3. Internet policy

3.1 Role of incumbent telecom operator

SingTel, the incumbent telecom operator, is deeply involved in the Internet.[1] Activities range from Internet service provision to one of the most extensive international Internet backbones in the world.[2] *SingNet*, SingTel's Internet subsidiary, was the country's first commercial ISP, launching service in July 1994. This early start has given it an advantage as today it has the largest base of paying dial-up subscribers. Another advantage is SingTel's fixed telephone network; in December 1999 it announced that it would provide free Internet and e-mail accounts to all telephone subscribers.[3] SingTel benefits from dial-up Internet traffic since users have to pay local telephone charges. It has an agreement with StarHub to share telephone usage charges for the latter's *free* Internet access service. There is remarkably little rancour among other ISPs despite SingTel's advantages. One reason is that SingTel has agreed to provide unbundled access to other ISPs.[4] Another reason is that though SingTel has made the lion's share of investment in national and international Internet connectivity, it has thus far peered with other national ISPs.

3.2 Pricing

There are a range of Internet dial-up plans in Singapore. They revolve around three models:

- "Free" Internet access but subscriber pays for telephone usage charges - S$ 0.84 (US$ 0.48) per hour peak, that is 8am to 6pm weekdays - and S$ 0.42 (US$ 0.24) per hour off peak;

Table 3.1: SingTel's Internet Activities

Access		
SingNet	<my.singnet.com.sg>	ISP
SingTel Magix	<www.magix.com.sg>	ADSL
mysingtel	<www.mysingtel.com.sg>	Internet access for all telephone subscribers
e-ideas	<www.mysingtel.com.sg/e-ideas.html>	WAP
Infrastructure		
NCS Media Hub	<www.ncs.com.sg>	Web hosting
Consumer Connect	<www.consumerconnect.com.sg/ie-1000.htm>	B2C e-commerce
SingTel IX	<www.ix.singtel.com>	Internet traffic exchange
ID.Safe	<www.id-safe.com.sg>	Certification authority
Content		
Lycos Asia	<sg.lycosasia.com>	Portal
SESAMi.com	<www.sesami.com>	E-procurement

Source: ITU adapted from http://home.singtel.com/about/eactivities/eactivities.asp, December 2000

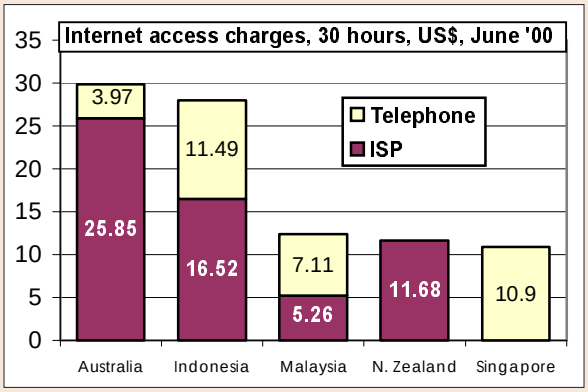
- Monthly Internet access fee for a certain number of hours of use with no telephone usage charges; and
- Monthly Internet access fee plus telephone usage charges.

The free Internet plan generally works out the cheapest so it is unclear why anyone would opt for a paid subscription unless they are really heavy users.[5] A price comparison among Asia-Pacific countries for 30 hours per month of Internet access is shown in Figure 3.1. At 30 hours of use, Singapore has the lowest dial-up charges compared to selected ISPs in the Asia-Pacific region (Figure 3.1).[6]

Broadband access services available in Singapore include conventional leased

Figure 3.1: Who is the cheapest?

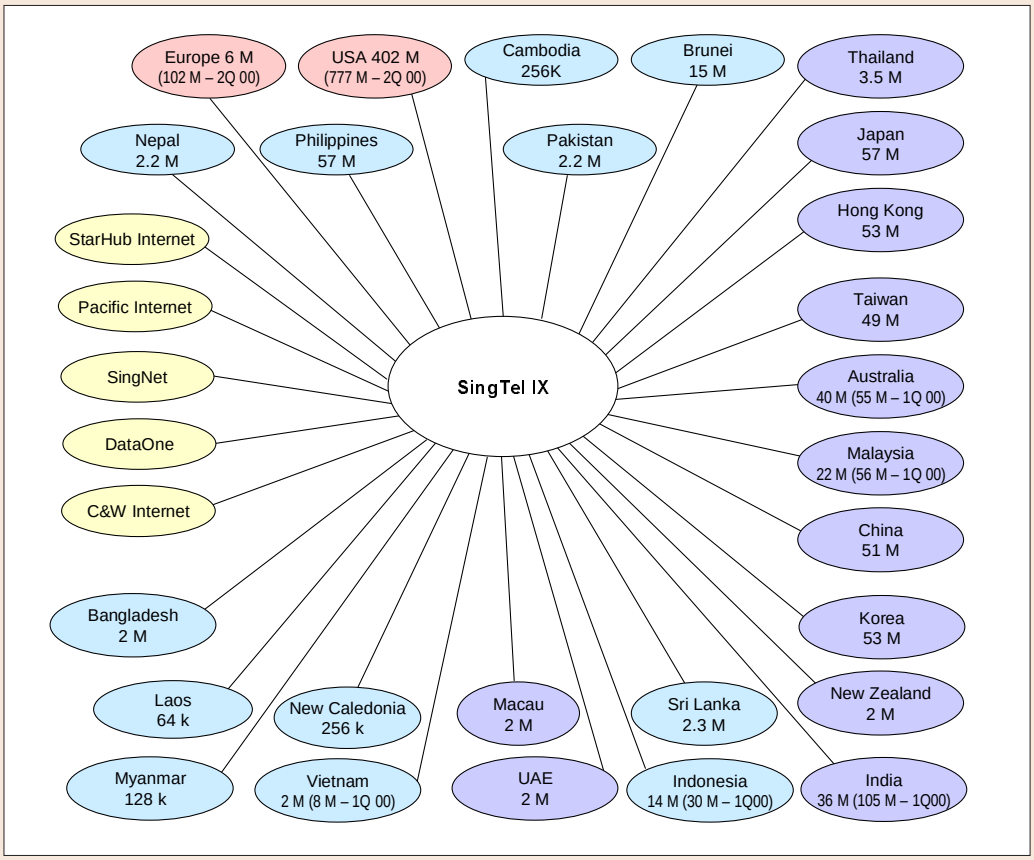
Dial-up Internet access charges including telephone usage charges, selected countries, June 2000, US$



Source: ITU adapted from Sources shown.

Figure 3.2: SingTel IX

November 2000



Source: http://www.ix.singtel.com/services4.html.

Table 3.2: Internet access prices

Dial-up Internet access charges for 30 hours of use per month, Singapore, June 2000, Singapore Dollars, not including tax

						Charge for 30 hours per month		
ISP	Plan	Joining fee [1/]	Monthly fee [2/]	Free hours [3/]	Extra hour [4/]	ISP [5/]	Tele-phone [6/]	Total
[7/ 8/]	Free off-peak	0	0	0	0	0	12.6	12.60
[7/ 9/]	Free average	0	0	0	0	0	18.9	18.90
SingNet	Plan II	40.00	24.95	35	3.00	24.95	0	24.95
[7/ 10/]	Free peak	0	0	0	0	0	25.2	25.20
Pacific	Easy Access Plus	39.95	19.95	40	2.95	19.95	18.9	38.85
StarHub	Unlimited	29.95	19.95	[11/]	0	19.95	18.9	38.85
Pacific	Unlimited	39.95	29.95	[11/]	0	29.95	18.9	48.85
SingNet	Plan I	40.00	9.50	13	3.00	60.60	0	60.60
Pacific	Easy Access 2000	39.95	4.95	13	2.95	52.15	18.9	71.05
SingNet	Plan Lite Surf	40.00	3.50	0	3.00	93.5	0	93.50
Pacific	Surf N Save	39.95	2.95	2	2.95	85.55	18.9	104.45

Note: [1/] Connection fee for signing up with the service. [2/] Monthly fee for subscription-based packages. [3/] The number of free hours included for subscription-based packages. [4/] Amount to pay for exceeding free hours. [5/] The monthly ISP fee plus extra hour fee if applicable. [6/] Telephone usage charges where applicable S$ 0.84 (US$ 0.48) per hour peak - 8am to 6pm weekdays - and S$ 0.42 (US$ 0.24) per hour off peak. For subscription-based packages, an average of S$ 0.63 (US$ 0.36) per hour has been used. [7/] StarHub and SingTel offer "free" Internet access (telephone charges are applicable). The joining fee for StarHub is S$ 29.95 (US$ 17). [8/] Free Internet access based on off-peak telephone usage. [9/] Free Internet access based on average of peak and off-peak (15 hours each) telephone usage. [10/] Free Internet access based on peak-rate telephone usage. [11/] Unlimited usage.
Source: ITU adapted from ISP data.

lines, Integrated Services Digital Network (ISDN), Asymmetric Digital Subscriber Line (ADSL), and cable modem. ADSL and cable modem are being promoted as consumer broadband access services in Singapore. They are cheaper than conventional offerings such as leased lines or ISDN but on a strict per price comparison, more expensive than dial-up Internet access. Cable modem access is a better value (e.g., unlimited use) and more comparable to international pricing than ADSL (see Table 3.3).[7] In November 2000 SingNet introduced flat rate, volume-based packages for ADSL. These packages allow unlimited use up to between 250 – 1'000 Megabytes. After those limits have been passed, users are charged S$ 2.95 (US$ 1.7) per ten Megabytes. SingNet states that the time-based package is more suitable for those downloading multimedia files while the volume-based plan is more appropriate for those engaged in general web surfing. SingNet is also exploring unlimited access to local sites arguing that an unrestricted flat rate package is not feasible due to the high cost of international Internet connectivity.

In November 2000, IDA announced that in February 2001 it would auction five lots of spectrum for Fixed Wireless Broadband (FWB) as yet another alternative to high speed Internet access. Most FWB technology is based on Local Multi-point Distribution Services (LMDS) that theoretically can provide speeds of up to 155 Mbps. In January 2001, IDA announced a delay in the auction until after May based on input from poten-

Table 3.3: Broadband Internet pricing

September 2000, US$

ISP	Type	Connection	Hours	Extra Hour	Taxes Included	Monthly price
SCV	Cable	29.69	Unlimited	0	Yes	43.82
SCV [1/]	Cable	29.69	Unlimited	0	Yes	32.29
SingTel	ADSL	17.30	20	1.73	No	34.59
SingTel	ADSL	17.30	60	1.73	No	69.18
Comparison with US:						
@Home	Cable		Unlimited	0		$39.95-$44.95
BellSouth	ADSL		Unlimited	0		49.95

Note: Converted to US$ at June 2000 exchange rates.
[1/] For existing cable television subscribers.
Source: ITU adapted from ISP data.

tial bidders who stated they needed more time to assess the technical feasibility and market situation. One problem has been a deterioration of quality when it rains, something that happens quite often in Singapore.

