennai has a credit card culture, in which some people almost take a sort of pride in using their cards. And while the percentage of people with credit cards is quite low, it is highly correlated with access to a computer. Meaning that although “traditional” e-commerce won’t work for everyone in the short term, there may be enough users to get it off the ground. Whether or not users will entrust their credit card to a computer is another matter, particularly without extensive mail order or ATM experience.

### ***Business-to-Business Electronic Commerce***

There is a history of large organizations (including the Army) using EDI (Electronic Data Interchange), so it is fairly safe to assume that many of them will migrate towards B2B solutions as they become increasingly attractive, and that they will draw others along with them. There has not been much in the way of new B2B e-commerce, partially due to the unclear legal environment, but also because of the standard signature necessary to conduct business. Thus, many transactions can be facilitated electronically, but not actually completed.

### ***E-Government***

There has been notable progress in putting government online for citizens’ benefit and headway in streamlining the internal processes of government. Tenders are posted in high traffic locations on the Web, development projects are posted on-line, ration cards are computerized, and driving licenses are stored on a database. The official Tamil Nadu web-site also has a wealth of documentary and statistical information about the state. The state has more than 100 application forms available online (although it is not yet possible

to submit them that way) in English and Tamil. A database for all land records throughout the state is being created. The Commercial Tax Department plans to have the biggest stores paying online first, thus immediately increasing revenue and convenience, with the smaller businesses to follow.

One important and extremely positive development in Tamil Nadu is the beginning of extensive use of application software. It is being used for maintaining the database of land records, and for creating database of digitized land maps. It is also being used for many types of registration purposes under the STAR (Simplified and Transparent Administration of Registration) program. It has also been developed for Transport-related governmental offices and for tax assessment. It is even being used to monitor development projects in some places.

The Registration Department's Project STAR is designed to facilitate processes around a variety of important documents such as encumbrance certificates (for property transfer), property valuation and marriage registration. Still in its pilot stages, STAR has reduced search times from days to minutes, allowed records to appear in English and Tamil while easing the burden on the employees and citizens. The system is currently not networked and thus has yet to achieve its ultimate goal of allowing access to records through distinct entry points. This low-cost/high-yield strategy for making use of IT in government does a fine job of addressing corruption/transparency while improving the public experience of government and improving work conditions for civil servants.

The biggest missing factor in these initiatives is networking, which is essential to take full advantage of the current programs. While WorldTel's plans to have all district headquarters on line by year's end could help the process significantly, the politics of removing government's gatekeepers may be quite complex.

#### **NETWORK POLICY**

With the cyber law finally passed the environment for e-commerce has improved immeasurably. Regulation continues to be the thorniest issue of national policy, largely due to the size of DoT/DTS and income of VSNL, and massive power associated with them. One major success has been the minimal licensing fee for ISPs, and another improvement has been the introduction of revenue sharing as a licensing fee for local telephone service providers.

#### ***Telecoms Regulation***

Some reforms have occurred but the results have been slow and lacking. As it stands now, the efficacy of the reconstituted Telecoms Regulatory Authority of India (TRAI) is unproven, and DOT and DTS seem unrelenting in protecting themselves. VSNL has been corporatized and has improved tariffs, but they were so high to begin with that efforts are still lacking. The World Bank recently approved a US \$62 million loan to strengthen India's telecom regulatory environment and modernize the Department of

Telecommunications (DoT), so if there is indeed interest in structural change, there is now also some funding support.

The wireless industry is lagging behind, especially considering the convenience it offers and the low landline quality. The structures of reforms and rates have led to significantly lower growth than was seen in China. The most recent major step backwards was the decision against calling party pays.

As states increasingly realize the role that the telecoms sector has in their economic development, they may begin to press the Center for speedier and more effective reforms. Rather than asking for additional funding, they may ask for legislative results, and that may be quite reasonable considering today's coalition politics.

### ***IT Trade Policy***

Trade policy has been improving, but partly due to convergence issues within telecoms, delays and inconsistencies in import duties are commonplace (particularly on capital goods like ISDN switches). Increased transparency/simplification of the import regime would allow businesses to better rely upon the timely arrival of inputs at the expected cost. There is also corruption within customs. Simplifying the import regime will be good for all industries, not least of which is IT.

Tax policy rewards software and software services exports by making them duty free, but imposes taxes on the same products when delivered locally. Since the export market is already 60-70% more profitable, this seems to risk further stunting domestic uptake of IT, something which India cannot afford. These and other similar policies which promote exports should, at the very least, not do so at the cost of hurting local service delivery.

## OBSERVATIONS AND RECOMMENDATIONS

### OVERVIEW OF GUIDING PRINCIPLES

There are certain overarching principles that have become clear as a result of the Assessment process and broader lessons learned from previous experiences with information and communication technologies in a developing world context. These ideas should guide Tamil Nadu in its quest to benefit more from access and applications of these new technologies.

**IT initiatives should be designed to support government's larger strategies and goals for economic and social development.** As Tamil Nadu seeks to address fundamental challenges<sup>17</sup> of universal literacy, improved public health, economic growth and political reform, IT can and should be an invaluable tool that is woven into the state's efforts. At the same time, to both foster improvement in IT capacity and achievement of other essential developmental goals, the government should push to improve the telecoms environment quickly and significantly (through increased competition and reform of DTS and VSNL), continue to foster ties with Non-Resident Indians, and improve higher education.

