The e-City:

Singapore Internet Case Study

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SINGAPORE INTERNET CASE STUDY

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1.   Country background

1.1   Overview

The Republic of Singapore, with an area of only 660 square kilometres, is located in Southeast Asia at the southern tip of the Malaysian peninsula. It is comprised of a main island and several islets. Singapore's northern neighbour is Malaysia, linked by a bridge crossing across the Johore Strait. On the south, is Indonesia. Singapore's strategic location at the crossing of many trade routes has contributed strongly to its history and economic development. The island is relatively flat, with a tropical temperature due to its proximity to the equator and abundant rainfall from its sea exposure. Less than two per cent of the land is used for agriculture. The rest is evenly divided between developed and undeveloped areas. The name of the country is derived from a Sanskrit word SingaPura (Lion City).

1.2   Demography

In June 2000 the population of Singapore was four million, of which 3.0 million were citizens, 290'000 were permanent residents and 755'000 were non-resident.[1] Average annual population growth from 1990-2000 was 2.8 per cent. The population is predominantly of Chinese descent (77 per cent), followed by Malay (14 per cent) and Indian (8 per cent) ethnic groups. Since independence, the Singapore government and Singaporeans themselves have committed to the policy, culture and practice of equal treatment of all races. Chinese (Mandarin), Malay, Tamil and English are all official languages, with English being the predominant language in business and government dealings.[2] Some 20 other languages are also used on the island <www.sil.org/ethnologue/countries/Sing.html>. In 2000, there were 923'000 resident households for an average household size of 3.7. The total number of occupied housing units was 964'138.

Figure 1.1: Map of Singapore

Source: The World Factbook 1999.

1.3   Economy

With a small domestic market, few natural resources, and a strategic location, Singapore has a long history as a trading nation. It leads the South

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Figure 1.2: Weathering the storm

Singapore distribution of GDP, 1999 and GDP change over previous year

Services 66%

Manufacturing 26%

Construction 8%

Singapore: GDP Share 1999 Total: S$ 144 billion

Singapore GDP Growth

| 8.0% | 7.5% | 8.4% | 0.4% | 5.4% |
| 1995 | 1996 | 1997 | 1998 | 1999 |
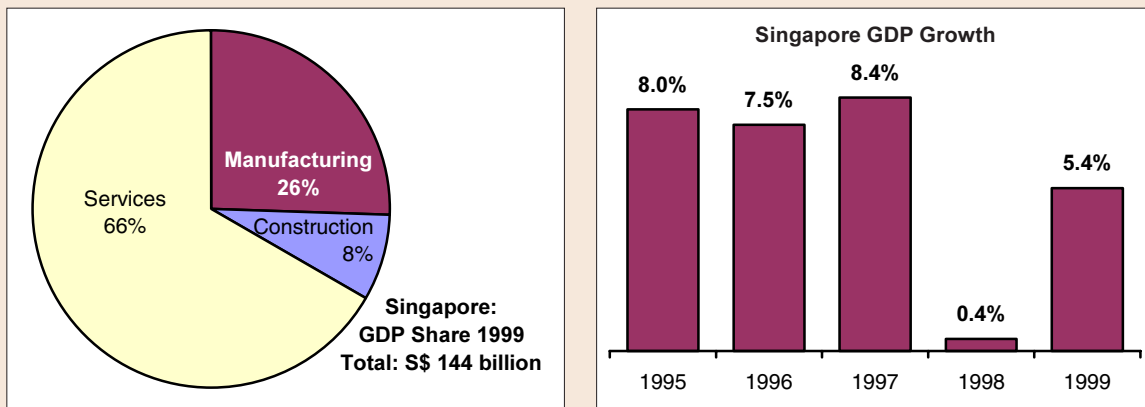
Source: Singapore Department of Statistics.

East Asia region in imports and exports per capita. Singapore has a service-oriented economy and its GDP per capita of US$ 24'210 ranks eighth in the world. The strength of the economy is shown by its ability to continue growing (albeit slowly) during the Asian economic downturn of 1997-98 (Figure 1.2). While these facts reflect a healthy, robust economy, they do not reveal the active planning role of the government, which, in combination with an atypical Civil Service policy, has had a profound effect on Singapore.

1.4   Human development

While Singapore enjoys the eighth highest GDP per capita in the world, it ranks only 24th on the United Nations Development Programme's Human Development Index (HDI). The HDI is a function of wealth, health, and education, and, while Singapore ranks high on GDP per capita and life expectancy, it is pulled down by a relatively poor performance in education. The mean years of schooling is 8.1 years and the literacy rate 94 per cent, both relatively low for such an affluent nation.[3] Table 1.1 compares Singapore's HDI to other economies in the Asia-Pacific region. Singapore is the highest-ranking South East Asian nation in human development, and ranks second in Asia after Japan.

1.5   Political

Singapore's recent history dates back to 1819 when Stamford Raffles established a British trading post on the island. Singapore became a Crown Colony in 1867, a situation that lasted until 1959 with an interruption during the Japanese occupation between 1942 and 1945. There was a strong independence movement, and elections were held for self-government in 1959. The People's Action Party (PAP) won the election and Lee Kuan Yew became the first Prime Minister of the State of Singapore. Lee pressed for a union with Malaya and when Malaysia was formed in 1963, it included Singapore. Singapore withdrew in 1965 and became an independent republic. The PAP has ruled continuously since 1965 and Goh Chok Tong became the country's second Prime Minister in 1990.

Table 1.1: Human Development Indicators

Singapore compared to selected Asia-Pacific economies, 1998

HDI Rank	Economy	Life expectancy at birth (years) 1998	Adult literacy rate (%) 1998	Combined school gross enrolment ratio (%) 1998	GDP per capita (PPP US$) 1998
4	Australia	78.3	99.0	114	22'452
9	Japan	80.0	99.0	85	23'257
20	New Zealand	77.1	99.0	96	17'288
24	**Singapore**	**77.3**	**91.8**	**73**	**24'210**
26	Hongkong SAR	78.6	92.9	64	20'763
31	Korea (Rep.)	72.6	97.5	90	13'478
61	Malaysia	72.2	86.4	65	8'137

Note: Adult literacy and school enrolment data for Singapore vary from that reported by national authorities. See endnote 3.
Source: United Nations Development Programme.

[1] Singapore Department of Statistics. "Singapore Census of Population 2000 – A Quick Count*." Press Release 17*. 31 August 2000.

[2] The adoption of English as Singapore's working language is credited with promoting harmony and adds to Singapore's competitive advantage. See Michael Richardson. "English Bridges Cultural Gap in Singapore." *International Herald Tribune*. 12 February 2001. <www.iht.com>.

[3] Literacy data reported by Statistics Singapore differs from that reported by the UNDP even though the year and concept used by both appear to be the same. Ministry of Education data on gross school enrolment also differ from the UNDP with the former reporting 86 per cent (compared to 73 per cent).

2. Information and Communication Technology markets

2.1 Telecommunication Sector

Singapore has one of the most advanced telecommunication networks in the world with very high levels of access. This has been possible due to the small size of the country—essentially a large city—as well as rising levels of income and government commitment to telecommunication excellence. The telecommunication market has been characterized by progressive liberalization from a state-owned monopoly provider to full competition (see Table 2.1).

2.1.1 Regulation and policy-making

Government ministries are responsible for overall policy with subsidiary statutory boards providing technical support and day-to-day regulation. The *Ministry of Communications and Information Technology* (MCIT) is responsible for overall transportation, postal services and Information and Communications Technology (ICT) policy. The *Info-communications Development Authority* (IDA) is the statutory board responsible for regulating and promoting postal and ICT services. IDA was created in late 1999 from the merger of the Telecommunication Authority of Singapore (TAS) and the National Computer Board (NCB).

The Ministry of Information and The Arts (MITA) was created in 1990. It is the public relations arm of the government. It also oversees the regulation and promotion of the broadcast, Internet content and print media, as well as the arts and heritage sectors. The Singapore Broadcasting Authority (SBA) is the statutory board responsible for broadcasting regulation, including Internet content.

2.1.2 Operators

Singapore's small size coupled with the recent introduction (April 2000) of full telecommunication means that there are only a handful of Facilities-Based Operators (FBO) in the country. Due to the small market and technical and financial constraints, it is unlikely that the number of FBOs will grow significantly. The country's FBOs include:

- **Singapore Telecom** (SingTel) <www.singtel.com> is the nation's incumbent operator. As in many countries, SingTel enjoyed a monopoly until recently. However, unlike many countries, the level of infrastructure development and quality of service was high with SingTel striving to measure up to international best practice. SingTel was partially privatized in 1993 and is a major international investor in its own right with over US$ 2.5 billion invested in 19 countries. Singapore Post, the country's postal service, is a subsidiary of SingTel. At end March 2000 SingTel's domestic network included 1.9 million fixed line subscribers and 1.1 million mobile cellular subscribers.

- **Mobile One** (M1) <www.m1.com.sg> was formed in August 1994 to bid for Singapore's second mobile cellular license. It was awarded mobile cellular and radio paging licenses in May 1995. Both services were launched on 1 April 1997 when SingTel's monopoly in these areas expired. M1 started with a GSM-900 system and introduced a CDMA network in June 1998. M1's shareholders are Keppel Group (Singapore's largest industrial conglomerate) (35%), Singapore Press Holdings (35%), Cable & Wireless (UK) (15%) and Pacific Century Cyberworks (Hongkong SAR) (15%). M1 had around 600'000 mobile cellular subscribers at 30 June 2000.