3.3 Regulatory issues

3.3.1 ISP

As with telecommunication liberalization, Singapore has progressively eased the conditions for providing Internet access. Two new ISPs—*Pacific Internet* and *Cyberway* (now StarHub Internet)—were licensed in September 1995 to compete with *SingNet*, Singapore Telecom's ISP. They were provided with a five year license (renewable on a 3 yearly basis) in exchange for a one-time S$ 450'000 (US$ 259'000) license fee and an annual payment of one per cent of annual gross turnover subject to a minimum of S$10'000 (US$ 5'765). This trio had the market to themselves until October 1998 when IDA lifted its ban on market entry. The combination of the relatively high license fee, small market size, and restrictions on foreign investment attracted only one new entrant. In September 1999, the foreign equity limit of 49 per cent was lifted, attracting an additional two ISPs, Cable and Wireless and UUNet. Market entry into the Internet access provision market was further liberalized from 1 April 2000—along with full telecommunication market opening—when the one time license fee was changed to a yearly payment of one per cent of annual gross revenue or a minimum of S$ 10'000 per year.

ISP service falls under IDA's Service-Based Operator (SBO) Individual license category.[8] The license is called an Internet Access Service Provider (IASP). This type of license allows the licensee to "establish, install and maintain a public Internet access facility for the provision of public Internet access services."[9] There were 36 IASP licenses at February 2001. ISPs must seek IDA's approval for pricing and meet certain minimum quality of service levels. This in-

Table 3.4: ISP Quality of Service conditions

Parameter	QOS Standard
Network availability	over 99.5%
System accessibility - Dial-up access - Leased-line access	 over 95% over 99%
Service Activation Time from date of receipt of application - Dial-up access - Leased-line access	 3 working days 7 working days

Source: IDA.

cludes 99 per cent network availability, 95 per cent dial-up availability and processing dial-up applications within three days and leased lines within one week.

An SBO (Individual) licence is necessary to provide international Internet access and traffic exchange. Singapore Telecommunications was the sole Internet Exchange Service Provider (IXSP) until June 1999 when this market segment was opened. As of February 2001, there were 18 IXSPs.

In the past, peering was not much of an issue since there were only three ISPs and they agreed to exchange traffic through the Singapore One broadband network. Whether this situation will continue is uncertain given the growing competitiveness of the ISP market.

Groups such as cybercafés, hotels and others are allowed to resell Internet access without having to apply for a license since they would normally be provided service by a IASP. They are not allowed to price service higher than the rates of the IASP.

Singapore has been at the forefront of the campaign for equitable cost sharing of Internet circuits to the United States. Foreign ISPs have traditionally borne the full cost of the Internet circuit to the United States. As a result US ISPs can provide access to Internet sites around the world for their users without having to pay for the costs. In January 1999 SingTel, along with seven other Asian telecom operators, signed a resolution encouraging US ISPs to share the cost of the international Internet link.[10] In May 2000, the Singapore Minister of Communications and Information Technology urged a meeting of the Asia-Pacific Economic Cooperation (APEC) to support equitable sharing of international Internet links.[11] A moral victory of sorts was obtained in October 2000 when the World Telecommunication Standardization Assembly—the body that proposes principles for international telephone charging—endorsed a recommendation that calls for more equitable cost sharing of international Internet connections.[12]

3.3.2 Top level domain name

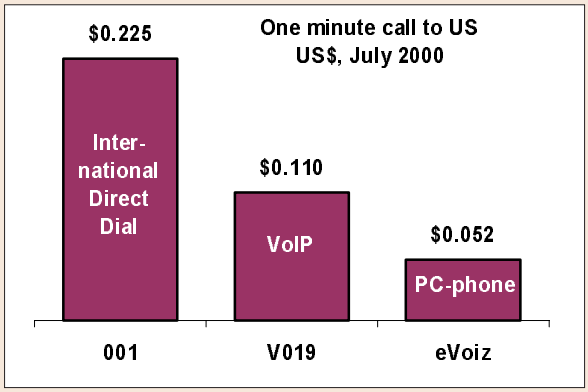
The Singaporean top level domain (ccTLD .sg) is administered by the Singapore Network Information Centre (SGNIC) <www.nic.net.sg>. SGNIC was formed in October 1995 to take over domain name management from TechNet when it was sold to Sembawang Media (establishing Pacific Internet). SGNIC's present members are the three original ISPs and IDA. Singapore follows a traditional scheme for second-level domain names (i.e., .com, .gov, .edu, .net, .org) with very specific registration requirements.[13] A recent addition is the personal (.per) second-level domain that allows applicants to use their own name for web site addresses (e.g., www.yourname.per.sg). The fee for registering a domain name is S$ 60 (US$ 35) per year. According to the Internet Software Consortium, there were 148'249 hosts using the .sg domain name in January 2000. Although practically all government-related organizations use the .sg domain name there is some evidence that businesses are also using the three-letter .com for their web sites. According to Network Solutions, one of the registrars for the .com top-level domain, Singapore ranks twentieth in .com registrations (although behind a number of other Asia-Pacific economies including the Republic of Korea, Japan, Australia, India, China and Hongkong SAR). Singaporean laws apply to web sites using the .sg domain regardless of whether they are physically located in the country.

3.3.3 Internet Protocol (IP) telephony

Prior to full liberalization of the telecommunication market in April 2000, only SingTel could provide IP-based telephony services as this was considered a voice service. The one exception was computer-to-computer telephone calls between two Internet users. With market liberalization, a new *Internet-Based Voice and/or Data Service* class license was created. Any organization can offer Internet based voice or data services provided they have a license and

Figure 3.3: Calling choices

SingTel overseas calling plans



Source: ITU adapted from SingTel.

abide by a minimum quality of service. At mid-September 2000, there were 70 companies that had been licensed to provide Internet-Based Voice Services.

While many incumbent telecommunication operators have been leery of Internet-based telephone calls, SingTel has launched a couple of IP telephony services that are significantly cheaper than its normal international tariff. *eVoiz* allows users to make a call from their PC to telephone subscribers in selected countries. A one-minute call to the US costs S$ 0.09 (US$ 0.05) compared to S$ 0.39 (US$ 0.23) per minute for International Direct Dialling (IDD). SingTel estimates that eVoiz will add ten million minutes a year of international traffic.[14] SingTel's *V019* service, launched in August 2000, allows any telephone user to make an international call over IP-based networks by dialling a special number. A one-minute VO19 call to the US costs S$ 0.19 (US$ 0.11), almost half the normal IDD charge.[15]

3.3.4 Content

Internet content is regulated by the Singapore Broadcasting Authority (SBA) as part of its responsibility for all broadcast media. SBA's regulatory framework for the Internet is embodied in the Singapore Broadcasting Authority (Class License) Notification 1996 <www.sba.gov.sg/work/sba/internet.nsf/pages/Doc21>. This license contains the regulatory requirements for both ISPs and Internet Content Providers (ICPs). There is an automatic licensing framework and no need to obtain prior approval from SBA. However, ISPs eventually need to register with SBA, after being granted a license by IDA and within two weeks of operating their service. ICPs do not need to register with SBA unless their web pages are primarily set up to promote political or religious causes. ISPs pay an annual license fee ranging from S$ 100 (US$ 57.7) to S$ 1'000 (US$ 577), depending on the type of service they are offering. Internet Access Service Providers (IASPs) and non-localized Internet service resellers who have more than 500 user accounts pay an annual licence fee of S$ 1'000 (US$ 577), while non-localized Internet service resellers with less than 500 user accounts and localized Internet service providers pay S$ 100 (US$ 57.7) a year.

The SBA's content role is based on maintaining community social values and racial and religious harmony in Singapore. Its objective is to have minimal legislation and instead encourage industry self-regulation and public education. The SBA is responsible for ensuring that content broadcast on the Internet follows the Internet Code of Practice <www.sba.gov.sg/work/sba/internet.nsf/pages/code>. The Code of Practice identifies what the community regards as offensive, namely pornography, violence, racism and religious slurs.

ICPs are liable for content that breaches the license restrictions mentioned above. ISPs are not liable for content accessed through their connection but are liable if they operate web sites for the public. SBA is concerned only with the provision of ma-

terial to the public. Thus corporate Internet access for business use is outside the scope of SBA's regulations, as is private communications (e.g. electronic mail and instant messaging). The scope of the license covers all web sites physically located in Singapore, as well as content created in Singapore. The SBA receives around a dozen complaints every month. Once the SBA receives a complaint, the content provider is informed and typically takes the necessary steps to make its web site conform with the regulations.

As a symbolic gesture initiated by the government to indicate its concern over dissemination of pornography, SBA obligates ISPs to block out 100 pornographic web sites. SBA has also provided funding to ISPs for them to provide *family* subscriptions. These subscriptions are operated through proxy sites that prevent access to pornographic and other controversial sites using commercial filtering services such as CyberPatrol and SmartFilter <www.surfcontrol.com/index.html and www.smartfilter.com>. SBA also supports content classification using the Platform for Internet Content Selection (PICS) system developed by the World Wide Web consortium. It urges content providers in Singapore to support this effort by labelling their sites, as part of industry self-regulation.

Since the introduction of Internet content regulation in 1996, SBA has been consulting with the community and industry so that it can fine tune its policies to promote and facilitate the growth of the Internet. SBA emphasizes public education and awareness since there is a limit to what domestic legislation can achieve in the face of a borderless medium like the Internet. Through organizing exhibitions, conducting talks for the public and working with schools, libraries and community organizations, SBA strives to build awareness. SBA also aims to educate parents on the tools that are available for them to better supervise their children's use of the Internet. SBA works closely with a volunteer group called the *Parents Advisory Group for the Internet* (PAGI) <www.pagi.org.sg>, which was established in November 1999. PAGI provides a support network for parents to share their ideas and concerns on guiding their children to use the Internet in a positive way. The PAGI web site hosts an online discussion forum for parents to exchange views, ideas, and experiences on safe surfing and best practices. PAGI has conducted workshops in various languages to cater to the multilingual community. These workshops also help parents themselves to use the Internet.