IT can help in myriad ways and is essential to the development process. Tamil Nadu can improve its status as a state of excellence in areas as diverse as manufacturing, engineering, textiles and sugar, through wise use of IT in these industries. Likewise, Tamil Nadu can further its reputation as a state of good governance and a business-friendly destination by effectively using IT to further improve government processes. IT can certainly play a role in improving educational resources, creating a more dynamic environment, and even allowing for asynchronous learning at the school and university level. Developing these initiatives simultaneously benefits IT firms themselves as well, by providing them learning opportunities that rank high on the value chain.<sup>18</sup> However, it is important to realize that IT is not a panacea for all economic problems but remains only one piece of the puzzle of economic growth.<sup>19</sup>

The state is enjoying early success in the information age, but in order to sustain its gains and truly capitalize upon them, Tamil Nadu needs to **make existing projects more innovative and aggressive, while creating effective new approaches to remaining challenges -- and realizing ubiquitous and effective access.** The state as a whole cannot take advantage of IT if most of its people and organizations are left off the network or unable to capture its benefits. Initiatives to share IT's advantages more widely and deeply within society, reaching out to non-IT businesses, rural areas, non-English

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<sup>17</sup> As suggested by Jeffrey Sachs and Nirupam Bajpai in the April 15 issue of Economic and Political Weekly.

<sup>18</sup> A CEO of one Indian IT firm referred to the perception (and to some extent the reality) that Indian firms are known as cheap diligent coders, rather than providers of excellent end to end solutions.

<sup>19</sup> Nirupam Bajpai and Navi Radjou, Raising the Global Competitiveness of Tamil Nadu's IT Industry, October, 1999.

speakers and illiterate people -- not just the mostly urban elite currently using IT -- are essential if Tamil Nadu is going to join the Networked World.

The Government-led effort that standardized the Tamil keyboard and fonts represents a major achievement in making IT applications more accessible for tens of millions of Tamil speakers in India and abroad. There is still a long way to go before residents have ubiquitous and valuable access to IT. The planned high-bandwidth statewide government Wide Area Network (WAN) will provide opportunities for government to increase the scope of IT penetration by facilitating access and putting more of its services and activities online. While the government's laws on rights of way and the WorldTel initiative will support the WAN, it is difficult to predict when it may become a reality.

As far as widespread public access goes, it is essential to get the private sector involved in the process, since the government and its entities simply do not have the funding or incentives to move quickly enough to create adequate infrastructure, services and content in the short-term. Government should implement policies that reduce the cost of appliances, facilitate infrastructure rollout, and encourage entry into under-served areas.

**Government should mobilize academia and business to establish common goals for IT and work together to achieve them.** By setting measurable and achievable (if ambitious) benchmarks, stakeholders agree on a common vision and commit to it. Tamil Nadu needs to expand its already successful cooperation with the private sector into new areas, while continuing existing efforts. In the past, government has focused on creating joint ventures (mostly through ELCOT), facilitating existing business, and encouraging new business. New attempts at harnessing the private sector's growing resources (money, influence, knowledge) should be initiated to complement government's endeavors in boosting Tamil Nadu's readiness.

Academia's value as the third leg of support in Tamil Nadu's push for IT competitiveness should not be overlooked, because its inclusion not only helps private resources go further, but also creates a better-prepared workforce. By turning government's two-way relationships with business and academia into a three-way cooperation, there can be a synergistic effect that bolsters the capacity of each individual group, and capitalizes on benefits of collective action.

#### SUGGESTIONS FOR GOVERNMENT ACTION

Based on the Readiness Assessment and considering the aforementioned principles, there are certain areas where it has become clear that government should concentrate its efforts. These activities must be approached in an integrated and strategic fashion such that the government may take advantage of the synergies they create, while protecting its initiatives from political problems that might derail the implementation of effective policy. Government has already shown significant insight and dynamism in many of these areas, but has had varied success with implementation.

Specific areas are described briefly, and examined with greater depth in the following section of the document.

1. **Continue to build out telecommunications, physical and business infrastructures.** Infrastructure is necessary, although not sufficient to ensuring an IT growth in Tamil Nadu.
2. **Push for further telecoms reform** and more competition. Healthy competition is the key to affordable, appropriate, and accessible ICTs.
3. **Improve governance with IT:** Electronic governance empowers people with new tools to access government. By fostering improved transparency, service and information flow via use of IT, the government can set a powerful example of appropriate use of technology, while also attracting investment to the state.
4. **Focus on all levels of education:** Increase focus on primary and secondary education, and keep teaching English.
5. **Get more from higher education.** Greater interaction between academia and industry will promote better prepared students and context appropriate research.
6. **Prepare people (and organizations) to compete** in the local and global marketplaces. IT is becoming evermore important in and of itself and as a tool in many professions.
7. **Build a statewide database** of information relating to pervasiveness and maturity of technology use across sectors and society to inform decisions of business leaders and policymakers.
8. **Support the creation of locally appropriate content and interfaces.** Ease of use and utility are essential to making ICTs valuable and will also promote a local market for IT products and services. Rural and poor areas must not be left behind.
9. **Grow the domestic IT market** and IT firms. The IT industry needs to serve the domestic market, people and organizations need to understand how they can benefit from IT, and government needs to help expand that market and encourage entry.
10. **Market IT and success.** Share Tamil Nadu's success to date more widely and establish a vision for the future.