- **StarHub** <www.starhub.com.sg> won fixed and mobile

Table 2.1: Telecom liberalization milestones

Jun '94	Opening of pre-qualification tender for one more mobile phone and three more radio paging operators.
Nov '94	Opening up of VSAT provision and operation solely for intra-corporate business communications.
Dec '94	Liberalization of resale of public switched telecommunications services for existing resellers in hotel and service apartment sector.
May '95	Licensing of one more public cellular mobile telephone operator and three more public mobile radio paging operators to commerce services in April 1997 in competition with Singapore Telecom when its exclusive license for these services expire.
	Opening of tender for third IASP license.
Jun '95	Six bids for third Internet Access Service Provider (IASP) licence received.
Aug '95	Resale of international telephone services via customer-owned and operated Coinafons.
	Further opening up of resale of public switched telecommunications services, for any company, apart from existing resellers in the hotels and service apartment sector, to apply to TAS for licensing.
Sep '95	Liberalization of IDD/STD payphones.
	Licensing of 2 Internet public access providers, in competition with Singnet.
Oct '95	Resale of services by Internet public access providers permitted.
Apr '96	Announcement that TAS will license additional operators to provide basic telecommunication services from April 2002.
May '96	TAS advances the expiry of Singapore Telecom exclusive licence for basic telecommunications services to year 2000.
Sep '96	TAS decides to award up to two additional licences for the provision of public basic telecommunications services from 1 April 2000.
Dec '96	Resale of leased circuit services for intra-corporate communications permitted.
Jan '97	Announcement of PBTS license fees, the release of the Information Package and the start of the pre-qualifying tender on 1 March 1997.
	Removal of telecommunications service surcharge levied by hotels and service apartments.
Mar '97	Announcement that up to two additional PCMTS operators will be licensed by mid-1998 to provide commercial services by 1 April 2000.
Apr '97	Waiver of licence fee for mobile communications users.
	New paging operators, MobileOne, ST Messaging and Hutchison Intrapage, and mobile phone operator, MobileOne, commence operations.
Jul '97	Announcement of all three consortia which had submitted proposals for the pre-qualification tender submissions for the PBTS License to be short listed to participate in the main tender.
Aug '97	Briefing for the three pre-qualified consortia for the PBTS Licence(s) on the details of the main tender.
Sep '97	Lowering of mobile and paging licence fees.
	Announcement of 1 October 1997 as the opening date of the public tender for the licensing of up to two more PCMTS operators which would begin operation from 1 April 2000.
Nov '97	Liberalization of Very Small Aperture Terminals (VSAT) licence with 17 VSAT operators approved to operate VSAT for intra-corporate communications.
Apr '98	StarHub wins the Public Basic Telecommunications Services and Public Cellular Mobile Telephone Services licences. Another consortium, P2P, clinches the second PCMTS licence.
	TAS announces it will not award PCMTS licence to P2P as the consortium's local partners were not able to form the consortium according to the shareholding structure proposed in its tender submission.
Oct '98	The Internet access service provision market is further liberalized. Any interested party who meets the minimum criteria can apply to TAS for a public Internet Access Service Provider (IASP) licence.
Jun '99	The provision of International Internet Exchange Services is liberalized.
Jul '99	The transmission of Value-Added Network traffic over the Internet is liberalized.
Sep '99	The foreign equity limit on IASPs and IXSPs is lifted.
Jan '00	Announcement of full competition in the telecommunications sector being brought forward from 1st April 2002 to 1st April 2000.
Sep '00	IDA issued the Code of Practice for Competition in the Provision of Telecommunication Services ("Telecom Competition Code")
Jan '01	IDA approved the Reference Interconnection Offer (RIO) by Singtel. The RIO was effective 31 Jan 2001

Source: IDA.

cellular licenses in April 1998. It launched its fixed and mobile services (GSM 1800) on 1 April 2000. StarHub bought CyberWay, an ISP in January 1999 and rebranded it as StarHub Internet in December 1999. StarHub is owned by Singapore Technologies (34.5%), Singapore Power (25.5%), NTT (Japan) (22%) and BT (UK) (18%). At June 2000 it had 79'000 mobile subscribers and an estimated five per cent share of the international telephone market.

• **Singapore Cable Vision** (SCV) <www.scv.com.sg>, the island's cable television operator, obtained a facilities-based (fixed) telecommunication license in June 2000. It is expected to launch telephone service by the

second quarter of 2001. It will leverage its cable television infrastructure to provide cable telephony, its third service after cable television and Internet access.

2.1.3 Market liberalization

IDA has tried to abide by a well-planned timetable in liberalizing the industry. However, rapid global changes have led the government to advance liberalization on several occasions. For example, SingTel initially had a monopoly on fixed-line and international services until 31 March 2007. In May 1996, this was changed to a duopoly to begin 1 April 2000. In January 2000 it was announced that the duopoly would be abolished and the market fully opened to competition in April 2000. The gov-

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Figure 2.1: Singapore Inc.

Ownership of Singapore's info-communications industry, June 2000

* Management shares

Source: ITU compiled from company reports.
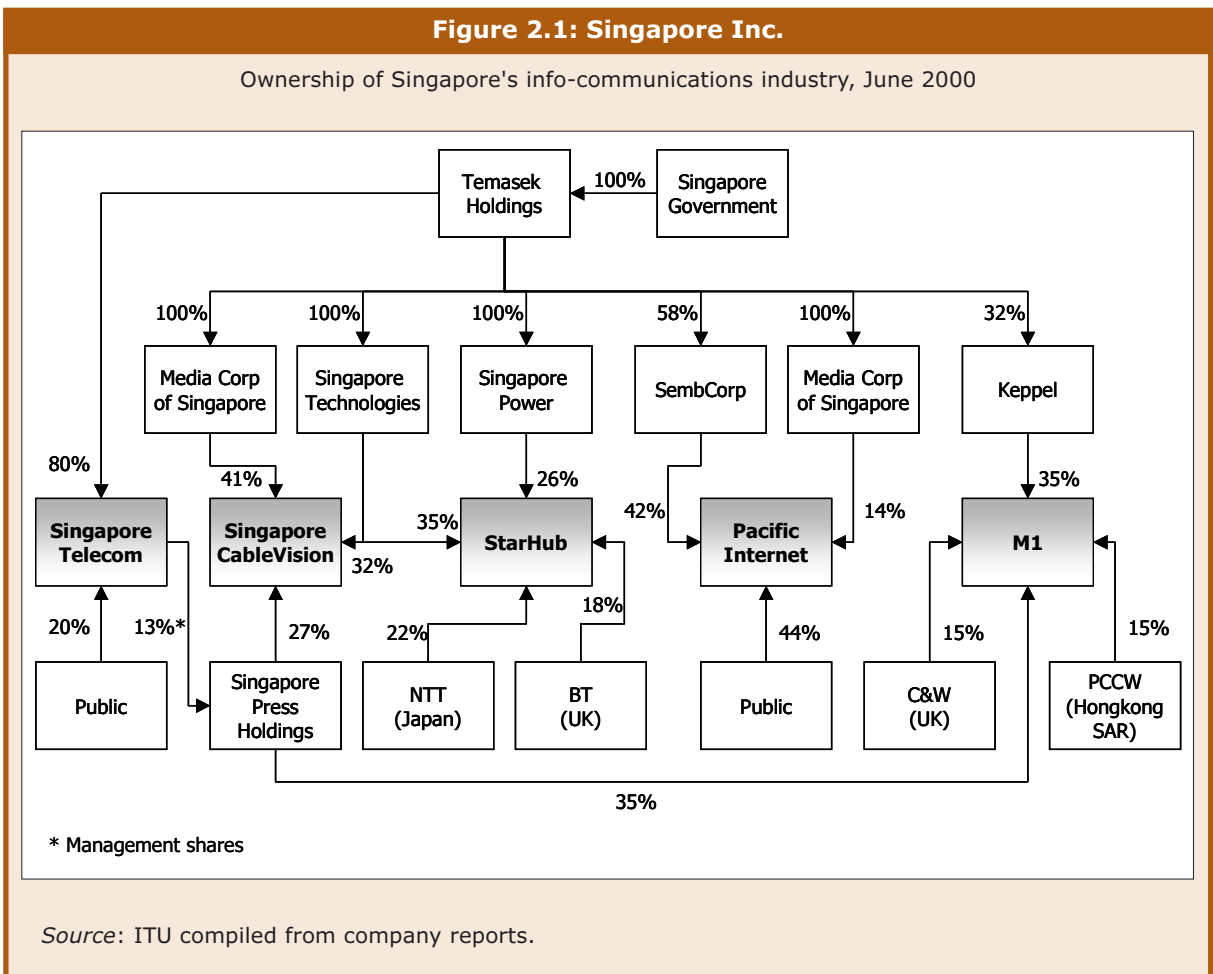
ernment has been successful in advancing the liberalization timetable by convincing incumbent license holders to accept the changes in return for financial compensation.[1]

Privatization

SingTel was partially privatized through two public sales of shares to the public in October 1993 and September 1996. Temasek, the Singapore government holding company, has also made sporadic sales of its holdings to institutional investors. In July 1999 Temasek held 79.74 per cent of the company.[2] Singapore's government holdings in the telecom sector go beyond SingTel as it has indirect stakes in all current operators through intermediary companies (see Figure 2.1).