For the most part, SBA's Internet content role is passive in that it mainly responds to complaints. Its preference is for the industry to be self-regulating. The fact that Singapore has tried to do something about controversial content has led to the incorrect impression that Internet use is restrictive in the country. The reality is quite different, as official content control is innocuous. On the other hand, the major efforts Singapore is making to develop content in local languages and promote Singapore as a multilingual Internet hub are to be applauded (see Box 3.2).

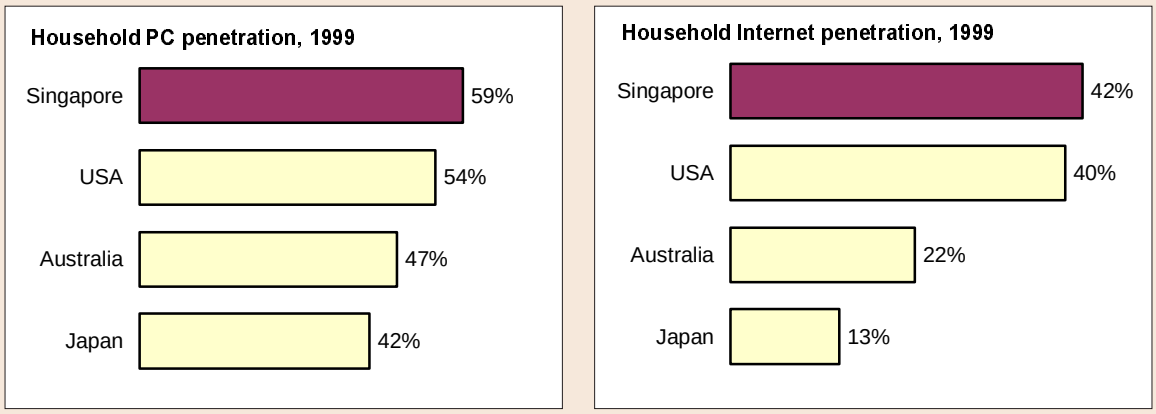
3.4 Universal access

Universal access takes on new meaning for a country with near universal telephone service and among the highest home PC and Internet access rates in the world. Although there is not a precise measurement of home telephone availability, evidence suggests it is close to 100 per cent.[16] Close to 60 per cent of the island's homes have a PC and 42 per cent have Internet access, the highest rates in the world (see Figure 3.4). SingTel has provided all its residential telephone subscribers with a free Internet account. If one assumes that all of the homes with a PC also have a telephone line, then 59 per cent of Singapore's households can theoretically access the Internet for the price of a local telephone call.

The small size of the island coupled with widespread public Internet access at schools and community centres and a scattering of cybercafés

Figure 3.4: Whose homes are most connected?

Household PC and Internet penetration, 1999



Source: ITU adapted from IDA.

suggests that no one is very far from the Internet if they need it. Therefore universal access is complete. Awareness of the Internet is also high; a 1998 survey found that over 90 per cent of Singaporeans were aware of the Internet. All the current dot-com publicity—including buses and cabs displaying URLs—suggests that awareness of the Internet today is probably close to 99 per cent.

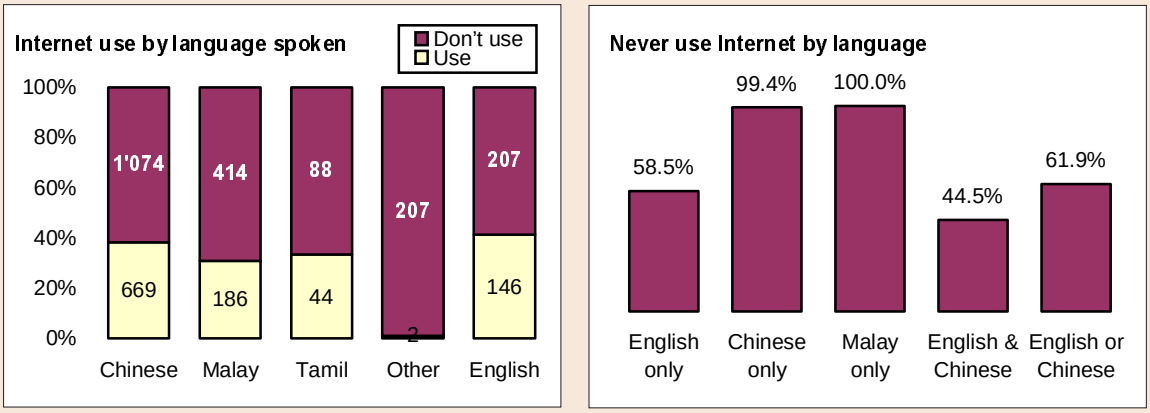
Therefore problems with access to the Internet are not primarily infra-

structural or economic (the country is Asia's second wealthiest after Japan) but more social and cultural. This includes convincing people that the Internet is relevant. For example, the 1999 IDA *Information Technology Household Survey* found that the main reason homes did not have Internet access was there was no perceived need for it (47 per cent) compared to only 16 per cent that found it too expensive. Other reasons included not having the appropriate hardware (ten per cent) and not knowing how to use the Internet (four per cent). Ten per cent of respondents indicated that they were planning to get Internet service soon.

In an effort to get more Singaporeans online, IDA announced a three-year S$ 25 million (US$ 14 million) program targeted at "*low-income households, different ethnic groups and the late adopters of infocomm technology*."[17] Projects include donation of used computers with free Internet access and basic training to some 30'000 low-income households as well as providing free broadband access to Singapore One at community centres and promoting Internet kiosks (see Box 3.1).

A profile of the Singaporean home Internet user reveals the same sort

Figure 3.5: Internet and language



Note: The charts show the share of population and Internet use by language spoken rather than ethnic group.
Source: ITU adapted from CABSAT/NETWATCH.

of Digital Divide that exists in other nations.[18] There are more males (57 per cent), users tend to be young (the age group with the highest share are those aged 20-29 while those over 50 account for only five per cent) and well-educated (over 60 per cent have post-secondary education). What is striking is the breakdown of Internet use by language; those who do not speak English well have a much lower level of usage. For example almost half of Singaporean adults that are literate in English are on-line compared to around one third of those that do not (see Figure 3.5). It also pays to be literate in more than one language. Around 55 per cent of Singaporeans who understand English and Chinese are online compared to 38 per cent of those who are literate in either Chinese or English but not both. Most remarkably, there are hardly any Internet users amongst those who speak only Chinese or Malay. The government is working to overcome these linguistic barriers by promoting the development of content in different languages (see Box 3.2).

Box 3.1: Kiosking Singapore

One has to look hard to find cybercafés in Singapore since there is already a high level of Internet access from work, schools and homes. According to one source, only two per cent of Singaporeans use cybercafés to access the Internet. This has not deterred i-One Net International, a Singaporean media company, from installing Internet kiosks across the island to reach out to the unwired. By July 1999, they had rolled out around 500 public kiosks along the main retail and tourist area of Orchard Road as well as shopping centres, government buildings, community centres and schools. The kiosks are linked to I-One Net's main portal that provides local information such as where to shop and eat. Kiosk users can also purchase items over the Internet using credit and bank cards to pay for their on-line purchases. The I-One Net portal hangs off of the Singapore One broadband network and although it is accessible to anyone with Internet access, the kiosks help to push I-One Net's brand name. In addition to on-line advertising and transaction fees, I-One Net also makes money from 'off-line' advertising by allowing merchants to display advertisements on the kiosks. I-One Net is preparing a second generation of kiosks that will contain new features such as videocams at department stores, larger monitors and on-line chatting. Because Singapore is so wired, I-One Net is taking its public access experience abroad. In China, I-One Net is developing a number of public Internet access franchises in Shanghai, Guangzhou, and Beijing.

Box 3.2: Multilingual Singapore

Widespread use of English in the educational, health, government and corporate business sector has contributed to Singapore's high Internet access since most Internet content is in English. However, the majority of the island's citizens speak other languages at home. The government is making strong efforts to promote content in local languages. These include Chinese, Malay and Tamil Internet initiatives.

The National Chinese Internet Programme (NCIP) provides hands-on training for Chinese Internet and exhibitions to raise awareness of Chinese Internet. NCIP has developed a Chinese portal (Chinese WebTop or Hua Zong Wang). The potential of tapping into the huge Chinese-speaking market in Asia is also driving private initiatives to develop content. Singapore Press Holding's online version of its Chinese-language newspaper, Lianhe Zaobao, claims to be the number one Chinese portal in South East Asia. It hosts over 2000 home pages and averages between one-two million hits a day, with 70 per cent coming from mainland China.

The Tamil Internet Steering Committee (TISC) was established in April 2000 under the auspices of IDA, to act as Singapore's focal group in the development of Tamil Internet <www.singtisc.org.>. It organized one of the largest conferences on the Tamil Internet in Singapore in July 2000 with some 20'000 visitors. Although Singapore's Tamil population is less than a quarter million, TISC's efforts are reaching the 65 million Tamil speakers around the world. Singapore is also hosting the secretariat for a world body that is promoting the development and use of Tamil on the Internet. The International Forum for Information Technology in Tamil (INFITT) is made up of Tamil speakers from Australia, India, Malaysia, Singapore, Sri Lanka, Switzerland and the US. INFITT will develop standards and help develop the Tamil Internet. It will also serve as a coordinating body for worldwide efforts in Tamil content creation, especially for educational use. According to one government official, "*promoting and popularizing the role of the Tamil Internet to non-English speaking Tamil Singaporeans will further IDA's aim of narrowing the digital divide*."[19]

The Malay Internet Steering Committee (MISC) was established in May 2000 to promote the development and use of ICT among the Malay community. The MISC is supported by a Panel of Advisors, comprising experts in culture, language, technology and commerce. Formed under the auspices of IDA, the committee's role is to advise IDA and MCIT in the areas of developing local Malay Internet content and culture-based programs, the promotion of e-commerce and Malay Internet usage; and transforming Singapore into a global multilingual Internet hub. The MISC will also facilitate the bringing together of partners in content creation and public education projects.

[1] Internet and data services are growing and are now the second largest source of SingTel's revenue. Commenting on its June 2000 quarterly results, SingTel notes: "*Revenue from Public Data & Private Network increased by 51.1 per cent to S$243 million as Internet usage within and out of Singapore continued to surge. This segment, which includes leased circuits and data services, has become the Group's second largest revenue contributor at 19.8 per cent, up from 13.4 per cent a year ago.*" SingTel. "The SingTel Group's unaudited results for the quarter ended 30 June 2000." *Press Release*. 28 July 2000.