**1. Continue to build out telecommunications, physical and business infrastructure.** Internet backbones (developed by WorldTel, DTS and others), IT resources like TIDEL Park, Chennai's Cyber Corridor, plus incubators in Coimbatore,<sup>20</sup> Madurai and elsewhere create opportunities for entrepreneurs and established businesses, while encouraging growth in the IT community around the state. There cannot be too much bandwidth, especially if the state receives it in exchange for rights of way. It is important to note that access and last mile costs amount to about two-thirds of the total per line network cost and will require still other solutions to address this issue.

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<sup>20</sup> Coimbatore's PSG-STEP was already incubating five IT startups in February 2000.

Government joint ventures (through ELCOT) and Software Technology Parks of India (STPI)<sup>21</sup> should continue to play a key role in expansion. It is important, however, that as interest, capacity and capital increase, government does not crowd out private entry. And in order to accomplish the necessary access upgrade in the near future, private capital will be essential at all levels of network development.

High-speed connectivity should be available all over the state, including rural areas. It is in those areas that the state must use its purchasing power, legal authority, or good offices to ensure that the rural areas are connected to the network. If the most remote and information poor areas are left behind early on, they will only lag further in future.

**2. Push for further telecoms reform.** Government should place pressure on the Center for further telecoms reform and privatization, along with better service from DTS and VSNL in the short term. These institutions recognize that they are still dominant providers and have improved the minimum amount necessary. Where they remain monopoly providers, they should offer service guarantees for everything from up-time and data transmission rates, to speedy provision of infrastructure such as leased lines or gateway access.

VSNL's international calling monopoly is currently scheduled to be reviewed in 2004 – that timeframe is simply too long. Exorbitant international long distance rates, excessive rates for leased half circuit connections to the international Internet backbone, inadequate international bandwidth and generally substandard service are seriously retarding development and deployment of IT.

The Prime Minister took an excellent first step on July 15 when he announced that undersea fiber optic cables (like FLAG and SEA ME WE 3) will be opened to private providers -- not just VSNL. Entering into effect on August 15, it should increase the woeful total national Internet access bandwidth.<sup>22</sup> Government should ensure that all requests for connectivity are processed rapidly, not cloaking delays in security or other concerns.

DTS is large and centralized, but its regional companies have different resources and constraints. Central inflexibility leaves regional telephone companies with little opportunity for creative solutions to local challenges. Corporatizing DTS would prepare it for privatization and could make it a more effective provider. Allowing basically open competition in areas where teledensity is lowest would spur new entrants and creative solutions to last-mile problems.<sup>23</sup>

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<sup>21</sup> Government has given a cash grant and interest-free loan to STPI so that it can set up new links (and thus IT parks) in Trichy, Madurai, Salem and Tirunelveli by the end of 2000.

<sup>22</sup> Today it is estimated at about 350 Mbps, or a few percent of what a single Silicon Valley service provider has.

<sup>23</sup> Lessons may be learned from the success associated with India's unregulated cable TV environment

Consideration of technological convergence will also be essential, especially considering the increasing potential for overlap potential between the Union Ministries of IT, Communications and Information and Broadcasting.<sup>24</sup> Other Center action areas include rethinking the prohibition on Internet telephony, changing the terms of the Group PBX to encouraging provide local telephone and Internet,<sup>25</sup> and making the Telecoms Regulatory Authority of India truly independent.<sup>26</sup>

**3. Government should set a powerful example and attract new business by fostering improved transparency, service and information flow via use of IT.**<sup>27</sup> Government use of IT can help increase its internal effectiveness, and facilitate improved relationships with other governments, business, non-profits and citizens. By using IT to increase its own efficiency, government leads other organizations by example, helps grow the local market for IT and IT services, and creates the sort of locally appropriate web content that encourages Internet use.

Integration of IT into the government will be quite complex, to be sure, and Tamil Nadu will have to determine the most effective approach to the process, whether incremental, initially limited to certain internal or external areas, and so on. Government use of these technologies must not become a patronage or kickback program.<sup>28</sup> To build initial success stories, the government should begin with projects that are easier to implement technically, financially, bureaucratically and politically. The STAR program may be a good example of the initial steps in that direction. Even cosmetic changes may act as a valuable first step in the ultimate goal of lasting change in government functioning. Experiences of other developing world states and nations suggest a wide variety of effective approaches, each unique to the situation.<sup>29</sup>

Government has already received accolades for its effective and business friendly nature,<sup>30</sup> but should not stop now while there are so many efficiency and transparency gains to be made. Government as a whole should make a commitment to improving itself

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<sup>24</sup> There is draft convergence legislation, but neither its likely effectiveness nor date of introduction has been confirmed.

<sup>25</sup> The law allows non-DTS provision of local phone service, but directs 80% of earnings to the DTS.

<sup>26</sup> See recent papers by Dr. Ashok Jhunjhunwala, IIT-Madras' Head of Electrical Engineering and Computer Science. *Looking Beyond NTP '99* and *Voice on Internet and Long-Distance Call Charges* for interesting discussion.