Licensing

The provision of virtually any telecommunication service requires a licence issued by IDA.[3] There are two general types of licenses: facilities or services. Facilities-based operators require an individual license while services-based operators may require either an individual license or a class license (i.e., providers are assumed to have read the licensing guidelines and are automatically licensed but nevertheless should register with IDA). In general, individual licensees must pay an annual license fee equivalent to one per cent of annual revenue subject to the respective minimum sums as elaborated in Table 2.2 below, while class licensees pay S$ 200 (US$ 115) every three years. Though there are no pre-defined limits on the number of licenses, technical limitations (e.g., spectrum) and market considerations influence the issuance of facilities-based licenses.

Tariffs

IDA is responsible for approving telecommunication tariffs. There have been few changes to national fixed telephone prices, whose structure is quite straightforward. There are no national long distance tariffs, as calls placed and destined within Singapore

are considered local. There are separate monthly telephone line rentals for residential and business subscribers. Local calls had been included in the flat monthly charge until December 1991 when a usage-based call charge was introduced (1.4 Singapore cents per minute peak and 0.7 Singapore cents off-peak). To compensate, fixed telephone residential monthly subscriptions were dropped from S$ 15.83 (US$ 9.13) to S$ 8.33 (US$ 4.8), and business from S$ 24.17 (US$ 14.24) to S$ 12.50 (US$ 7.21). A second change occurred in 1996 when the Goods and Service Tax (GST) was introduced, adding three per cent to telecommunication charges. No further changes to national fixed telephone charges have occurred. International call charges have been steadily declining. SingTel's average international price per minute dropped from S$ 2.05 (US$ 1.18) in 1996 to S$ 1.21 (US$ 0.7) in 2000.

Like fixed telephone prices, charges for entry level mobile cellular service have not changed dramatically despite the introduction of competition. The major innovation has been the introduction of free minutes with the subscription. Singapore has a Receiving Party Pays system for mobile so users must also pay for incoming calls. SingTel Mobile had seven different plans in January 2000 that ranged from S$ 25 (US$ 14.5) – 325 (US$ 187.4) per month, depending on the number of free minutes included.

Interconnection

Limited competition prior to April 2000 has meant that interconnection has not been much of an issue. Interconnection among facilities-based operators is required but left to commercial negotiations. IDA is prepared to facilitate the negotiations and can intervene if necessary. In addition, unbundling of network facilities is also required. IDA has issued a Code of Practice to assist with interconnection issues.

Universal service

According to the Info-communications Development Authority Act of Singa-

Table 2.2: Licenses		
Status at January 2001		
Licence	**New licenses issued after 1 April 2000**	**Licence/Registration Fee**
Facilities-Based Operators	16	
FBO designated as PTL		Initial Fee: None. Annual Fee: 1% AGTO Subject to minimum of S$ 250,000 (US$ 144'133) per year Licence Duration: 20 years, renewable for a further period as IDA thinks fit
Terrestrial telecommunication networks for telecommunication purposes		Initial Fee: None. Annual Fee: 1% AGTO Subject to minimum of S$ 100,000 (US$ 57'653) per year Licence Duration: 15 years, renewable for a further period as IDA thinks fit
Public cellular mobile telephone services		The licence fees and duration will be specified together with the approach to award licences. There will be a separate comparative exercise (tender or auction) by 3rd Quarter 2000.
Public mobile broadband multimedia services		
Public fixed-wireless broadband multimedia services		
Public radio paging services		Initial Fee: None Annual Fee: 1% AGTO Subject to minimum of S$ 1'200 (US$ 692) per year Licence Duration: 10 years, renewable for a further period as IDA thinks fit
Public mobile data services		
Public trunked radio services		
Terrestrial telecommunication network for broadcasting purposes only		Initial Fee: None Annual Fee: S$ 5'000 (US$ 2883) Licence Duration: 10 years, renewable on a 5-yearly basis
Satellite Uplink/Downlink for broadcasting purposes		
Services-Based Operators		
Services-Based Operators to be Individually Licensed		
SBO (Individual)	88	Initial Fee: None Annual Fee: 1% AGTO subject to minimum of S$ 10'000 (US$ 5765) per year
Live Audiotex services only		S$ 200 (US$ 115) every three-yearly
Services-Based Operators to be Class – Licensed		
SBO (Class)	102	S$ 200 (US$ 115) every three-yearly
Resale of public switched telecommunication services		No registration fee payable
Store and retrieve value-added network services (without the use of leased circuits)		No registration fee payable

Source: ITU adapted from IDA.

pore Act 1999, IDA is responsible for ensuring that "*telecommunication services are reasonably accessible to all people in Singapore, and are supplied as efficiently and economically as practicable*." It has a number of tools at its disposal for ensuring this, such as the right to impose price controls or obligate public telecommunication licensees to provide basic services to anyone in Singapore who requests it. Singapore has achieved a high level of universal telephone service. Exact figures on household telephone penetration are not compiled, probably because it is assumed that almost every family has a phone. A statistical calculation based on the number of residential telephone lines results in a ratio of over 100 per cent. This is due to the growing portion of homes with second fixed lines (some twenty per cent at March 2000). Mobile is also helping to enhance access to telephone services. At the end of 1998, over half of Singapore's house-

holds had a mobile phone. There is complete nationwide mobile coverage. That fact, coupled with the availability of prepaid cards, means that there is no infrastructure limitation to universal telecommunication access.

2.1.4 Network

Singapore has a well-developed domestic communication network with 27 telephone exchanges. The fixed network has been fully digitalized since 1994. The Singapore *One Network for Everyone* (ONE) backbone uses ATM technology over fibre optic cable at speeds of up to 622 Mbps. The island has five digital mobile cellular networks (two GSM 900, two GSM 1800 and one CDMA). A significant milestone occurred in July 2000 when the number of mobile cellular subscribers exceeded fixed telephone lines (see Figure 2.2).

2.1.5 International service

Singapore has over 14'000 telephone circuits with international terrestrial links to Malaysia and submarine cable and satellite links to the rest of the world. Investments in regional submarine fibre cable systems include SEA-

ME-WE 3, China-US and Japan-US. SingTel and nine other regional telecom operators are building a new 2.5 terabits per second optic fibre submarine cable to be completed in 2002. When finished, the Asia-Pacific Cable Network 2 will connect eight Asian economies and be the highest capacity submarine cable in the region. The country has three Intelsat satellite earth stations. In addition, Singapore launched its own satellite, ST-1, in August 1998. Its footprint covers most of Asia and is one of the most powerful in the region.

International telecommunication traffic has always been important for the island-state with a trade-oriented economy. Although revenues from international telephone traffic provide the largest proportion of SingTel's revenue, this share has declined to 34 per cent in 1999 from over 50 per cent in 1993 (see Figure 2.3). Yet overall profitability has not been affected due to growing revenue from other sources such as data and Internet services. There were 885 million minutes of outgoing international telephone traffic (excluding Malaysia) in the year ending 31 March 2000, up six per cent over the previous period.

Figure 2.2: Telephone subscribers

Fixed and mobile telephone subscribers (000s), Singapore

	Mar-98	Mar-99	Mar-00	Jul-00
Fixed lines	1'685	1'778	1'877	1'905
Mobile subscribers	849	1'095	1'631	1'970
Fixed penetration	54.3%	56.2%	58.3%	58.4%
Mobile penetration	27.3%	34.6%	50.7%	60.4%
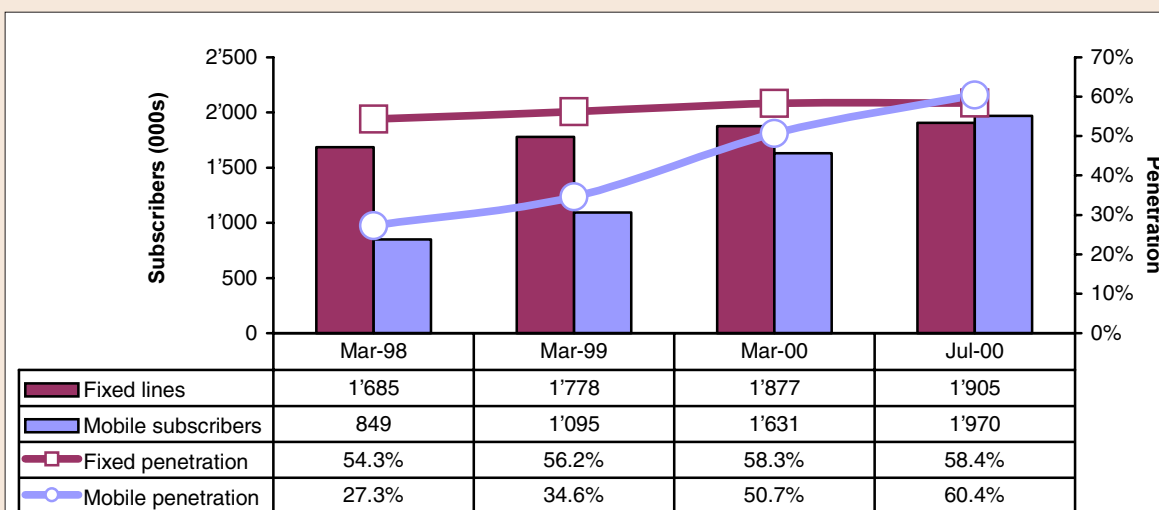
Source: ITU adapted from IDA.