[2] A list of SingTel's Internet services can be found at: http://home.singtel.com/about/eactivities/eactivities.asp.

[3] SingTel. "Free Internet for every SingTel home and business." *Press Release*. 12 December 1999.

[4] For example it has offered wholesale prices for its ADSL service to other ISPs. See SingTel. "SingTel to offer broadband access service to ISPs." *Press Release*. 7 June 2000.

[5] Free Internet access generally has limited features. However, SingTel's free service provides an 8MB e-mail account and 12MB of user storage.

[6] However, after 30 hours of use, New Zealand would be the cheapest country in the region for home Internet access since residential users do not pay for local telephone calls.

[7] There are arguments about whether ADSL or cable modem is better. One functional advantage of ADSL is that there is no need for a second telephone line since you can talk and surf at the same time. Cable modems can theoretically send out data at 128Kbps and download it at 1.5Mbps while ADSL speed in Singapore is 512Kbps each way. However actual speed is dependent on backbone bandwidth and in the case of cable, how many users are on the same connection. Complaints about service have led IDA to look into quality of service issues for broadband networks. See IDA. "IDA'S Response To Public Feedback on SCV Cable Modem." *Press Release*. 13 April 2000.

[8] The list of services that can be provided under an SBO (Individual) licence include International Simple Resale, Internet Access Services, Internet Exchange Services, Virtual Private Network and Managed Data Network Service.

[9] IDA. *The Regulatory Environment for the Provision of Public Internet Access and Internet-Related Services In Singapore*. 3 February 2000.

[10] SingTel. "Asia Pacific Carriers Campaign for the US to Share Cost of International Internet Link." *Press Release*. 26 January 1999.

[11] Ministry of Communications and Information Technology. "Singapore Calls for an End to Unfair International Charging Practices for Internet Services." *Press Release*. 26 May 2000. http://www.mcit.gov.sg/p_00_05_26.html.

[12] ITU. "Major Decisions reached at World Telecommunication Standardization Assembly." *Press Release*. 6 October 2000. http://www.itu.int/newsroom/press/releases/2000/22.html.

[13] For example, .com is for commercial companies registered with the Registry of Companies and Businesses, .org for not profit organizations registered with the Registry of Societies, .gov is for members of the Singaporean government and.edu for educational organizations registered with the Ministry of Educations. See http://www.nic.net.sg/sgdom.html.

[14] SingTel. "SingTel introduces eVoiz, a PC to Phone service." *Press Release*. 6 March 2000.

[15] SingTel acknowledges that the quality of IP-based calls is inferior but *notes "While the V019 call quality may be somewhat below our 013 BudgetCall service, our target customers will still find it acceptable and very much value-for-money*." SingTel. "Say hello to easy and cheap international calls with V019." *Press Release*. 30 July 2000.

[16] One of the reasons that there is no official statistic on home telephone ownership is that it is assumed everyone has one. For example SingTel notes: "Almost all Singapore homes have basic telephone services and about 12 per cent of households have more than one DEL." SingTel. *Full Financial Report. 1996/1997*.

[17] See "Helping Singaporeans Go Online". IDA Press Release. 1 March 2000. Available on the IDA web site at www.ida.gov.sg.

[18] 1999 IT Household Survey.

[19] "Tamil Community on the Web." *Singapore Wave* (IDA publication). 15 September 2000.

4. Information & Communication Technology & the Nation

4.1 Government

The Singaporean government is involved with Information and Communications Technology (ICT) in three ways. One is as a *user* in its own right. The second is as a *provider* of electronic government services to the public. The third is as a *promoter* of ICT—or as the Singapore government likes to call it, *infocommunications*—on the island.

4.1.1 Government as user

The Singapore government was an early adopter of ICT. In 1981, it introduced a *Civil Service Computerization Program* to train all public employees in the use of Information Technology. In 1998, the Ministry of Defence launched the world's first Internet-based government procurement system. Today the Singaporean government is recognized as one of the most computerized in the world. Singapore's some 30'000 public servants use the government e-mail system while the government Intranet attracts 50 million hits a year.

One notable application is Government eBusiness (*GeBiz*) <www.gebiz.gov. sg>, launched in June 2000. GeBiz is an on-line portal for the government's business-to-business dealings. The Ministry of Finance intends to transfer all procurement processes that can be put online to GeBiz. The system integrates financial and procurement systems of government ministries and agencies, allowing users to browse supplier catalogues and purchase products. It also displays procurement requirements of different government ministries and agencies for potential suppliers.

4.1.2 Government as provider

The government is actively developing and promoting electronic services delivery with the objective of creating an e-based society. All ministries have a web presence, integrated through the government's central portal <www.gov.sg> which averages over three million hits per quarter. As of June 2000, about 450 public services were available online. Within the next three years, all government over-the-counter procedures should be online. One example of a

Figure 4.1: e-citizen

Source: <www.ecitizen.gov.sg>, December 2000.

successful application is the online submission of income tax forms. So far, about one quarter of all tax returns have been filed on-line through the *eFiling* service provided by the Inland Revenue Authority. One incentive has been allowing a one-week extension for tax forms filed online.

One of the government's most significant projects is *eCitizen* (www.ecitizen.gov.sg). The aim is to create a single portal providing a plethora of government services. The *eCitizen* portal is a window to public services. Services are organized according to life events, rather than by departments or agencies. As citizens travel down the "road of life," they can stop at "buildings" that line the road. The buildings represent topics such as family, housing, health and education. Each topic integrates information from various government agencies. For example, the "Family" topic, has information on "Care for the Elderly" from the Ministry of Health, while information on "Getting Married" comes from the Ministry of Community Development. A user could find out how much a marriage license costs, where to file the application and even submit it online. *eCitizen* was launched in April 1999, offering 16 service packages and 108 electronic services. The eCitizen portal aims to offer more than 60 service packages and more than 200 services by April 2001.

The design of *eCitizen* allows each agency to keep its own web site but to display the content by function. The new approach is accomplished by integrating information and services from various government agencies. This integrated approach requires government agencies to adopt customer orientation and strong coordination efforts.

The Singaporean government will spend S$ 1.5 billion (US$ 0.86 billion) on e-Government related programs in the next three years. It is adopting a flexible approach seen in its readiness to challenge traditional methods of system procurement and implementation and assumptions of delivering public services on private sector infrastructure and through public-private sector collaboration. A portion of this fund will be set aside to develop programs to give civil servants in-depth understanding of how ICT tools impact the country's economic and social situation.

One of the success factors of eGovernment initiatives is the strong coordination between ministries and the key leadership roles of the Ministry of Finance and IDA. The Ministry of Finance has the financial muscle to secure top management commitment across government agencies and ministries while IDA assists with technical support.

4.1.3 Government as promoter

The government has historically played an active role in economic planning and investment in several sectors, including IT. The success of this central control has been due in large part to a unique policy, which attracts and retains outstanding civil servants. In the 1980s, the government turned its attention to IT, beginning with the 1981 Civil Service Computerization Program. In 1986, a Committee on National Computerization was formed to create a national IT plan. In 1992, the *IT2000* plan was published, calling for the construction of a broadband infrastructure; common network services (such as directories, security, authentication, and billing); experiments with applications; forging international strategic alliances with industry leaders in Japan, Europe and the US; and establishing a policy and legal framework on issues like data protection, privacy, copyright and intellectual property rights, and the admissibility of computer-imaged documents in court.[1] In 1997, the Ministry of Education created an ambitious five-year plan for IT-based education (see section 4.3).

A number of government or government-linked organizations were also established in the IT area:

- The National Computer Board (NCB), playing the key role in strategic planning;

- 1-Net, a consortium originally consisting of ISPs and the government to build and operate Singapore ONE, the island's ATM backbone; and

- The Economic Development Board, charged with attracting capital and brainpower.

With the completion of the *IT2000* plan, government leadership in IT has accelerated. In December 1999, the NCB and the Telecommunication Authority of Singapore (TAS) merged, forming the Infocomm Development Authority (IDA), a statutory board under the Ministry of Communications and Information Technology. Next, the government accelerated the introduction of full market competition in telecommunications by two years, from 1 April 2002 to 1 April 2000, and lifted foreign equity limits for all public telecommunications licenses. Between 1994 and 1999, the government budget for communication and IT services grew from S$ 44.9 million (US$ 25.9 million) (0.5 per cent of the budget) to S$ 458 million (US$ 264 million) (3.3 per cent of the budget).[2] It also invested more than S$ five billion (US$ 2.9 billion) over the same period in ICT (see Figure 4.2). IDA is now working on a series of Infocomm Technology Roadmaps in consultation with industry and academia.[3] The first of these reports was published in July 2000 <www.ida.gov.sg/registration/RoadmapReg.nsf/frmForm?OpenForm>.

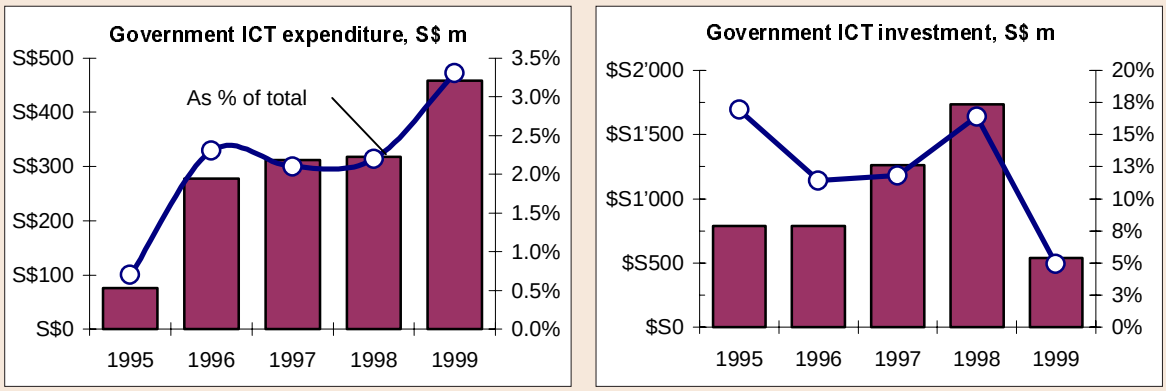
In addition to planning, government agencies and government-linked corporations make direct investments and offer subsidies in technologies and ventures they wish to advance.