<sup>27</sup> Nirupam Bajpai and Navi Radjou, Raising the Global Competitiveness of Tamil Nadu's IT Industry, October, 1999.

<sup>28</sup> Government should not be expected to buy from local IT companies unless they are better than the competition, but can create incentives for them to offer services domestically and other organizations to utilize them. Strategies like offering tax benefits for investments in IT and facilitating networking and educational events can contribute to the creation of a more lucrative local market.

<sup>29</sup> For instance, Andhra Pradesh decided on a gradual approach to putting certain services online after government employees threatened to strike. A Chilean committee tasked with modernizing government found monetary arguments to be most convincing for IT adoption for government as a whole. On a Ministry level, incentives were created with a carrot and stick -- the best websites won public recognition, while offline agencies were also note publicly.

<sup>30</sup> As suggested in *India Today*

through reforms (employing IT in many cases). Government should put more internal activities online, while continuing to add services that facilitate interaction with citizens and businesses. One concrete way government can use IT to facilitate improved service and transparency is to put related approvals and decisions on a fast track -- guaranteeing a speedy resolution and allowing the process to be followed online.

The state can help create a critical mass of content and access, which in turn will generate users and delivery schemes, which translate into a sustainable and useful IT network. WorldTel optical fiber should be laid to most district headquarters and larger cities by year's end. The state should use its commitment to buy significant bandwidth on this backbone to its advantage by using it for a range of projects, especially including electronic government initiatives, and sharing the cost across them. Additional bandwidth is likely to result from the fiber rights of way policy guidelines.<sup>31</sup>

Current public services such as downloadable forms, driver's licensing, the STAR Program, tenders, and availability of organizational information are off to a good start, but can be improved. Online transactions, such as submission of forms, should be promoted. Offices need to be networked so services can be rendered anywhere, not just in one particular neighborhood, thus leading to competition between offices and improved service, and cutting down on opportunities for corruption. Tenders should be posted digitally so that they can be easily searched with different criteria (by date, government entity, service type, amount, etc.) and are quicker to download<sup>32</sup>. Also, the tender should be posted in both English and Tamil. A more user-friendly tendering process will lead to new opportunities for suppliers, as well as competition between them and ultimately better offers for government.

Services should be added and offered in a strategic fashion in order to share the benefits evenly across society and earn widespread support. Services must be offered in person as well as online, lest those without Internet access be offered a lower grade of service. Some mixture of private community access centers along with the touch pad kiosk centers that are becoming increasingly common is one possible avenue. Successful implementations of IT as seen on the Indian Railways should be imitated -- where time-consuming processes become simpler and quicker -- and the public enjoys the benefits, thus gaining political capital and strengthening support for the process.

As one of the greatest challenges facing India today and a primary responsibility of government, diverse programs supporting health should be considered. Everything from developing a system for remote consultation (regionally, nationally and internationally), to the sharing of medical techniques, disease monitoring and eventually online medical records. Use of IT is particularly valuable in supplementing the challenged rural healthcare system, and the state Wide Area Network should offer an excellent backbone

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<sup>31</sup> The May 5, 2000 guidelines require that 2MBPS on all optical fiber laid on state property be given to government at no cost.

<sup>32</sup> In their present form, most tenders are scanned in as picture files which take longer to download

for that host of services. Pilot projects should be developed now so implementation can begin as the WAN goes live.

#### **4. Increase focus on primary and secondary education, and keep teaching English.**

Access to and integration of IT should be taken more widely into secondary schools and more deeply into primary schools, and its capacity to attract students should also be noted. Preparing and encouraging all teachers (especially those in non-IT subjects) to integrate IT in their coursework is as important as pushing for access, and should be made top priority.<sup>33</sup> If instructors do not “buy in” to the benefits of technology, we can hardly expect parents and students to do so.

The Schools Program is off to a fine start, but should be pushed further. The curriculum should be reviewed and made more flexible – dictating standards rather than methods. As it stands, the private training organizations providing most computer teachers are limited to using the state’s curriculum – negating the potential benefits of competition between contractors and disallowing experimentation, variation and locally targeted approaches to learning. As other technologies continue to improve, the Program should consider using Linux<sup>34</sup> and different operating platforms, other resources (notably CD-ROMs and thinner computing systems), alternative teaching methods and unstructured access to computers. The Program should also certify (or guarantee) computer literacy.

When not taught as a subject (e.g., computer science), use of IT should be combined with other efforts at educational reform -- using IT to address traditional problems such as resource shortages and low attendance. It should also be used to reduce reliance on rote learning and repetition, instead focusing on skills like problem solving that are based on the collaborative work and research that IT enables. By building on more interactive and unique approaches to learning, the educational system can also foster improved skill sets in essential areas for IT like entrepreneurship and research and development.

Access to computers should be expanded to younger children even if it is intermittent, since it can play an important role in demystifying IT and providing individualized interactive educational opportunities.<sup>35</sup> Economical possibilities include allowing visits to computer Schools Program Computer Labs, using donated simple or out-dated machines with limited functionality, or focusing programs like Infosys’ Reach the Rural<sup>36</sup> on youth.

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<sup>33</sup> Teachers in the Schools Program were initially intended to receive introductory computer training over the next few years, rather than immediately.