Figure 2.3: SingTel revenue

SingTel's revenue, 1996-2000, US$ million and distribution of revenue, year ending March 2000

SingTel telecom revenue, US$ million / International as % of total

SingTel revenue distribution, year ending 3/2000
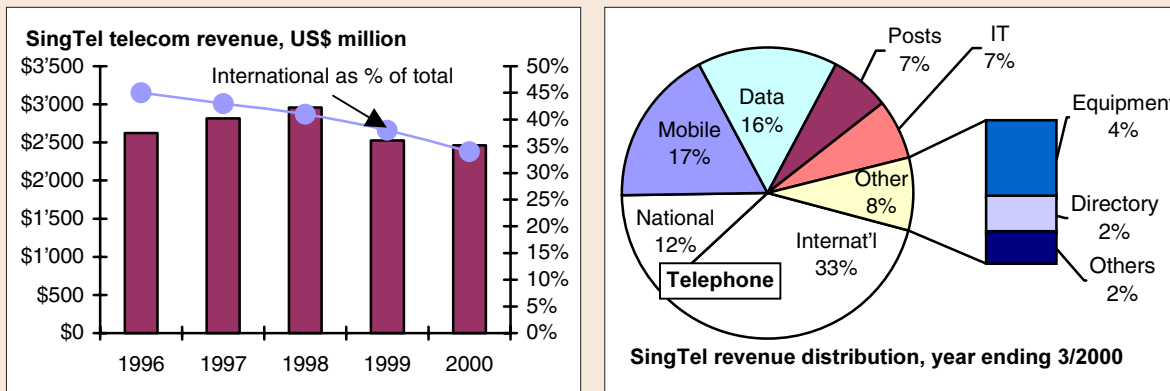
Note: Years ending 31 March. Share of international revenue is based on total revenue.
Source: ITU adapted from SingTel data.

Box 2.1: Mobile Internet

The island's three mobile operators have been actively promoting mobile data and Internet access. All provide Short Messaging Service (SMS)—a sort of precursor to mobile Internet—including support for Chinese if users have the appropriate handset. M1 claims that its users send one million SMS messages a day.[4] Mobile Internet based on the Wireless Access Protocol (WAP) was initiated in the first half of 2000. M1 launched its *Mi World* service in February, SingTel's *e-ideas* service was commercially introduced in March and StarHub's *iPower* was available from April. The operators have been busy developing and signing up content providers for their mobile portals. Applications include online banking, stock inquiries, and news and sports results.

The mobile operators have begun developing faster mobile Internet services to boost GSM's normal speed of 9.6 kbps. M1's WAP service utilizes a special platform that provides 14.4 kbps allowing it to boast of Singapore's fastest service. In December 2000, M1 claimed to be the first to have launched General Packet Radio Service (GPRS) roaming. It builds on the world's first WAP roaming service with Hongkong (started in July 2000); roaming subscribers can access the *Mi World* portal at 36 kbps from Hongkong. Calls are routed over an IP network to get around international long distance rates. SingTel launched a fast wireless service in September using High Speed Circuit Switched Data (HSCSD). This provides a

speed of 38.4 kbps. StarHub launched a GPRS trial at the end of October 2000.

The take-up of mobile Internet in Singapore thus far appears to be lukewarm compared to Japan's popular i-mode service. Hard data about the number of users is difficult to come by. StarHub claimed more than 10'000 WAP users at end September 2000 while SingTel Mobile stated it had 20'000 Mobile Office customers in early September. There are no published figures for M1 regarding mobile Internet customers. IDA's figure for mobile data services subscribers—which captures customers of Public Mobile Data licensees but does not include WAP users—was 11'700 at September 2000. Extrapolating from the available data, there were less than 50'000 mobile Internet users in September 2000 or about two per cent of the total mobile subscriber base. Resistance to mobile Internet is related to pricing and handset availability. All operators have waived WAP registration and subscription fees. Usage is charged on a basis of ten Singapore cents (5.8 US cents) per minute.

In October 2000, IDA announced the procedure for awarding third generation (3G) mobile licenses.[5] Unexpectedly, it has decided to use an auction system to award four licenses. The rationale was that an auction is the most objective way of awarding the licenses. The floor price at which the auction will begin has been set at S$ 100 (US$ 57) million. The auction will be held in April 2001.

2.2 Information Technology Sector

Singapore has a vibrant IT sector. The electronics industry, including computer equipment manufacturing, is large and the country is a major export base for big multinational companies such as IBM, Hitachi and Sun. Indeed, exports of Office Machines (which include data processing equipment) was some S$ 41 billion (US$ 23.7 billion) in 1999, more than a third of the country's total exports. There are around 93'000 people employed in the ICT sector in the country, growing at 10-12 per cent a year. Professional and industry associations include the Singapore Computer Society <www.scs.org.sg> and Singapore Information Technology Federation <www.sitf.org.sg>.

2.2.1 Computer market

There is a large selection of computer equipment available in Singapore with many retail outlets. There are even two shopping malls mostly devoted to computer products. Prices are reasonable with a Compaq iPAQ Desktop (Pentium III, 500 MHz processor) costing S$ 1'588 (US$ 915) in July 2000, around US$ 40 less than if purchased over Compaq's US web site.

According to IDC, some 427'000 personal computers were sold in Singapore in 1999, an increase of almost 30 per cent over the previous year.[6] It is estimated that there are around 1.7 million PCs in use on the island, resulting in a penetration rate of 44 per cent, the second highest in the Asia-Pacific region (after Australia). Singapore's household computer penetration stood at 59 per cent in 1999, up almost 20 per cent over the previous year.

2.2.2 The Internet market

Singapore was one of the first countries in Asia to get an Internet connection. This was the culmination of many years of connectivity experience with academic networks preceding the Internet. The pioneering network initiatives of the National University of Singapore (NUS) were critical, attesting to the importance of the academic sector in developing a sustainable Internet environment.[7] Networking activities date back to the early 1980s when Singaporeans obtained new-to-market personal computers and set up Bulletin Board Systems (BBS).[8] Some of these BBS had daily dial-up connections to the international FIDOnet for exchanging emails and files with users in other countries. In 1987, the NUS joined BITNET with the first email received from the City University of New York in January over a 4800 bps link. This was the first Asian link outside of Japan to the BITNET and is cited as a milestone in Singapore's early Internet lead over other countries. Another first took place in August 1990 when a 64kpbs Internet link was established between NUS and Princeton University in the United States. This was the first Internet site in Singapore and the Southeast Asian region. Full Internet connectivity for NUS was officially launched in April

Table 2.3: Singapore PC Market

	1997	1998	1999
PC sold (000s)	370	332	427
Estimated PC base (000s)	1'244	1'450	1'703
PCs per 100 people	33.3%	37.5%	43.7%
Percent households with PC	35.8%	41.0%	58.9%

Note: Estimated base derived from sales data.
Source: ITU adapted from IDC, IDA and national statistics.

1991. Other regional firsts for NUS include the first Gopher server in 1992 and the first World Wide Web server in 1993.

In 1992, TechNet was established to provide Internet connectivity for the island's R&D community, extending access beyond NUS. Technet was later 'commercialized' and became Singapore's second ISP known as Pacific Internet. SingTel launched public Internet services in July 1994 through its SingNet subsidiary. These two ISPs were joined by the then Cyberway, which launched service in March 1996. These three were the only companies allowed to provide Internet service until October 1998 when the ISP market was opened. By June 2000, there were 18 licensed ISPs in Singapore (see Table 2.4) although the original three retain the bulk of the consumer dial-up market with most of the newcomers either serving niche corporate markets[9] or not yet in operation.

ISPs are granted a license by IDA. The license is valid for a period of three years, renewable for another three years after that. The license fee is one per cent of annual gross turnover. In addition, ISPs are automatically granted a class license by SBA, which covers content issues; they are supposed to register with SBA within 14 days after commencing service.

IDA has been publishing Internet dial-up subscriber figures since January 1997. At June 2000, IDA reported 1.8 million dial-up subscribers, resulting in a penetration rate of 54.2 per cent. The number of subscribers rose substantially from December 1999 to March 2000, since the launching of free ISP service by StarHub in December 1999. This was followed by SingNet which provides each SingTel telephone subscriber with a free Internet account via the *mysingtel* portal. In addition SingNet has waived dial-up telephone usage charges for its Internet clients that subscribe to a monthly package. Growth has been flat since March 2000, with the number of Internet subscribers roughly equivalent to the number of telephone lines.

Table 2.4: ISPs in Singapore

Licensed ISPs, June 2000

ISP	Web site
1 1-Net Singapore	<www.1-net.com.sg>
2 AT&T Worldwide Telecommunications Services	
3 Cable & Wireless Network Services (Singapore)	
4 Circle Dot Com (S)	
5 Concert Global Network (S)	
6 Dataone (Asia)	<www.dataone.com>
7 Equant Singapore	
8 Global One Communications	
9 LGA Telecom	
10 Loral Cyberstar International Inc	
11 Pacific Internet	<www2.pacfusion.com/sg>
12 Singapore Telecommunication	<my.singnet.com.sg>
13 StarHub Internet	<www.starhub.net.sg>
14 Stt.com	<www.stt.com.sg>
15 Swiftech Automation	<www.swiftech.net.sg>
16 T.M.I. Telemedia International Hong Kong	
17 UUNET Singapore	<www.uu.net/sg>
18 Winstar Communications Singapore	

Note: These are licensed ISPs and not necessarily in operation.
Source: ITU adapted from IDA.