One might expect this deep government involvement in planning, selection of technology, granting of incentives and direct investment to result in inefficient resource allocation and corruption. While the allocation of resources has not been perfect[4], there is no denying that Singapore has made very impressive strides in IT and other sectors of the economy. This is confirmed by various surveys pitting Singapore against other countries (see Table 4.1). Government intervention in the market has been successful because it has been accompanied by a unique civil service policy, coupled with the consensus spirit of Singaporean society.

The government recruits the best and the brightest, pays them well, and offers performance-based incentives. The mission of the Public Service Division of the Office of the Prime Minister is to "*build a first-class public service for a successful and vibrant Singapore*," and their motto is "*peo-*

Figure 4.2: Putting the money where the mouth is

Singapore government expenditure and investment for ICT, 1995-1999, S$ millions



Source: ITU adapted from Singapore Department of Statistics.

Table 4.1: Ranking Singapore

Singapore's rank in selected international surveys, 2000

Survey	Singapore Ranking	Remarks
Global Competitiveness Report	2 out of 59	World Economic Forum study that measure the factors that contribute to the future growth of an economy.
e-business-readiness	8 out of 60 (highest ranked Asia-Pacific country)	Economist Intelligence Unit rankings measuring the relative preparedness of the world's main markets for the e-business era.
Information Society Index	11 out of 55	World Times/IDC ranking by which nations are measured according to their ability to access and absorb information and information technology.
World Competitiveness Scoreboard	2 out of 47	International Institute for Management Development (IMD) study on the competitiveness of nations, it assesses and ranks how a nation's environment sustains the competitiveness of its firms.

Source: ITU adapted from WEF, EIU, World Times and IMD.

ple our pride, service our pledge, and integrity our core" <www.gov.sg/psd/pau/index.html>. Good students are attracted initially through a program of university scholarships.[5] Government salaries are reviewed annually to ensure that they are competitive with the private sector. Civil servants receive bonuses when the economy does well, and innovation and excellence are encouraged by significant bonuses based on individual accomplishment. There is also the Enterprise Challenge, a S$ 10 million (US$ 5.77 million) fund for innovative proposals that have the potential to create new value or significant improvements to the delivery of public service. Finally, lifelong learning is a priority with a variety of training programs and a program to identify and develop leadership. The net result is that civil service positions are prestigious and sought after. Thus, government planning and investment in IT (and other areas) is conducted by well qualified, motivated, and corruption-free civil servants making "industrial quality" decisions.[6]

4.2 Health

Singapore's health sector has been making steady progress in the use of IT. Singaporean hospitals are considered to be the best in the region. The health sector approach to IT remains pragmatic, though, and IT is adopted once applications have been tried and shown to have real benefits.

4.2.1 Ministry of Health

Utilization of information technology is pervasive at the Ministry of Health (MOH).[7] There is Internet access from every desktop at the headquarters. Polyclinics and hospitals are connected to the Internet. The Ministry web site provides a wealth of information ranging from listings of all medical practitioners on the island to links to the

Table 4.2: Singapore's health infrastructure

Number of health facilities and medical personnel, 1999

Hospitals/Specialised Centres	26
Hospital Beds	11'742
Family Health Service Clinics	18
Public Sector Dental Clinics	205
Doctors	5'325
Dentists	942
Nurses/Midwives	15'947
Pharmacists	1'043

Source: Singapore Ministry of Health.

government StoreFront where health-related publications are sold online. One hospital has a service called '*Ask a Nurse*', whereby the public can receive medical consultation via asking questions online. The national Health Education Department also offers a service called '*Ask an Expert*', where users can send queries about health concerns.

The MOH also has various web-enabled applications:

Continuous Medical Education <www.smc-cme.gov.sg>. This project, implemented in collaboration with the Singapore Medical Council, enables doctors to earn points based on their participation at medical seminars, reading journals, attending conferences, etc. in order to maintain their on-going certification.

School Health Screening Program <www.gov.sg/moh/mohiss/shlthsvc.html>. This system screens students in primary and secondary schools. Upon entry into the school system for the first time, every child is registered in a database. An electronic notification is automatically sent to students' schools prior to immunization due dates. Medical-related information is tracked for each student and can be downloaded to the school from the MOH database.

A similar system, the Elderly Screening Program, is currently underway for those 55 years and older. Over a period of three years, 380'000 people will be screened. They are tested for cholesterol, glucose, hypertension and other symptoms that affect the elderly. Referral letters are automatically generated, indicating actions to be taken for a particular patient.

eCitizen
The MOH is currently working to develop service packages that can be delivered over the government's e-Citizen portal. There are currently four services available: elderly care, hospital services, dental care and healthy lifestyles.

4.2.2 Impact of the Internet on the workplace

The Internet is viewed as having a major impact on both the health community and users:

Self-Help: Consumers are able to help themselves by getting medical information on the Internet.

Research: The Internet has provided a wealth of information for the medical community. It has facilitated access to information, which would not otherwise be so easily available without the Internet.

Education: Consumers are becoming more knowledgeable. The patient does not simply accept doctors' explanations; some of them are even questioning doctors' decisions. However, this has introduced another problem. The doctor is not seen as the sole authority. People can be misled by information they encounter over the Internet, which may lead to under-treatment, mistreatment or self-treatment, all of which may have negative repercussions for the patient.

IT at your Fingertips: The Internet has allowed doctors and nurses to easily grasp technology. The simplicity and ease of use of the Internet has allowed information technology to be easily integrated in the workplace.

4.2.3 E-Commerce

There are no regulations preventing drugs from being sold over the Internet, which the public sees as an attractive opportunity since it is more convenient and cheaper to buy medicine online in comparison to many retail outlets (some add a 20 per cent premium).

4.2.4 Scepticism

Singapore takes a very practical approach to health care applications and has thus far been sceptical about the concrete benefits of trendy applications such as e-procurement and telemedicine. Some Singaporean health personnel questions whether e-procurement dramatically reduces costs. Although there are estimates of savings between 20-30 per cent, it seems that some 60 per cent actually result from an improvement of internal processes. Regarding telemedicine, there is a pilot project using an ISDN connection to connect a hospital to a polyclinic for transferring x-rays. However, demand

has been low. In a small place like Singapore, it is far cheaper for the doctor to go directly where he/she is needed than to use telemedicine to transfer an x-ray. Another telemedicine application involves a private Singaporean hospital and Johns Hopkins Hospital in the U.S. It uses video-conferencing to exchange real-time medical data and consultation. Patients pay for it on an as-needed basis. Singaporean doctors do not favourably view telemedicine as a means for diagnosis. X-rays are better viewed in person as opposed to being digitally viewed on a screen. Online resolution levels have not yet reached those of film. The colour of a lump, for example, cannot be as clearly viewed on a screen.

4.3 Education

Strolling around the campus of the National University of Singapore (NUS), one notices many students with portable computers plugged into jacks by tables in common areas. This is an indication that the Internet is well established in higher education. The universities are connected and make good use of the Internet in teaching and research. While several nations can make similar claims for higher education, what sets Singapore apart is its level of connectivity of primary and secondary schools and the use of IT in the curriculum.

4.3.1 Higher Education

Universities in Singapore have a long, successful history of Internet connectivity and application. They are active participants in international network-based research, and have many excellent teaching programs. The latter produce many of Singapore's networking professionals and the government and institutions of higher education work together to anticipate and supply IT manpower.

University Connectivity

As in many nations, the university community pioneered computer networking in Singapore. The Computer Centre of the National University of Singapore (NUS) <www.nus.edu.sg> had a BITNET connection in 1987. In 1990, they established an IP network, TechNet, with Gopher and WAIS servers. NUS established a web site in 1993. In 1995, TechNet was spun off, forming a commercial Internet service provider, Pacific Internet.[8] After TechNet was sold, the NUS Internet Research and Development Unit (IRDU) used the funds for a variety of research and development projects. In 1997, IRDU (now the Centre for Internet Research) <www.cir.nus.edu.sg> joined forces with Kent Ridge Digital Labs <www.krdl.org.sg>, and the Network Technology Re-

Table 4.3: Singapore at school

Number of educational institutions, students and teachers, 1999

	Institutions	Students	Teachers
	Number		
Total	384	622,372	31,318
Primary Schools	199	300,153	12,132
Secondary Schools	152	173,007	9,210
Pre-University	16	25,032	1,841
Institute of Technical Education[1]	10	16,390	1,449
Polytechnics	4	57,126	3,422
National Institute of Education	1	3,317	511
Universities	2	47,347	2,753

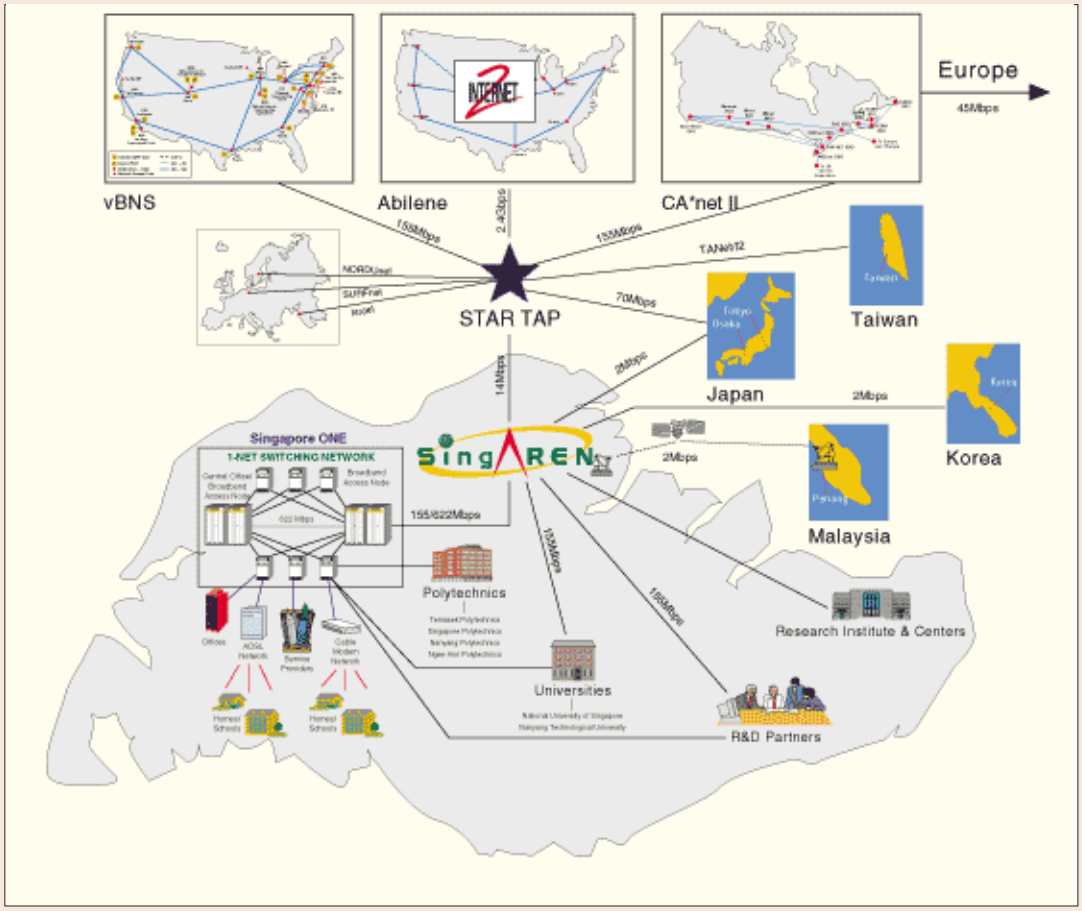
Note: Figures for primary, secondary and pre-university exclude private schools. Figures for institutions of higher learning include part-time students and teachers. [1] Refer to full-time teaching staff and students.
Source: Statistics Singapore.