<sup>34</sup> Mexican public schools recently chose a Linux operating system due to the software cost savings, reliability, capacity to run on older machines, and group programming opportunities offered by the software’s open architecture.

<sup>35</sup> NIIT’s Sugata Mitra’s recent experiment with low intervention learning provides food for thought.

<sup>36</sup> By equipping a van with computers and sending it into rural areas, this initiative seeks to provide a little basic education, basically demystifying the machines somewhat. It seems that using even simple tools like educational computer games could help reach a whole new segment of the population.

While Tamil has been designated the official language of Tamil Nadu, government should ensure that English as a medium for instruction is still widely available – for it has played an essential role in the state’s IT success. Rather than ending use of English to encourage use of Tamil, efforts to create Tamil software and content should be stepped up to make it more appealing and economically valuable to job seekers.

**5. Get more from higher education.** The single greatest resource in Tamil Nadu has been the high quality labor it has produced in the 150 plus technical colleges across the state, but they can do even more with better support from partners and more administrative flexibility. Steps are not limited to IT-related fields and include:

- Building partnerships with other academic institutions and businesses (in India and abroad)
- Increasing sponsored research
- Creating stronger doctoral programs (especially via exchanges with partners, increased research relevant to India, and more research funding)
- Commercializing ideas and technologies emerging from research<sup>37</sup>
- Making internships more effective for students and mentor organizations
- Fostering proactive and frequent curriculum review with support of partners
- Pushing for more administrative latitude for colleges and universities
- Creating coursework on use of IT in management/business for students and executives, management classes in “IT business,” and short training programs that help transition technical (but non-IT) students to IT positions<sup>38</sup>
- Sponsoring a certification program to address business’ bias against hiring people with little or no experience
- Encouraging more community service using IT

Tamil Nadu Institute of Information Technology (TANITEC) may be able to play a role in much of this, not necessarily as a university, but as coordinator, resource, and advocate for business/government/academic partnerships. Rather than creating a new academic institution, it may be more effective to build up the existing ones, which also avoids excessive centralization of resources. In this sense, TANITEC could become useful in a variety of ways, everything from promoting interaction between business and academia, to touting educational resource and running job IT job fairs and business plan competitions for students.

Government’s initiative to extend the Schools Program to the college level, offering students and law, medical, dental and arts and science colleges computer literacy appears to be a strong step in the right direction for extending IT into new fields. Basic computer literacy is becoming more and more necessary for every field – technical or non-technical.

**6. Tamil Nadu’s educational environment should grow people (and organizations) capable of competing in the local and global marketplaces.**<sup>39</sup> IT is becoming

<sup>37</sup> IIT-Madras’ Jhunjhunwala and TeNet have already started four companies.

<sup>38</sup> See the Center for Entrepreneurship Development in Madurai.

evermore important in and of itself and as a tool in many professions. Organizations (and their employees) must master IT for whether they are technology developers or consumers, IT comprehension is an increasingly large component of human capital. The capacity to develop, commercialize and utilize technology (at all levels) has become an essential element of any community's economic competitiveness. Education and training has been one of Tamil Nadu's strong suits, and the state can ill afford to rest upon its laurels<sup>40</sup> now, especially in the areas of management and entrepreneurship.

Current managers (regardless of their field) should prepare themselves to better use IT, and ensure that a division between the older and younger (or savvy and not) does not occur around technology use. Technology's capacity to alienate those unfamiliar with it has caused many organizations either to resist adoption (because principals did not understand) or disregard the value of experienced employees (where ageism lead to perceptions of lack of technical capacity).

There is no factual basis to the once common assertion that India produces better engineers than entrepreneurs (and there may be evidence to the contrary), but the link between and value of both skill sets should not be underestimated. Constant re-evaluation and adaptation of the educational system is necessary to ensure that it prepares people to create, grow and maintain organizations in today's complex climate. Education even has a role in issues such as addressing cultural stigma associated with failing business ventures or building less hierarchical organizations. Education alone certainly cannot change society, but can consider its tendencies and their implications.

**7. Support the creation of locally appropriate content and interfaces.** Individuals and organizations will only pay for IT if they think it is valuable to them. Most of what is on the Internet is not relevant or accessible to most residents of Tamil Nadu. The greater the quantity of useful information (whether from government, private sector, non-profit organizations or citizens at large) and the more accessible its format (present it in Tamil, English, and even audio or visual formats if possible), the more likely Internet use is to increase. More content drives more users, in turn increasing the value of advertising and customer base of telecenters. At the same time, an increased indigenous user base will also help to drive interest in building locally appropriate (and profitable) content.

Government and business should investigate incentive schemes and grants in order to reach the critical mass of local content quickly. Government can begin by encouraging/requiring its entities to have an effective online presence. A mix of grants and partnerships between business, academia and government could lead to web presence

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<sup>39</sup> Continuing to develop quality manpower will be a key element for success. One Indian IT executive estimated revenue per employee to be 60-70% higher in the US than in India. Most people felt that attention to quality was good, but that it needed to improve in order to be competitive on the international market.