As a result of free access, figures for Internet subscribers are a bit misleading. Singapore is one of the rare countries where the number of regular Internet users is less than the number of subscribers. A number of recent surveys provide differing figures on Internet use on the island (see Figure 2.4). A 1999 survey provided by SCV based on a sample of 4'200 people states that roughly one third (31.4%) of the population used the Internet. A March 2000 survey put the active Internet universe at 404'000 users (10 per cent of population).[10] Yet another study, released in September 2000, stated that Singapore had the highest Internet penetration in Asia with 46 per cent of the population older than 15 accessing the Internet in the past month.[11] One explanation for these wide discrepancies is that some of the surveys only cover home use and thus would not cover Singaporean residents accessing the Internet from school or work.

Singapore's high level of Internet development is reflected by its active promotion of high speed Internet access through the nationwide Singapore ONE network <www.s-one.gov.sg> (see Figure 2.5). Singapore ONE is a government-led initiative to develop broadband infrastructure and services. 1-Net provides the infrastructure for Singapore ONE.[12] The network is based on Asynchronous Transfer Mode (ATM) switching technology with fibre optic transmission speeds at up to 622 Mbps.

Broadband local access is available through two services. The first is cable modem access provided by Singapore Cable Vision. The second is SingNet's ADSL Magix service. Over 99 per cent of the island's households are passed by broadband infrastructure and there were 250'000 users in September 2000.[13]

Singapore's international Internet connectivity is, on a per capita basis, one of the highest in the world thanks to SingTel's Internet Exchange (STIX) <www.ix.singtel.com>. It is connected to over 30 countries with some 800 Mbps of bandwidth.

Figure 2.4: Internet market in Singapore

Number of Internet subscribers, 1997-2000 and
estimated number of users, various surveys, June 1999 - September 2000
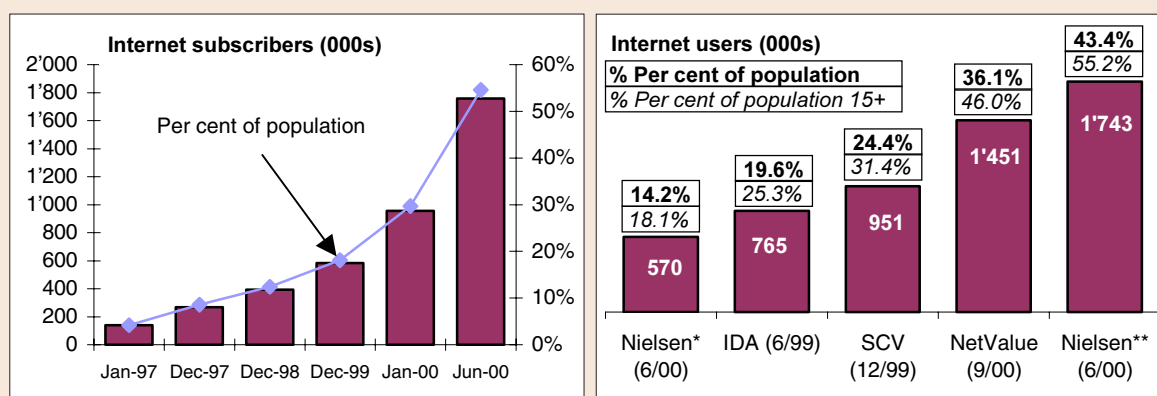
Note: Left chart: 'Free' Internet access was introduced in December 1999. Right chart: Figure in parenthesis refers to date of survey. Nielsen* figure refers to home users accessing Internet in the last month. IDA refers to their household IT survey. SCV refers to Singapore Cable Vision survey. NetValue data is derived from percentage of 15+ Internet users. Nielsen** figure refers to the total Internet universe.
Source: ITU adapted from IDA, Nielsen, SCV and NetValue data.

Figure 2.5: SingaporeOne Network Infrastructure
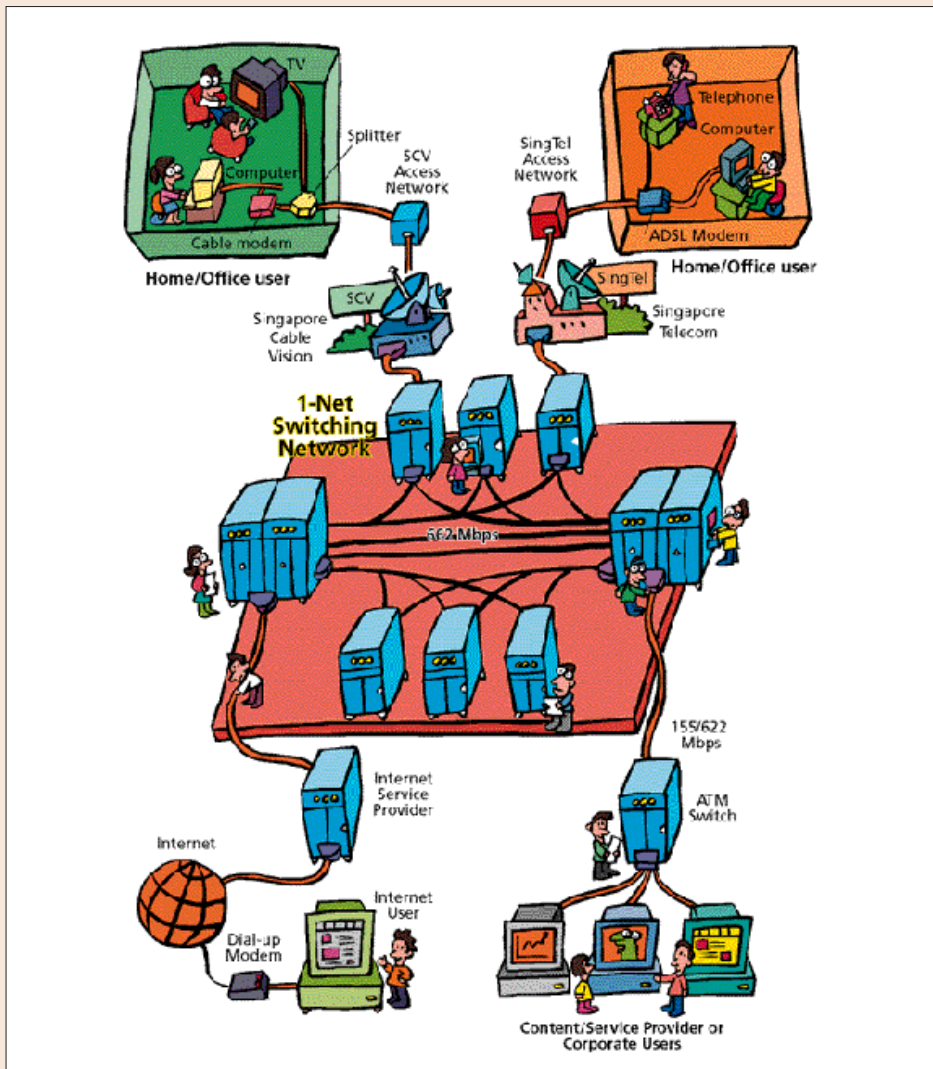
Source: http://www.1-net.com.sg/images/aboutus/s-one/Network.gif, December 2000.

2.3 Mass media

There is a high level of technology adoption by Singapore's mass media. This includes not only the Internet but also other advanced broadcasting technology such as Digital Audio Broadcasting (DAB) and Digital Television (DTV). Virtually all of Singapore's newspapers and radio and television stations have web sites. Many have gone further by building portals, developing content or providing audio and video streaming. Singapore's relatively small market size encourages media companies to develop Internet properties with regional pull. This is aided by the perception that Singapore's media is more objective—particularly for Chinese language reporting—than other regional media. Despite the variety of newspapers and broadcast stations, they are all owned by two

companies. The country has recently partly liberalized the media sector by notably allowing the leading printed media company to get into broadcasting and vice versa.

2.3.1 Print

There are eleven local daily papers—six English, three Chinese and one each in Malay and Tamil. There are also about 190 foreign newspapers and more than 5'000 foreign magazines available in Singapore. Daily circulation for the local papers is over one million with the English language papers accounting for more than half. Seven of the papers are on the web, made easier by the fact that they are all published by *Singapore Press Holdings* (SPH) <www.sph.com.sg> (see Box 2.2).

Box 2.2: From printed newspapers to online ones

AsiaOne <www.asia1.com.sg>, a Singapore Press Holdings (SPH) dot-com spin-off, illustrates how Singaporean media companies are embracing the Internet. AsiaOne originated within SPH as a multimedia division and was listed in June 2000 when 13 per cent of its shares were sold to the public. AsiaOne hosts the online version of SPH's seven newspaper editions. It also has content on various subjects such as food, computers and health. Other services include call centre support for horoscopes, sports results, and polling over the telephone.

The main source of AsiaOne's revenue is online advertising. It believes this will grow due to increasing Internet usage and liberalization of the Singaporean media market, which will attract more advertizers. Other sources of AsiaOne revenue include e-commerce transaction services (being one of the largest online shopping malls with more than 200 cyber stores) and voice serv-ices. A successful business model has been to bring news online before it comes out in print. AsiaOne also provides free email accounts and sends out breaking news to subscribers. These methods keep users *sticky* to the site. AsiaOne has also reached out to mobile users through a WAP service that provides news headlines and restaurant listings.

AsiaOne claims to get an average of three million page views a day and ranks second in terms of time spent on Singaporean sites with an average of almost half an hour per session (see Table). AsiaOne also operates Zaobao Online, the Internet version of Singapore's leading Chinese newspaper. Zaobao is a Chinese language portal that packages the news content of Lianhe Zaobao and overseas Chinese newspapers with a host of web features and services aimed at Chinese-speaking audiences around the world.