search Centre <www.ntu.edu.sg/ntrc> of Nanyang Technological University (NTU) <www.ntu.edu.sg> to form SingAREN, the Singapore Advanced Research and Education Network <www.singaren.net.sg>. SingAREN is a national initiative to create a high-speed network to support R&D and advanced technology development. It serves users from academia, research organizations and industry.

SingAREN connects 30 higher education and research institutions within Singapore <www.singaren.net.sg/html/localnet.html>. There are 2 Mb/s international links to Japan, Korea and Malaysia and a 15 Mb/s link to the National Science Foundation's Science Technology and Research Transit Access Point (STAR TAP) in the United States <www.startap.net>. Through STAR TAP, the Singapore research and education community has access to Internet 2 and other research networks in the US, Canada and Europe. The Asian links tie them into the Asia Pacific Academic Network <www.apan.net>.

As usual in Singapore, SingAREN has government and commercial ties. SingAREN is funded by the NSTB and the IDA. It is also connected to Singapore ONE, so new technologies and services can be developed and tested in an experimental environment then deployed for commercially. SingAREN is also responsible for supporting Sin-

Figure 4.3: SingAREN Network Configuration



Source: http://www.singaren.net.sg/html/netmap.html, December 2000.

gapore ONE in using new broadband technology and protocols. The commercial relationship is captured in the SingAREN acceptable use policy, which states:

SingAREN is mainly intended for collaborative research projects requiring high speed communication links between local universities/research institutes/centres, and their counterpart organisations overseas. However, development oriented projects, which have high relevance e.g. developing enabling technologies for Singapore ONE are also strongly encouraged. <www.singaren.net.sg/html/aup.html>.

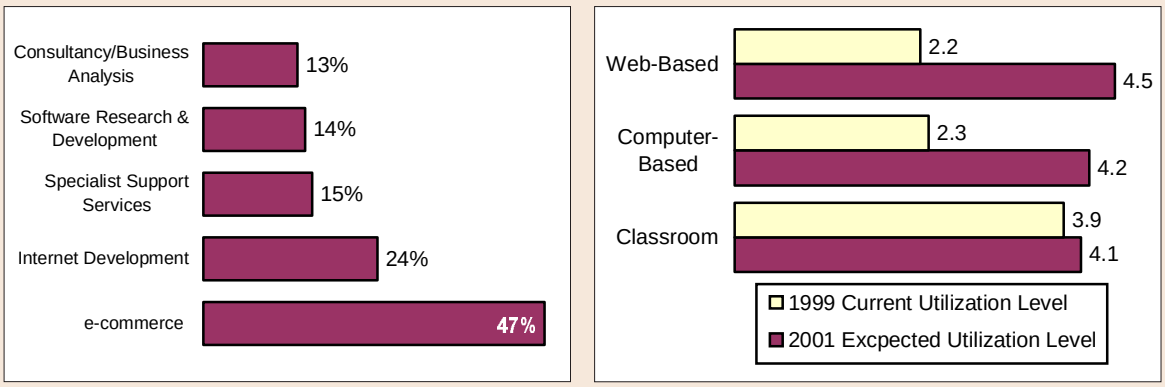
The close ties between the academic and commercial communities are further illustrated by the experience of the *Bioinformatics Centre* <www.bic.nus.edu.sg>. The Centre provides informatics service to the global biology community, teaches and conducts research. In addition to these traditional functions, it is encouraged to produce commercial spin-offs. To date, they have spun off BioInformatrix, Kris Technology and Bioinformatics Technology Group, and several others are being developed. The Director of the Centre, Tan Tin Wee, was also a founder and early leader of TechNet. He remains active in both the networking and biological research communities, and feels increasing emphasis on the commercialization of research at the university.

Meeting Singapore's Manpower Needs

Over 20 universities, polytechnics, and other higher education institutions offer degrees in more than 75 ICT programs ranging from practical skills to research. The quantity and quality of these programs reflects the Singaporean commitment to ICT. While the universities are autonomous, the IDA monitors and plans ICT manpower requirements via a biennial survey. The latest survey, conducted during the second half of 1999 found that 52 per cent of ICT employees have a bachelor's degree, 14 per cent a masters, and 0.2 per cent a doctorate. About 30 per cent have polytechnic diplomas. The number of ICT jobs is expected to grow at a rate of 10-12 per cent, from 92'800 at the end of 1999 to 114'000 by the end of 2001. The greatest growth is expected in e-commerce (47 per cent) and Internet development (24 per cent) (see Figure 4.4, left). The survey also showed that CEOs planned to increasingly meet training demands using Web and computer-based instruction (see Figure 4.4, right).

Figure 4.4: ICT manpower needs and training

ICT manpower categories with expected biggest growth 1999-2001, and Utilization levels of training methods



Note: In the right chart, 1 = no utilization, 10 = very high utilization.
Source: IDA 1999 Infocomm Manpower and Skills Survey.

A National Manpower Council (NMC) was formed last year to do integrated manpower planning for the economy <www.gov.sg/mom/news/news99/990831.html>. At their inaugural meeting, the NMC set new targets for universities and polytechnics. For example, NUS and NTU were advised to expand their intakes of Engineering and Computer Science students for the academic year 2000/01 by about four per cent. The NMC also initiated a variety of IT training and career conversion programs, and training incentive programs for industry.

The universities have also acted on their own. Notably, there are new degree programs in e-commerce. NUS offers an e-commerce specialization in their MBA program, and starting with the July 2000 term, their MBA core curriculum was redesigned to incorporate e-business concepts and strategies. The Faculty of Business and School of Computing also offers a joint undergraduate program in e-commerce and will offer an MS in e-business in July 2000 <www.fba.nus.edu.sg/postgrad/gsb/eBusiness>.

4.3.2 Pre-university Education – the Master Plan

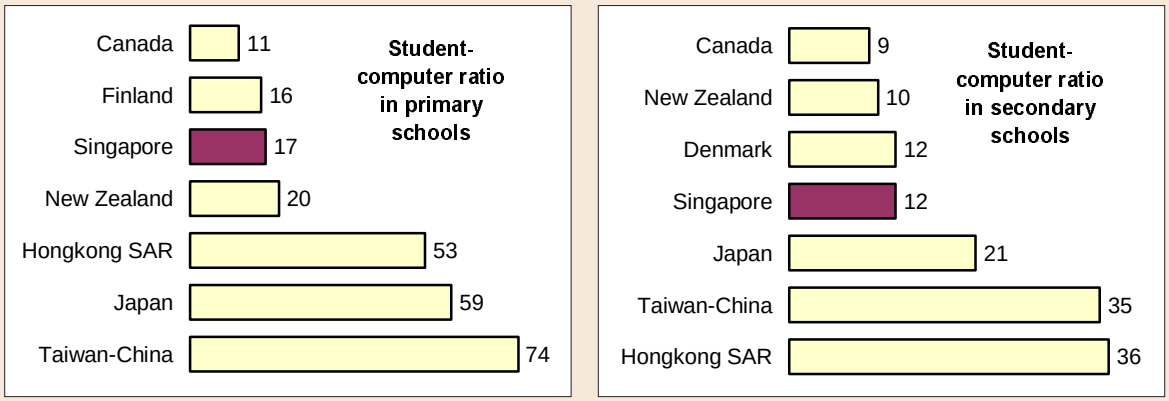
Trained and demanding users are a major determinant of Internet adoption and diffusion in a nation.[9] While networking technicians build the network and applications, their work must be preceded by a perceived need, by demand pull from users who understand what the Internet can do and are capable of using it. As we have seen, Singapore is doing well with respect to educating IT professionals, and, as we see in this section, it is one of the most advanced nations in the world with respect to computer availability and training at the primary through junior college levels (see Figure 4.5).[10]

The Ministry of Education (MOE) <www1.moe.edu.sg> has had an interest in IT since 1980s when they installed administrative systems in the schools. By 1994 there were roughly ten computers per school and some were beginning to connect to the Internet. In 1996, 100 computers were put in labs in each primary school, some of the Junior Colleges were networked, software tools were developed for students and teachers, and pilot tests were run with notebooks and LANs and the use of the Internet in teaching in a few schools. These preliminary, piecemeal efforts provided background experience and laid the groundwork for developing an integrated Master Plan.

Singapore's IT2000 plan called for the establishment of a broadband back-

Figure 4.5: Whose schools are most wired?

Number of students per computer, data released November 1999



Note: Based on 26 participating economies.
Source: Singapore Ministry of Education.

bone and availability of access for every Singaporean. If the people were trained Internet users, Singapore would be an attractive test bed for developers of broadband applications. The plan also anticipated widespread use of the Internet for interaction between citizens and the government, again requiring an Internet-savvy citizen. Furthermore, IT skills were seen as necessary for productivity in a global information economy, and it was felt that the utilization of IT could improve education in general. Prime Minister Goh Chok Tong summed up these premises by stating "*Computers are changing the way we work and the way we live . . . We will use IT to encourage students to learn more independently, to learn actively*," and, in April, 1997, the MOE announced a five-year, S$ two billion (US$ 1.15 billion) Master Plan for IT in Education (<www.moe.edu.sg/new/mite.htm>, <www.moe.edu.sg/iteducation/masterplan/summary.htm>).