<sup>40</sup> The largest number of H1-B visas issued by any US Consulate in the world is from Chennai. Further, a survey by Business World in Jan 99 rated Tamil Nadu as having the highest capacity for technology absorption in the country.

for non-profit organizations and improved web-authoring skills for students or start up organizations, along with useful content. The Tamil Internet conferences and the Tamil Internet Research Center are laudable steps in the right direction. The Tamil Software Development Fund reinforces the government's commitment for innovative software in Tamil.

**8. Build a state-wide database containing information about level of penetration and maturity of use of information technology and communication technologies across sectors and society.** The database is fundamental for IT solution providers to target specific markets and for the government to assess the performance of different sectors in the usage of IT. This will also help individual organizations to make strategic decisions about their own usage of IT. For instance, if the buyers in a certain industry are seen to be adopting IT, the sellers would know how to respond to that change and vice versa.

The database would also be instrumental in assessing the level and maturity of usage of ICT in society at large. For instance, specific information about the geographical and gender distribution of the use of ICT would help in strategic policy-making. Likewise, by tracking data overtime, program effectiveness will become apparent.

**9. Promote domestic awareness of IT utility and encourage domestic IT firms to service its needs.** Build a thriving domestic market, and succeed in reinventing e-business and e-commerce for Tamil Nadu, India and other parts of the developing world. Tamil Nadu faces tough business competition from its Indian neighbors, to say nothing of the communities around the world angling to garner IT-driven prosperity. By providing local IT solutions, IT companies gain experience with end to end solutions, expand their ranges of services, and climb the value chain. Consumers (organizations and individuals) get the benefits of market-appropriate solutions,<sup>41</sup> increased competition (lower prices and better service), dealing with companies that understand the local context, and physical proximity. The relationship strengthens the IT industry, local business, government (through taxes) and boosts the economy as whole.

Initiatives include:

- Promoting ubiquitous access
- Accessing the huge Tamil speaking population by capitalizing on government's success in Tamil standardization
- Offering tax benefits or loans to organizations investing in IT to spur early adoption
- Expanding IT-enabled services up the chain from Medical Transcriptions (especially those facing new technology developments) to more value added areas,<sup>42</sup> and beginning to offer lower end services from rural areas<sup>43</sup>

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<sup>41</sup> An appliance example: by designing a US \$400 phone connection, TeNeT is seeking to serving Indian needs, not those of developed world economies -- whose lines cost double that.

<sup>42</sup> McKinsey & Company's December 1999 study for NASSCOM suggests the financial services area as a great opportunity for buyers and sellers.

- Clustering IT business initiatives, so businesses can capitalize on existing industries, business models, expertise, relationships, and other economic interests
- Ensuring that the tax structure no longer favors export earnings over domestic earnings<sup>44</sup>

One essential component of Tamil Nadu's success has been the personal attention offered to the private sector. Initiatives such as IT-trade missions, one-window approvals, land grants for IT companies, and other favorable treatment should be considered<sup>45</sup> (and publicized if granted). Importance should be placed on attracting new big entrants (recent significant arrivals in India -- but not Tamil Nadu -- include Intel, TI, Microsoft), especially those interested in research and development.

It is also essential to attract and create new and smaller IT businesses through activities such as a seed capital venture fund,<sup>46</sup> business plan competitions, partnerships between technical and management schools, and conferences. In this respect, active cooperation between government and industry is of absolute necessity. The Tamil Nadu Software Fund forms an excellent complement but there should be more seed funds for smaller ventures needing less capital.

**10. Share Tamil Nadu's success to date and establish a vision for the future, encouraging IT adoption and new business.** Government's low-profile support for business-led growth has been very effective at developing the IT sector, but has limited the credit Tamil Nadu has received for its success.<sup>47</sup> Areas such as IT-enabled governance and education reforms, and broader societal use of IT require a greater public leadership role, preferably in cooperation with the private and non-profit sectors. By making the approach more cooperative, capacity for success increases as does the number organizations with a stake in success. Rather than following the model in Andhra Pradesh -- where the government is leading the charge -- a joint approach would both be more trusted and also share associated burdens (and rewards) among partners.

Government can help create the environment necessary to make IT an effective tool for Tamil Nadu -- which involves attending to policy, programs, publicity and leadership -- to allow and encourage all citizens and organizations to use IT effectively. And while government should not have to lead in all cases, it must not be afraid to do so.

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<sup>43</sup> Cambridge-based Spryance has long expressed interest in medical transcriptions outsourcing to rural areas, but up to now has been delayed by infrastructure deficits.

<sup>44</sup> Also detailed in McKinsey's study for NASSCOM.

<sup>45</sup> Government sponsored a successful IT-trade mission to Singapore in February 2000. Companies on Chennai's Cyber Corridor received special consideration in infrastructure development.

<sup>46</sup> Seed capital in the one-two lakh rupee range (US \$ 25,000-50,000) was reported in many interviews as being difficult to access because its size does not compensate for administration costs. Amounts ranging from 20-30 million rupees are easier to get from investors.

<sup>47</sup> Informal surveys of IT and India experts and mainstream journals suggest strongly that Bangalore and Hyderabad are considered to India's IT leaders, and rarely even mentioned Chennai.

Communication of these programs is essential. Some combination of government and its partners must publicize the state's achievements.