Box Table 2.2: Singapore's top web sites

Ranked by time spent per person, July 2000

Property	Unique audience	Reach %	Time per person
1. MSN	238,014	43.38	0: 42: 33
2. AsiaOne	80,652	14.70	0: 28: 50
3. Yahoo!	278,629	50.78	0: 26: 26
4. Pacific Internet	158,823	28.94	0: 12: 51
5. Singapore Telecom	217,377	39.62	0: 11: 57
6. Lycos	131,304	23.93	0: 09: 02
7. Excite@Home	66,351	12.09	0: 08: 31
8. AOL Web sites	146,486	26.70	0: 07: 07
9. AltaVista	81,404	14.84	0: 06: 56
10. Microsoft	107,175	19.53	0: 04: 23

Note: The data cover home Internet users.
Source: ITU adapted from Nielsen//NetRatings.

2.3.2 Broadcasting

Singapore has a diverse broadcast scene, despite the fact that it has traditionally been government-owned. In 1994, the Singapore Broadcasting Corporation was corporatized as the Singapore International Media Group (SIM) whose subsidiaries include all the leading broadcasters: Radio Corporation of Singapore (known as MediaCorp Radio), Television Corporation of Singapore and Singapore Television Twelve. SIM underwent a restructuring in 1999 and has been renamed Media Corporation of Singapore.

Radio

There are 18 FM radio stations on the island of which twelve belong to *Radio Corporation of Singapore* (RCS).[14] RCS, now known as MediaCorp Radio, broadcasts in four languages, reaching about 2.5 million listeners a week. All RCS's stations are on Internet via its main web page <radio.mediacorp singapore.com>.

The Internet has provided a way for new stations to overcome scarce FM frequency by developing web sites with audio broadcasts. For example, UTV Entertainment <www.utvi.com. sg> has webcasts with six video and two audio-on-demand channels over the broadband Singapore One net work. MediaCorp Radio also operates 20 NetRadio channels at <radio eastwest.com>.

Television

There are currently six free-to-air television channels on the island. They are Channel 5, Channel 8, Suria, Central, Sportscity, and Channel NewsAsia (CNA). Singapore's largest terrestrial broadcaster, Television Corporation of Singapore (TCS), now known as MediaCorp TV <tv.mediacorp singapore.com> , owns and manages the entertainment channels, Channel 5, Channel 8, Sportscity, and the Malay entertainment and information channel, Suria, as well as the one specialized in programs for and on children, Indian- and arts communities,

Central. Channel 5 and 8 offer viewers round-the-clock English and Mandarin mass entertainment and information programs respectively. Sportscity offers sports fans sporting action from around the world. MediaCrop News owns and manages CNA, which provides news and information on global developments with an unique Asian perspective. In September 2000, MediaCorp launched its second feed, Channel NewsAsia (International), to cater to viewers outside Singapore. MediaCorp TV also owns TVMobile, Singapore's first outdoor digital television channel, and MDigital, which promises viewers the interactive television experience of the future. In June 2000, the government announced that is was prepared to grant SPH licenses to run up to two free-to-air TV and two radio channels. Shortly after, SPH MediaWorks was formed and announced that it would start its commercial TV channels, TV Works and Channel U, by May 2001.

Singapore has a license fee system whereby all television set owners are required to pay an annual charge. License fees generated S$ 92 million (US$ 53 million) for SBA during its 1999/2000 fiscal year, accounting for 88 per cent of revenue. Ironically, despite a ban against chewing gum and strict littering laws, it seems that around 20 per cent of Singapore's households are evading license fees. Though television penetration is felt to be near universal, SBA had issued 758'683 licenses at December 2000, accounting for 82 per cent of the households in the country.

Singapore Cable Vision (SCV) was licensed in June 1995[15]. It was required to cable all homes on the island by 1 January 2000 in return for a 7-year exclusivity franchise. The S$ 600 (US$ 346) million hybrid fibre-coaxial network was completed in September 1999, three months ahead of schedule. SCV has a number of subscription packages offering up to 40 cable channels depending on the package chosen. SCV's entry package, the Basic Tier, costs S$ 33.94 (US$20) per month and includes free channels like the six local terrestrial stations, two Malaysian ones

	Table 2.5: Mass media indicators	
Indicator	**Value**	**Source**
Daily newspaper circulation	1,068,942	1999. Statistics Singapore.
Per 1'000 inhabitants	275	
Television licenses	758'683	December 2000. SBA.
Households with license	82%	923'300 resident households per Statistics Singapore at June 2000.
Television households	896'000	1999. AC Nielsen.
Households with TV	99%	1999. AC Nielsen.
Cable TV subscribers	255'000	2000. SBA
Households with cable TV	28%	

Source: ITU adapted from sources shown.

and SCV's Preview Channel. There were some 255'000 cable TV subscribers by December 2000 or just over one quarter of all homes.

Following a three-year trial period since 1996, SCV launched a cable modem service called MaxOnline, in December 1999. There were 38'000 MaxOnline subscribers in December 2000. The connection charge is S$ 51.50 (US$ 30) and the monthly fee is S$ 76 (US$ 44) (S$ 56 for existing MaxTV subscribers).

There is currently a ban on Direct-To-Home satellite reception.

[1] The compensation is based on the estimated loss of earnings from competition. SingTel was compensated S$ 859 million (US$ 495 million) and StarHub S$ 1'082 million (US$ 623 million) for moving forward the date of full competition from 1 April 2002 to 1 April 2000. See IDA. "IDA Announces Compensation to SingTel and StarHub." *IDA Media Release*. 11 September 2000.

[2] Temasek also owns a *Special Share* which ensures that no major changes can be made to SingTel without its prior written approval. Temasek's web site is http://www.temasekholdings.com.sg

[3] IDA's licensing and regulatory powers are granted under the 1999 Telecommunications Act.

[4] M1. "M1 SMS to rival networks now free." *Press Release*. 26 June 2000.

[5] IDA. "IDA Announces 3G Licensing Framework." *Press Release*. 20 October 2000.

[6] IDC. "Asian PC Market Surges to Over 14.1 Million Units in 1999, Says IDC." *Press Release*. 14 February 2000. http://www.idc.com.sg/Press/releases/PR-AP-PC_99.htm.

[7] Overcoming a sense of isolation has been put forth as a prime reason for the keen interest of Singapore's academic community to establish international computer connections.

[8] Much of the history of the Internet in Singapore in this section is based on Bernard Tan. "Origins of the Internet in Singapore (Part 1)." '*envision*' (Singapore Broadcasting Authority). January-March 2000 as well as a forthcoming draft of Part 2 provided to us by Dr. Tan.

[9] For example a number of the newly licensed ISPs such as Equant are global ISPs; their Singaporean operations are targetted at their global customers (many of which have their regional headquarters in Singapore). Others, such as DataOne, target the business community by providing value-added services in addition to plain ISP.

[10] See Nielsen/NetRatings. "Nielsen//NetRatings Announces First-Ever Multi-Country Internet Audience Measurement Results." *Press Release*. 4 May 2000.

[11] NetValue. "Asian Internet Users Come Out of the Closet." *Press Release*. 4 September 2000. www.netvalue.com/corp/presse/cp0013.htm

[12] 1-Net's web site is: http://www.1-net.com.sg/index.cfm. A network diagram is available at http://www.1-net.com.sg/images/aboutus/s-one/Network.gif and a schematic of the types of services is available at http://www.1-net.com.sg/images/aboutus/s-one/s1apps.gif. In September 2000, IDA announced that 1-Net's shareholders would sell their holdings to MediaCorp. See IDA. "Industry Players Divest 1-Net shares to Mediacorp." *Media Release*. 27 September 2000.

[13] IDA. "Singapore One Reaches a Quarter of a Million Users." *Media Release*. 18 September 2000.

[14] The AM radio frequency is not used.

[15] SCV's owners are Media Corporation of Singapore (41.3%), ST Telecommunications (32%), and Singapore Press Holdings (26.7%) and its web site is <www.scv.com.sg>.

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$
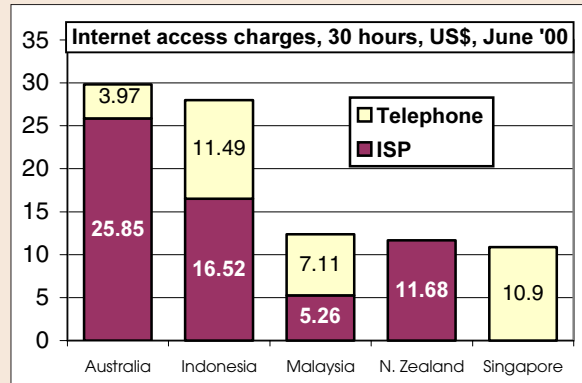
Source: ITU adapted from Sources shown.