The Master Plan covers primary and secondary schools and junior colleges. Its goals are access to an IT-enriched school environment for every child, improved linkages between schools and the rest of the world, innovation in education, enhanced creative thinking, lifelong learning and social responsibility, and excellence and efficiency in education administration. Four general steps were to be taken to achieve these goals: providing physical and technological infrastructure, development of learning resources, curriculum revision and assessment, and teacher development.

Physical and technological infrastructure

The MOE decided to move away from general purpose computer labs and to emphasize networking and classroom connectivity. Equipment has been installed in phases, beginning with 22 schools in 1997. By the end of 2000, all schools will be on the Internet with a two or five Mbps links.[11] There will be a networked computer for every five students within secondary schools and junior colleges. At the primary level, the ratio is one computer for every 6.6 pupils. The goal is to reach a computer per two students by the end of 2002 for schools, which are more advanced in the use of IT. There is also an LCD projector in every classroom for common viewing of local and remote material. Each school will also have a digital camera, video editing suite, scanner, and a science kit with transducers and motors and other effectors for control systems. Equipment upgrades and maintenance are budgeted for, and a full time technology assistant is assigned to each school.

All teachers are provided with email accounts and the Ministry has arranged with ISPs to offer low-cost e-mail accounts to pupils at all educational levels. Computer purchase is also subsidized for teachers. MOE will pay 20 per cent of the cost of a desktop computer or 40 per cent of the cost of a portable <www.moe.edu.sg/iteducation/masterplan/cpst.htm>. This offer covers computers, modems, printers, and Microsoft Office. There is also the Edumall, an intranet for teachers with educational software libraries and support for interest groups and the interchange of experience.

Curriculum development and assessment

The entire curriculum is being revised to use technology effectively. It will focus on mastering concepts and skills, active and independent learning and problem solving, and critical thinking and communication, reducing the time spent on acquiring factual knowledge. The emphasis will shift from receiving information to finding and managing it. Cutting rote material will save 10-30% of the time in the various curricula. The time saved will be used for different topics and emphasis and for the teaching of new material. IT-based instruction will increase from about 10-15% of the time today to 30% by the end of 2002.

This curriculum reform has been influenced by developments in the US, Israel and other nations. There will be awards for innovation in educational technology. For example, students are being sent into the field with portable computers, and assigned to create web sites, demonstrating what they learned upon return. Singaporeans are also active in the Think Quest competition

in which student teams develop curriculum <www.thinkquest.org>. Singapore ranks second to the US in participation and numbers of finalists and winners.

While current modes of assessment remain relevant, MOE feels IT can facilitate assessment of pupil competencies across more than one subject area and in several skills. Such assessments could include project work, simulation software to assess pupils' ability to formulate and test hypotheses and their innovativeness, and self-assessment software for pupils to monitor their own learning.

Learning resources

The Master Plan allocates S$ 100'000 (US$ 57'653) to each school for the purchase of software and on-line learning resources. MOE has a staff that evaluates and recommends software and web sites that are relevant to the curricula. Schools have autonomy to decide what material they want to use, and the MOE has begun training teachers in the evaluation and selection of software. MOE also negotiates publisher discounts and has established digital media repositories, accessible by both students and teachers. The Educational Software Procurement Scheme allows schools and teachers to purchase software from authorized companies at a substantial discount <www.moe.edu.sg/iteducation/masterplan/schemes. htm>.

In addition to purchasing software packages, MOE will develop and co-publish software which is needed but not commercially available. For example, programs dealing with Singaporean topics such as history or programs in the Malay or Tamil languages must often be developed from scratch. MOE is cooperating with IDA and the Economic Development Board of Singapore in funding these efforts, and they are also training a pool of educational software development professionals.

Teacher development

Hardware and software cannot be integrated into the curriculum without the support of a trained faculty. There are approximately 25'000 teachers in Singapore and all will have received core training by the end of 2000. This entails between 30-50 hours of formal training with access to support personnel afterwards. Primary school teachers receive general training at their schools and secondary teachers also receive discipline specific training. Training is provided by MOE personnel and experienced teachers. Newly graduated teachers are being prepared for the new curriculum and the use of IT.

The MOE experience is that perhaps 20 per cent of the teachers are somewhat reluctant in the face of this training and curriculum change. However, MOE is confident that all will be won over in time, and that students will add pressure by expecting IT to be a significant part of the school experience.

4.3.3 Conclusion

Singaporean universities are among the most connected in the world. Their IT training programs are expanding in an effort to keep up with manpower demand and they have close ties to industry, government, and the international IT research community.

While university programs are outstanding, Singapore's primary-JC program is unique. By 2002, there will be a 2:1 pupil-computer ratio in IT advanced schools, every classroom in the nation will be connected to the Internet and the high-speed Singapore ONE backbone, all teachers will have been trained to use IT and the Internet, all teachers and students above 3rd grade will have email accounts, and IT will be introduced in all subjects, and used in thirty per cent of curriculum time.

We stand to learn by watching this experiment. By the time they leave secondary school, students will have acquired a variety of IT skills and expectations, raising the possibility of asking research questions like: What impact will this have on government and industrial productivity? What sorts of applications will today's students demand and invent? Which skills will be important in Singapore

Box 4.1: Future schools: Radin Mas Primary School[12]

From afar, Radin Mas gives no indication that it might be one of the most wired primary schools in the world. Set amidst tropical vegetation in a middle class section of Singapore, it looks a bit like a military barracks, long and sprawling. However, once a classroom is entered, you are in the school of the future. Computers proliferate like mushrooms. One room is full of around two dozen transparent iMacs. Another is filled with computers connected to midi-keyboards. Yet another is full of kids painstakingly recreating Chinese calligraphy on computer screens. What is the story behind all these computers?

Radin Mas—named after the daughter of a Javanese Lord, it means Golden Princess in Malay—started in 1926 and moved to its present site in 1984. It has around 2'000 students split into two daily sessions (7:30am–1pm, 1 pm-6:30pm). Radin Mas was designated as one of the six original *Accelerating the Use of IT in Primary Schools* (AITP) by the Ministry of Education. The school has around 200 computers, a ratio of roughly one computer per five students. Broadband access to both the Singapore One domestic backbone and the global Internet is provided via ADSL lines.

Each grade has its own web page. Every grade also has a computer-related project ranging from cross-cultural e-mail to 'visiting' different countries by surfing the web, through email and video-conferencing. Kids aged 9-11 have created a 'virtual zoo' with a map and images of different animals.

Radin Mas is also using computers to teach traditional subjects. It is perhaps easier to describe this by stating what it is not about. It is not about using a computer to teach math or science or using it as a reference tool (e.g., online encyclopedia). It is not strictly teaching how to use a computer (e.g., learning a programming language) although understanding how to use software such as Windows is an inevitable side effect. The focus is more on integrating computers into the learning and creative process. Examples:

- Students are using Apple Macintosh computers and Crayola Art as well as Kids' Studio software to create "Digital Art." This includes using ethnic motifs and themes such as copying Chinese calligraphy or adding batik backgrounds to black and white Picasso backgrounds. These imaginative creations have won several awards.

- Students are learning music through keyboards connected to computers. They can add different sounds to existing music while viewing the musical score on the computer monitor.
- Other applications include e-cards designed by children (e.g., Mother's day, Thank you, etc.), a 'Postkid' discussion list used by students and teachers to confer electronically and a 'cyber aunt' to whom kids can send an email when they have problems.

Access to the Internet is provided for both students and teachers. For example, the "Kid's matrix zone" is a place where kids who do not have computers at home can go before and after school for free (and supervised) access to the Internet. The staff room provides a location with computers hooked to a Local Area Network for teachers to use e-mail, access the Internet and carry out administrative tasks.

What will be the consequences of a heavy dose of computerization in primary schools? Will the already strong disposition towards myopia in Asian kids—around 60 per cent of first grade students in Singapore already wear glasses—be worsened? Will sitting in front of computers encourage a sedentary lifestyle? We witnessed half a dozen 'obese' kids doing exercises to a video during their recess as part of a mandated program to reduce weight. Or will intense computer exposure create a new breed of cyber kid, one who uses the computer as naturally as a pencil or a calculator, and armed with this intuition, create unimagined future applications?[13]

in 2020? What will be the cognitive impact on children whose primary contact with information is in machine-readable form, and who are proficient in image processing before they write well? What of the world view and temporal habits of children who take immediate global communication for granted? The Singaporean commitment to IT-based education presents us with an excellent opportunity for research.

4.4 Electronic commerce

The Ministry of Communications and Information Technology and more specifically IDA (and its predecessor organizations), have launched various initiatives and programs to promote electronic commerce in Singapore. A point worth noting is that the government positions itself as ahead of the community by determining trends and future plans of the country and providing support to local industry.

4.4.1 Electronic Commerce Hotbed

As early as August 1996, the government, through the former National Computer Board (NCB) introduced the Electronic Commerce Hotbed (ECH) Program to promote e-commerce and develop Singapore as an international e-commerce centre. Key features of the program included:

- **EC Policy Committee:** This committee was formed in January 1997 to ensure that the appropriate laws and regulations were developed for fostering e-commerce. Several study groups were formed to analyze what laws might need to be introduced or amended in light of e-commerce. Recommendations included the Electronic Transactions Act (described below) as well as changes to laws and industry codes for computer security, copyright and privacy.

- The **Electronic Transactions Act** came into force in July 1998.[14] It provides the legal foundation for electronic transactions and the recognition of electronic contracts and digital signatures. It also made provisions for government agencies to accept electronic records without making any modifications to existing laws. The act also created a Controller to license certificate authorities. There currently are two certification authorities in Singapore. The first, Netrust, was initially created as a joint-venture project with the former NCB but is today fully managed and run by the private sector.

- **E-commerce infrastructure:** The government, IT industry partners and financial institutions, have been developing infrastructure and services. For example Netrust was formed to issue and manage digital keys and certificates to enhance confidence among online buyers and sellers. Other initiatives included one of the first implementations of the Secure Electronic Transaction (SET) protocol, used for online credit card payments and the C-ONE cash card allowing purchasers to make low denomination online payments.

4.4.2 Electronic Commerce Master Plan

The Electronic Commerce Master Plan, launched in September 1998, followed the ECH Program.[15] Concrete targets in the plan include achieving S$ 4 billion (US$ 2.3) worth of e-commerce revenue and 50 per cent of businesses using e-commerce by the year 2003. Just as the ECH, a policy committee made up of various government agencies and known as the Electronic Commerce Coordinating Committee (EC3), has been created to oversee implementation of the plan.