There should be a coherent strategy to publicize Tamil Nadu's achievements<sup>48</sup> -- within government and Tamil Nadu, in the rest of India and around the world -- to attract new interest, new organizations and new investment in IT. By coupling nascent IT initiatives with accomplishments, and concrete future benchmarks that allow real evaluation, government can help establish a common vision for the state.

Contrary to popular supposition, publicity need not all be mass marketing, it can also be targeted to specific audiences and delivered on a small scale for major impact. By employing diverse networks including conferences, professional contacts, electronic newsletters and websites, achievements can be disseminated to those who care most, without expending resources and altering the message to reach or suit the masses. Thus, the academic, business and government communities can be kept better informed, and their resources marshaled.

Government should place top priority on creating functional and attractive websites for ELCOT, Chennai Corporation, and the rest of government entities. In many fields, and particularly those relating to IT, websites are likely to be the single most important initial means of communication, and there is simply no excuse for relevant government entities having anything less than a world class website. Further, there should be links to these sites wherever pertinent, and Tamil Nadu's initiatives should also be strategically disseminated (via the Union Ministry of Information Technology site, for instance).

There must be some champion for the state's IT industry within government, possibly the Chief Minister or Minister of Industry, with other ministers publicizing use of IT where it is related to their activities. The IT secretary should also be empowered and encouraged to speak publicly on behalf of the government on matters of IT. The state's politicians and high-level bureaucrats should be trained in the use of IT, and required to include IT in their discourse, budget and planning. There should be a communications component for every IT project.

Some of Tamil Nadu's comparative advantages that merit publicity are:

- Primary and secondary Education system -- among highest literacy rates in India for men and women with many English speakers.
- Schools program -- all the state's government higher secondary schools have computer labs, and most should be wired next year.
- Good access to quality higher education institutions -- IIT-Madras, universities, colleges, IGNOU, private training organizations (NIIT, Aptech)
- Most technical graduates of any state in India
- Government online -- downloadable forms, driver's licensing, STAR program, tenders, organizational information

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<sup>48</sup> TiE-Chennai may be an important platform for marketing to investors in the US

- Incubators -- Run by STPI and others in many major cities
- Numerous Government IT-related joint ventures -- many sponsored by ELCOT
- Support for business community -- recent trade mission to Singapore, one window approvals for new business, existing venture capital fund
- Biggest skilled labor exporter in India, which has positive implications for contacts overseas and returnees
- Significant economic base -- access to capital, business experience, potential local IT markets, strong manufacturing industry, vibrant film industry
- Offices of most of the biggest Indian IT companies -- TCS, CGS, Infosys, Satyam Infoway, Pentafour
- Excellent business climate/reputation -- known as a business-friendly government, has a state IT policy
- Ever improving IT infrastructure -- TIDEL park, Chennai Cyber Corridor, plus smaller projects in Coimbatore, Madurai, rapidly growing bandwidth, VSNL node in Chennai, STPI nodes in Coimbatore and Chennai
- Relatively good infrastructure -- electricity, roads (including new public-private toll roads), port, international airport (only 2 ½ hour flight to Singapore/Kuala Lumpur), new Madras Rapid Transit System for regional travel
- Geographical diversity -- not all business centered in capital city
- Relations with significant Tamil Diaspora
- NASSCOM study, HIID study on competitiveness, journal accounts all corroborate positive outlook
- Nice climate, beautiful geography, great food

## SELECTED GLOSSARY

CID	Center for International Development at Harvard
DoT	Department of Telecommunications
DTS	Department of Telecommunications Services
ELCOT	Electronics Corporation of Tamil Nadu Ltd.
HIID	Harvard Institute for International Development
ICT	Information and communications technology
IGNOU	Indira Ghandi National Open University
IIT	Indian Institute of Technology
IT	Information technology
ITG	Information Technologies Group at CID
NASSCOM	National Association of Software and Software Services Companies
NIC	National Informatics Center
NRI	Non-Resident Indian
STPI	Software Technology Parks of India
TeNeT	Telecommunications and Networking Group at IIT-Madras
TIDCO	Tamil Nadu Development Corporation
VSNL	Videsh Sanchar Nigam Limited

## SELECTED WEBSITES

**Articles**

Deployment in Developing Countries?

<[http://www.isoc.org/inet99/proceedings/1c/1c\\_2.htm](http://www.isoc.org/inet99/proceedings/1c/1c_2.htm)>

The First Mile of Connectivity

<<http://www.fao.org/docrep/x0295e/x0295e00.htm>>

Cyber Naidu's bug-ridden Andhra Pradesh

<<http://www.hindubusinessline.com/stories/042039ch.htm>>CNN.com - India's e-commerce law heralds economic progress, but privacy issues loom -  
June 29, 2000<<http://www.cnn.com/2000/LAW/06/29/india.IT.law/index.html>>

ISI Emerging Markets India

<[http://www.securities.com/cgi-bin/is/94dec/IN/homepage\\_config.html](http://www.securities.com/cgi-bin/is/94dec/IN/homepage_config.html)>

Elementary, my dear Watson

<[http://www.economist.com/surveys/displayStory.cfm?Story\\_id=375504](http://www.economist.com/surveys/displayStory.cfm?Story_id=375504)>

Economist

Untangling e-economics

Sep 21st 2000

<<http://www.economist.com/surveys/showsurvey.cfm?issue=20000923>>The Economic Times Online - India's No.1 Business Newspaper - Companies, Industry,  
Economy, Politics<<http://216.34.146.179/today/pagehome.htm>>

Business World- 17th January 2000

<<http://www.businessworldindia.com/archive/200117/index.html>>**Portals**

Chennaionline-Indian online Magazine from Chennai, India

<<http://www.chennaionline.com/>>

Gate-way to Chennai ...