Figure 3.2: SingTel IX

Source: http://www.ix.singtel.com/services4.html.
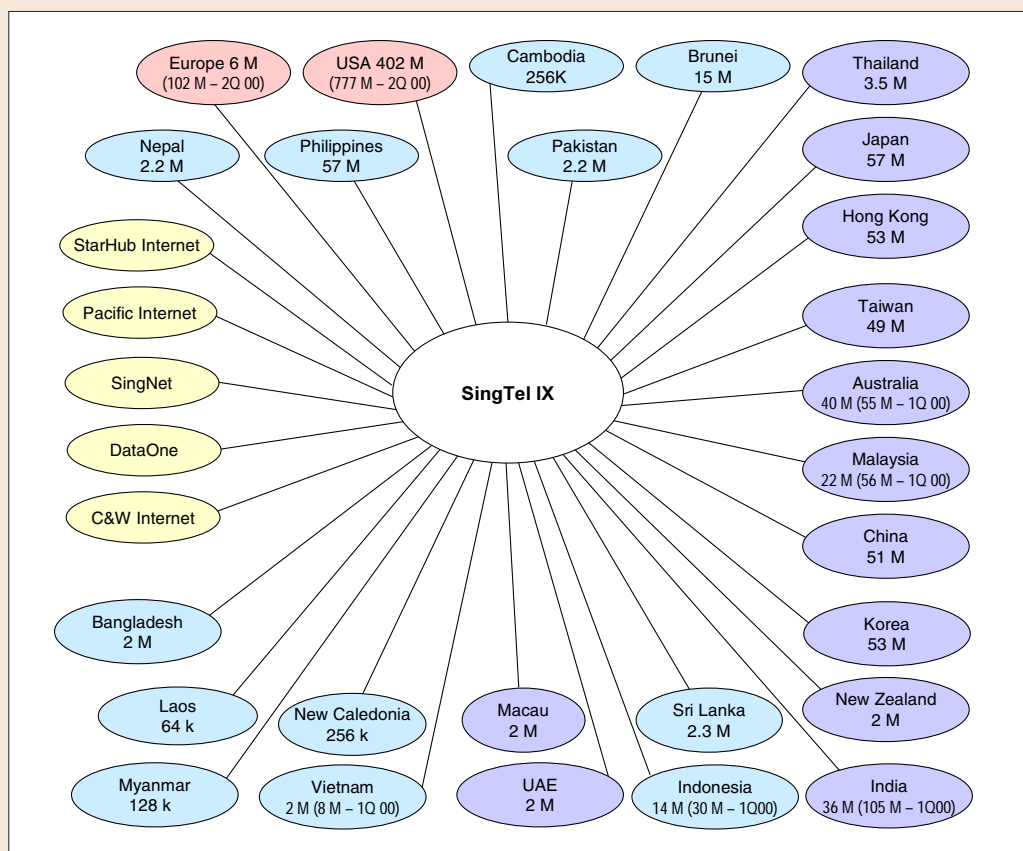
Table 3.2: Internet access prices

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

ISP	Plan	Joining fee 1/	Monthly fee 2/	Free hours 3/	Extra hour 4/	Charge for 30 hours per month		
						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.
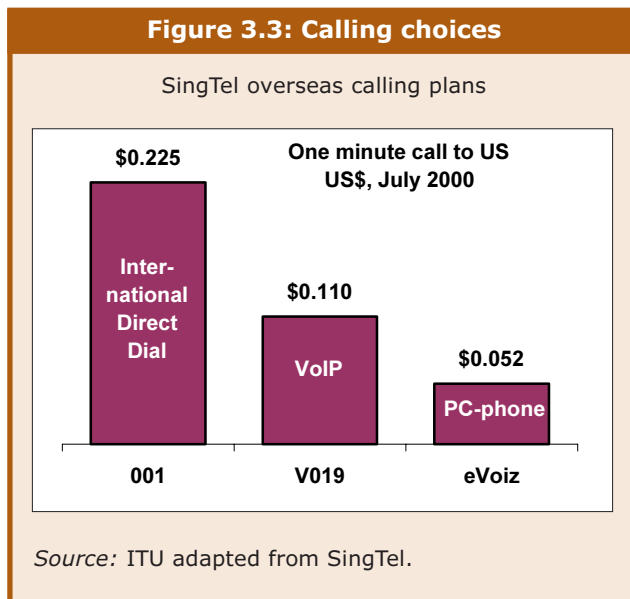
Singapore has been at the forefront of the campaign for equitable cost sharing of Internet circuits to the United States. Foreign ISPs have traditionally borne the full cost of the Internet circuit to the United States. As a result US ISPs can provide access to Internet sites around the world for their 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

One minute call to US
US$, July 2000

- $0.225 — International Direct Dial — 001
- $0.110 — VoIP — V019
- $0.052 — PC-phone — eVoiz

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

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Figure 3.4: Whose homes are most connected?

Household PC and Internet penetration, 1999

Household PC penetration, 1999

Singapore	59%
USA	54%
Australia	47%
Japan	42%

Household Internet penetration, 1999

Singapore	42%
USA	40%
Australia	22%
Japan	13%

Source: ITU adapted from IDA.

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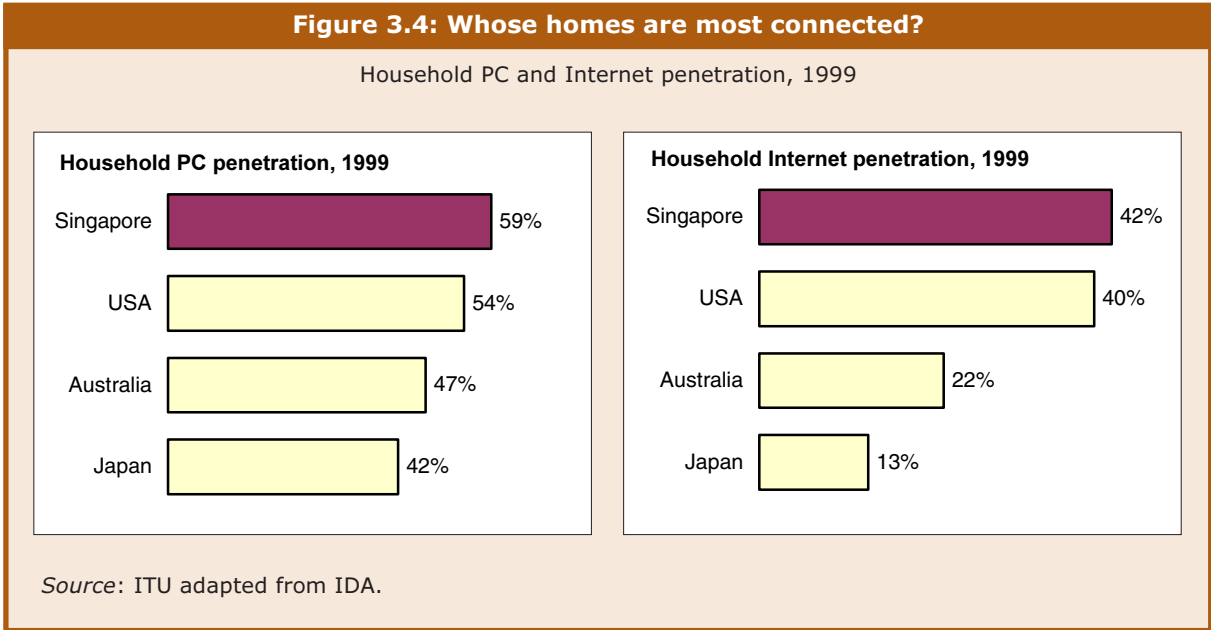
suggests that no one is very far from the Internet if they need it. Therefore universal access is complete. Awareness of the Internet is also high; a 1998 survey found that over 90 per cent of Singaporeans were aware of the Internet. All the current dot-com publicity—including buses and cabs displaying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

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Figure 3.5: Internet and language

Internet use by language spoken

Legend: ■ Don't use □ Use

Chinese: Don't use 1'074, Use 669
Malay: Don't use 414, Use 186
Tamil: Don't use 88, Use 44
Other: Don't use 207, Use 2
English: Don't use 207, Use 146

Never use Internet by language

English only: 58.5%
Chinese only: 99.4%
Malay only: 100.0%
English & Chinese: 44.5%
English or Chinese: 61.9%
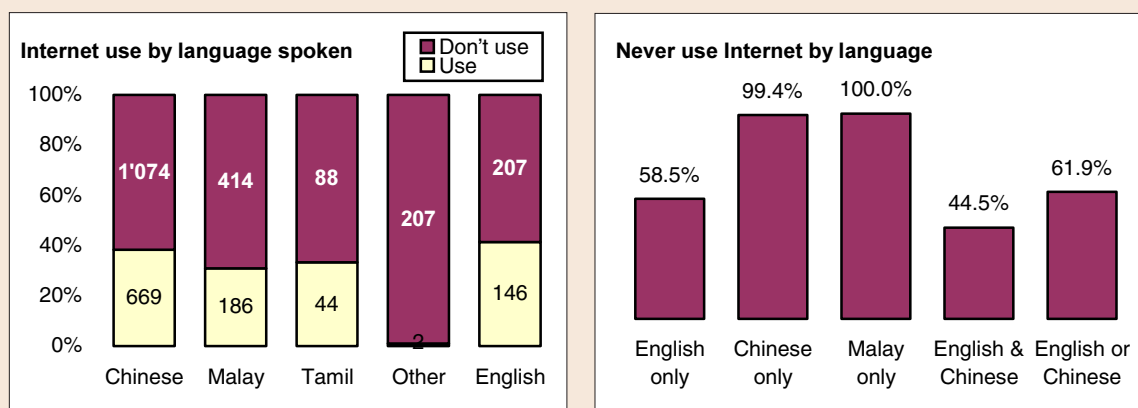
Note: The charts show the share of population and Internet use by language spoken rather than ethnic group.
Source: ITU adapted from CABSAT/NETWATCH.

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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.

DANGER – KEEP OUT !
危险，请避开！
அபாயம்-அருகீல்வரதீர்கள்
BAHAYA – JANGAN DEKAT !