The plan has five central points backed by specific programs and projects:

1. **Develop an internationally linked e-commerce infrastructure:** This aims at partnering global expertise with local partners to help build national e-commerce financial and logistics infrastructure. On the Business-to-Consumer (B2C) front, the Consumer-Connect service bureau provides secure electronic transaction processing services to web merchants and digital content publishers. It allows them to take advantage of low set-up costs and hassle-free implementation to commerce-

enable their business. On the Business-to-Business (B2B) front, IDA has successfully teamed up global companies with local ones (e.g., Commerce-1 with Sesami.com) through the Local Industry Upgrading Program (LIUP).

2. **Jump-start Singapore as an e-commerce hub:** This initiative focuses on the sectors in which Singapore has an inherent advantage as a hub as well as to attract international companies to establish offices in the country. Singapore's advantages include a stable financial infrastructure; an efficient transport and logistics infrastructure; and strong telecommunications connectivity and e-commerce infrastructures. The aim is to transform Singapore from being a port to a portal.

3. **Encourage businesses to use e-commerce strategically:** This initiative focuses on small and medium enterprises (SME) development and creation of local e-commerce expertise.[16] SMEs are encouraged to utilize e-commerce for their core businesses. Several financial incentives and funding schemes are available to help companies venture into electronic commerce including tax concessions on offshore income derived through e-commerce. Another step was lifting restrictions on the import of encryption products to further enhance confidence among companies conducting e-commerce in Singapore. Singapore also aims to attract foreign talent. Immigration procedures have been facilitated for employees coming into Singapore to work in the ICT sector.

4. **Promote usage of e-commerce through the public and private sector:** This initiative aims to provide key public services online by the year 2001. This will be paralleled with mass education and incorporation of e-commerce in the curricula of universities and polytechnic institutes. The National University of Singapore has launched a Master's program in e-Business, a joint program of the Business School and the School of Computing. Nanyang Technological University also provides a Master's program with a concentration in electronic commerce. Public awareness is being raised through presentations at community centres and events such as the *e-Festival* that took place March 2000.[17] In an effort to become a leader in the measurement of e-commerce, Singapore's Department of Statistics hosted an international conference on this subject in December 1999.[18]

5. **Harmonize cross-border e-commerce laws and policies:** The Singaporean government has been collaborating with major trading partners to synchronize e-commerce laws. It is actively participating in international forums on e-commerce related issues. Two bilateral agreements have been signed. One with Canada covers cross certification where both countries recognize respective countries' digital certificates. A second with Australia involves the development of joint e-commerce projects. Singapore is playing a major role in the Asia-Pacific region with regards to e-commerce activities. The Asia Pacific Economic Cooperation forum (APEC) created an e-commerce Task Force in 1998. This taskforce is co-chaired by Singapore and Australia who have developed an e-commerce plan to be implemented in the region. The Association of South East Asian Nations' (ASEAN) e-commerce arm (e-ASEAN taskforce) focuses on encouraging and facilitating the growth of e-commerce. It has formulated plans to accelerate the development of e-commerce across the region and identified key factors, such as cyber laws,

Table 4.4: E-commerce in Singapore

	e-commerce transactions			Internet access by companies	
S$ million	1997	1998	1999		1998
B2B sales	955	1'600	1'800	Have Internet access	91%
B2C sales	3	34	93	Have web site	46%
Total	958	1'634	1'893	Engage in e-commerce	4%

Note: 1999 data are projections. Data based on top 1'000 Singaporean companies (by revenue) and top 1'000 IT companies.
Source: Singapore Department of Statistics.

secure messaging infrastructure, payment gateways, and on-line services and products for regional development.

4.4.3 Profile of E-commerce Activity

The Singapore Department of Statistics is one of the few national statistical agencies in the world developing a framework for measuring e-commerce. It launched a national survey in February 1999 sent to the top 1'000 companies in Singapore (based on turnover) as well as the top 1'000 IT companies.

According to the survey, e-commerce transactions accounted for 0.1 per cent of the total turnover of the economy of Singapore. However, e-commerce activity is growing rapidly. The value of e-commerce transactions rose from S$ 958 million (US$ 552 million) in 1997 to S$ 1.6 billion (US$ 0.9 billion) in 1998. Business-to-business e-commerce constituted the bulk of transactions (98 per cent).

The survey also measured Internet access and usage among the companies with 91 per cent of the top 1'000 enterprises having Internet access. The highest ratios were found in the Retail Trade, Transport and Communications and Manufacturing industries. Nearly half (46 per cent) of the top enterprises have their own web sites. The study found that of those with web sites were primarily used for advertising, getting feedback and carrying out product searches. It is interesting to contrast those findings with another 1998 survey carried out by IDA. The IDA survey is based on a random sample of 747 companies with data disaggregated based on establishment size. It found that overall 80 per cent of the companies had Internet access; almost all companies with more than 100 employees have access. Almost one in three companies (30.8 per cent) has a web site; this ranges from 29 per cent for enterprises with less than 25 employees to 86 per cent among companies with more than 500 employees. The biggest barriers for e-commerce adoption among the company's surveyed were the cost and lack of IT expertise.

According to IDA's 1999 IT Household Survey, 11 per cent of Singaporean Internet users have shopped online. Of those, more than half made a purchase. The median value of a purchase was S$ 135 (US$ 78) . The most popular item purchased was books (39 per cent) followed by computer-related products (20 per cent), food (18 per cent) and movie and theatre tickets (16 per cent). Over 80 per cent of online purchases are made with a credit card; twelve per cent are made by cash on delivery. The major reason for not shopping online is a preference for physical shops in order to easily compare prices and other features.

Box 4.2: AsiaStockWatch.com

AsiaStockWatch.com is a comprehensive financial web site, which empowers the growing population of increasingly sophisticated and technologically-savvy investors. Through its Investment Adviser's License, it is regulated by the Monetary Authority of Singapore. AsiaStockWatch provides timely and objective analysis of important events affecting the local equity and financial scenes. Besides being an independent provider of financial and business information, it also offers a broad array of services and tools to assist investors in managing their finance portfolio effectively. The company has a registered subscriber base of 45'000. Revenue is derived from retail and corporate subscriptions, content syndication, advertising, sponsorship and e-commerce activities. Its parent company, SESDAQ-listed Panpac Media.Com Limited, is a leading home-grown publisher of special-interest magazines with offices in Singapore, Malaysia and Hong Kong. Panpac Media.Com's portfolio of more than 40 titles in three different languages covers a wide range of interests from IT and Internet to education, personal investment and lifestyle. AsiaStockWatch is able to complement its online activities with an offline presence by leveraging on the media experience of Panpac Media.Com. To date it has successfully organized financial-related seminars, exhibitions, talks with numerous financial institutions and organizations.

[1] National Computer Board of Singapore, "A Vision of an Intelligent Island," The IT2000 Report, SNP Publishers, Singapore March, 1992.

[2] Singapore Department of Statistics, Government Finance, http://www.singstat.gov.sg/FACT/SIF/sif17.html.

[3] IDA, Information Technology Roadmap, http://www.ida.gov.sg/website/IDAContent.nsf/14899db7846d2bcc482568360017c696/30818f31870d93b4c825691f000cbe02.

[4] For example, in spite of significant subsidy and guaranteed procurement in the building of the Singapore ONE backbone and services, broadband utilization and applications have taken off slowly. Three years after the launch of Singapore ONE, there are only 47,500 DSL and cable modem subscribers, and approximately 150 Singapore ONE applications. (There were 64 pilot services in 1997).

[5] There are 26 categories of scholarship for students in a variety of disciplines for studying in Singapore or abroad, http://www.gov.sg/psd/psc/award.html.

[6] Singapore's civil servants are renown for a lack of corruption. According to one survey, Singapore was the sixth least corrupt country out of ninety measured and the least corrupt in the Asian region. It is notably ahead of countries such as USA, Australia and Japan in this measure. See Transparency International. "Transparency International Releases the Year 2000 Corruption Perceptions Index." *Press Release*. 13 September 2000. http://www.transparency.de/documents/cpi/2000/cpi2000.html#cpi.

[7] The Ministry of Health web site is hosted off of the Singapore government's main web site: http://www.gov.sg/moh.

[8] All early research and education networks have had to make a transition as a result of the commercial tidal wave which has swept over them, see, Press, L., "Will Commercial Networks Prevail in Developing Nations?," OnTheInternet, Vol. 3, No. 2, March/April, 1997, pp 40-41, http://som.csudh.edu/fac/lpress/articles/commerc.htm.

[9] Press, L. "Developing Networks in Less Industrialized Nations." *IEEE Computer*. June 1995.

[10] See Singapore Ministry of Education. "Singapore Ranks Highly in the use of Information and Communication Technologies (ICT) in Education." *Press Release*. 19 November 1999.

[11] MOE expects the connections to be in the 10-15 Mbps range within two or three years.

[12] Two web sites are available for the school: http://www.moe.edu.sg/schools/radinmas and http://www.rmps.moe.edu.sg.

[13] Indeed, one problem is that the children are increasingly more IT-knowledgeable than teachers. See Peter Cordingley. "Wired for Life." *AsiaWeek*. 12 May 2000. http://www.asiaweek.com/asiaweek/magazine/2000/0512/cover1.html

[14] The text of the Electronic Transactions Act is available here: http://www.cca.gov.sg/eta/index.html.

[15] See "Singapore Launches Electronic Commerce Masterplan." *NCB Press Release*. 23 September 1998.

[16] There is less Internet take-up by small and medium enterprises (SME)—defined as firms of less than 200 employees—than larger companies. The Local Enterprise Electronic Commerce Program, launched in November 1998, promoted SME adoption of e-commerce. SME's could receive a grant of up to 50 per cent of project cost, including a connection to Singapore One. Moreover, the companies' services were promoted to interested parties. Over 500 companies were provided assistance under this program. The program came to an end in December 2000 and has been replaced by a new one called e-Business Industry Development Scheme (eBIDS). See "IDA & PSB Announce S$30 Million Incentive Scheme to Spur e-Business Development and Growth in Singapore." *IDA Press Release*. 19 October 2000.

[17] "eFestival Asia - An Enhanced Lifestyle For All." *IDA Media Release*. 22 February 2000

[18] See the web pages for the "Conference on the Measurement of Electronic Commerce" at http://www.singstat.gov.sg/EC/echome.html.