<<http://www.chennaionnet.com/>>

Coimbatore Online

<http://www.coimbatoreonline.com/>

Madurai Online

<<http://www.maduraionline.com/>>

India Times : The Total Solution to any Indian business information

<<http://www.india-times.com/>>

Welcome to rediff.com

<<http://www.rediff.com/>>

India Times

<<http://www.india-times.com/data1/links.html>>

Business Today

<<http://www.india-today.com/btoday/>>

Cyber India Online: Technology, news, reviews, analysis, career guides, and Internet resources for the Information Technology professional

<<http://www.ciol.com/>>

Welcome to Mantra Online

<<http://www.mantraonline.com/>>

VSNL Power Portal

<<http://internet.vsnl.net.in/>>

Indiatimes - Your Gateway to India

<<http://indiatimes.com/>>

Welcome to Deccan Net - South India Online!

<<http://www.deccan.net/>>

### **Organizations**

Welcome to NASSCOM Home Page

<<http://www.nasscom.org/>>

Welcome to SatyamOnline.com

<<http://www.satyamonline.com/main.asp>>

WorldTel Home Page

<<http://www.world-tel.com/>>

NCI

<<http://www.indiansources.com/>>

Dhar- The Symbol of Change

<<http://www.gyandoot.net/>>

indev - India Development Information Network

<<http://www.indev.org/>>

Indian Women Online

<<http://www.indianwomenonline.com/>>

Tamil Nation - a growing togetherness of more than seventy million Tamil people

<<http://www.tamilnation.org/>>

TeNeT - The Telecommunications and Computer Networks Group, IIT Madras, India

<<http://www.tenet.res.in/>>

FreeOS - The Resource Center for Free Operating Systems

<<http://www.freeos.com/indianlinux/>>

Welcome To DishnetDSL

<<http://www.ddsl.net/>>

### **Government Organizations**

National Taskforce on IT & Software Development

<<http://it-taskforce.nic.in/>>

Indian Institute Of Technology, Madras, India

<<http://www.iitm.ac.in/>>

Chennai Telephones- Home Page

<<http://www.chennaitelephones.gov.in/>>

ELCOT

<<http://www.elcot.com/>>

Welcome to the Official Website of Andhra Pradesh

<<http://www.andhrapradesh.com/>>

Videsh Sanchar Nigam Ltd., India - VSNL

<<http://www.vsnl.com/english/index.html>>

Tamilnadu Telecom Circlenewpage1

<<http://tamilnadu.dotindia.com/>>

IT Schools 2000 Project

<<http://jiva.org/itschools/>>

National Informatics Centre

<<http://www.nic.in/>>

News Archive of Ministry of Information Technology

<<http://www.mit.gov.in/newsarchive/index.htm>>

Links to other sites

<<http://www.mit.gov.in/other.htm>>

Welcome To ETH Education

<<http://education.eth.net/>>

FreeOS - The Resource Center for Free Operating Systems

<<http://www.freeos.com/indianlinux/>>

Welcome To DishnetDSL

<<http://www.ddsl.net/>>

Welcome to Deccan Net - South India Online!

<<http://www.deccan.net/>>

CENTRAL VIGILANCE COMMISSION

<<http://cvc.nic.in/>>

Mahithi

<<http://www.bangaloreit.com/Mahithi.htm>>

Gopinath Munde - Welcomes you for E- Governance

<<http://www.gopinathmunde.com/>>

Trade and Technology Centre for Electronics-India

<<http://www.ttce.org/>>

Infosys Technologies Limited

<<http://www.inf.com/infosys.htm>>

ISP India Info - Your Comprehensive guide about the Indian ISPs

<<http://www.ispindiainfo.com/>>

## **Data**

Welcome to Cyber-Geography Research

<<http://www.cybergeography.org/>>

Nua Internet How Many Online

<[http://www.nua.ie/surveys/how\\_many\\_online/index.html](http://www.nua.ie/surveys/how_many_online/index.html)>

ITU: Telecom Indicators

<<http://www.itu.int/ti/>>

Evaluating the size of the Internet

<<http://www.netsizer.com/>>

The Geography of Cyberspace Directory - Internet Traffic and Demographic Statistics

<<http://www.cybergeography.org/statistics.html>>

Global Diffusion of the Internet

<<http://mosaic.unomaha.edu/>>

Focus Tamil Nadu - Snapshot of Chennai

<<http://www.focustamilnadu.com/tamilnadu/focus/profiles/Snapshot.htm>>

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L. Ravichandran  
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Achyuth Reddy  
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R. Sakthivel  
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Tamilnadu Corporation for Development of Women Ltd.

Divya Sampath  
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Satyam Infoway Limited

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Electronic Data Systems (India) PVT. Ltd.

Pradeep Singh  
Chief Executive, Infrastructure  
Infrastructure Leasing & Financial Services Limited

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