[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 serv-

ants 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 on-line. One example of a

Figure 4.1: e-citizen

Source: <www.ecitizen.gov.sg>, December 2000.
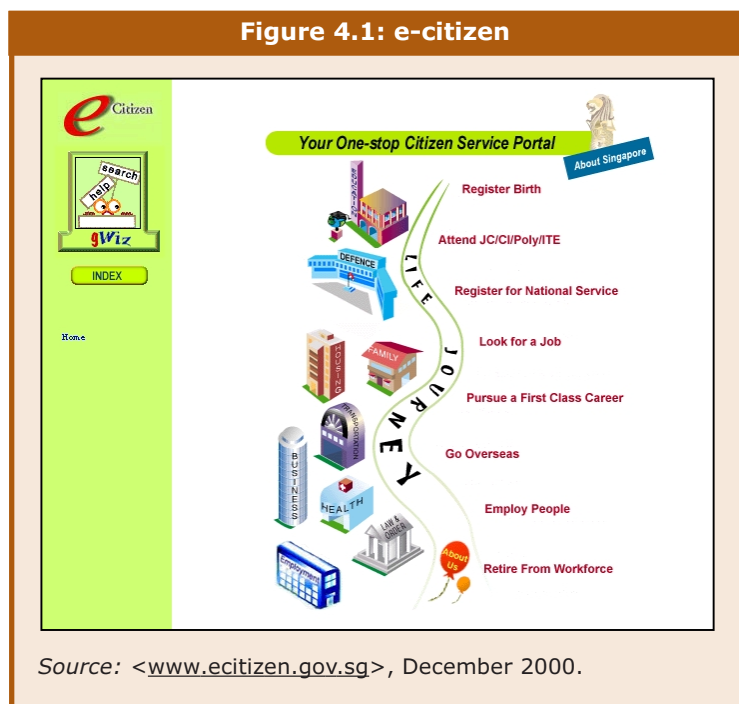
successful application is the online submission of income tax forms. So far, about one quarter of all tax returns have been filed on-line through the *eFiling* service provided by the Inland Revenue Authority. One incentive has been allowing a one-week extension for tax forms filed online.

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
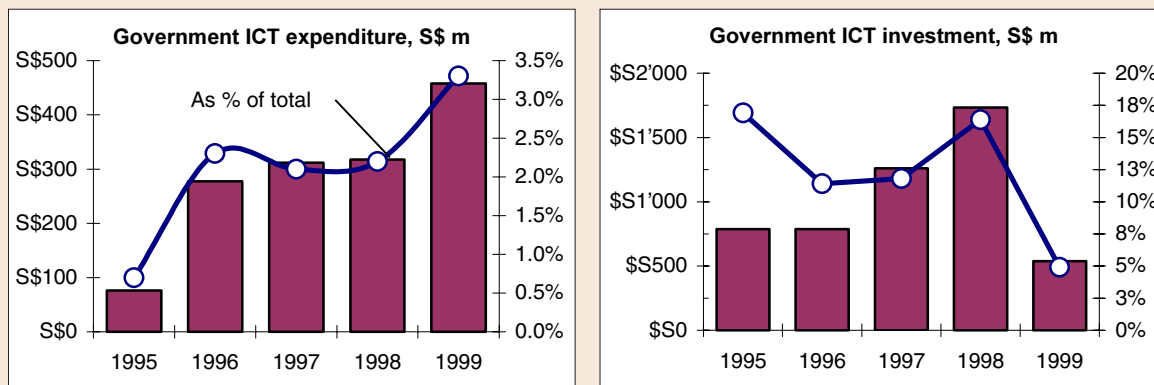
Source: ITU adapted from Singapore Department of Statistics.

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 prag-

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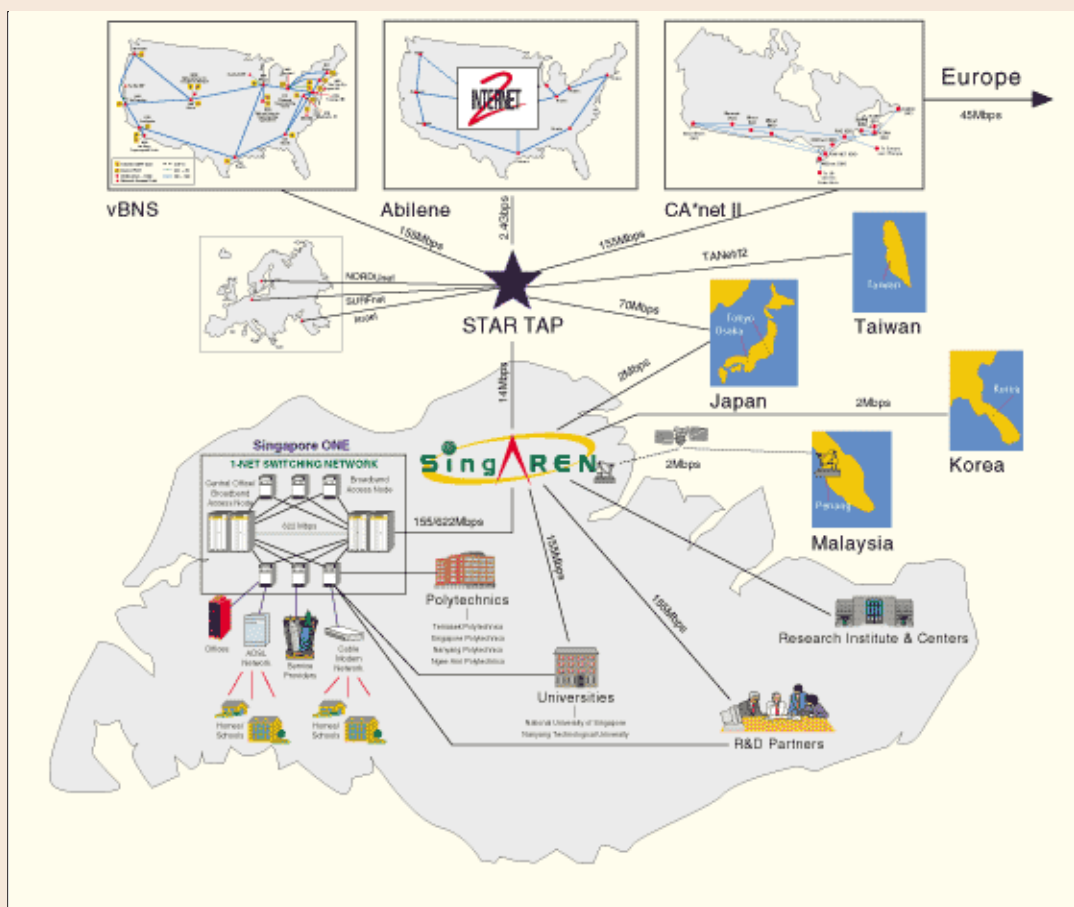
Source: http://www.singaren.net.sg/html/netmap.html, December 2000.

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 network-

ing 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

Consultancy/Business Analysis	13%
Software Research & Development	14%
Specialist Support Services	15%
Internet Development	24%
e-commerce	**47%**

	1999 Current Utilization Level	2001 Excpected Utilization Level
Web-Based	2.2	4.5
Computer-Based	2.3	4.2
Classroom	3.9	4.1
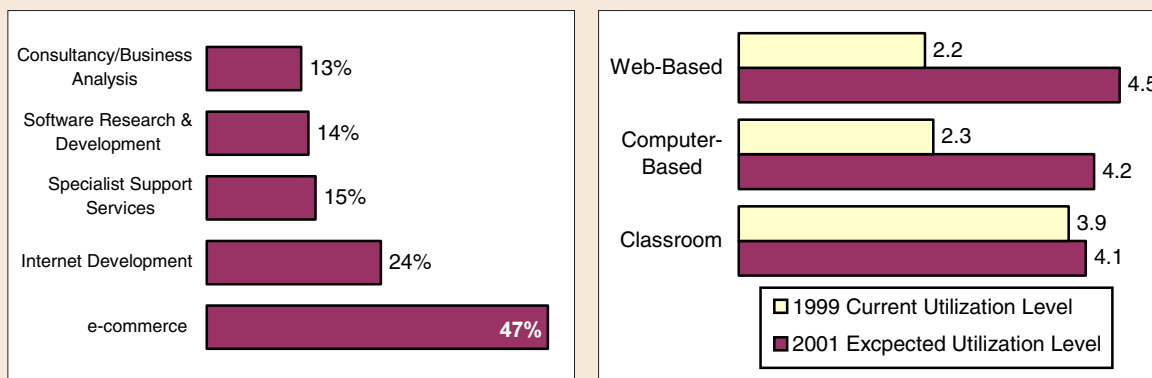
Note: In the right chart, 1 = no utilization, 10 = very high utilization.
Source: IDA 1999 Infocomm Manpower and Skills Survey.

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 net-working 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

Student-computer ratio in primary schools

Country	Students per computer
Canada	11
Finland	16
Singapore	17
New Zealand	20
Hongkong SAR	53
Japan	59
Taiwan-China	74

Student-computer ratio in secondary schools

Country	Students per computer
Canada	9
New Zealand	10
Denmark	12
Singapore	12
Japan	21
Taiwan-China	35
Hongkong SAR	36

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, life-long 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.

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.

5.   **Summary & recommendations**

5.1   **State of the Internet in Singapore**

The Mosaic Group (http://mosaic. unomaha.edu/gdi.html), has developed a framework for characterizing the state of the Internet in a nation. They consider six dimensions, each of which has five ordinal values ranging from zero (non-existent) to four (highly developed). The dimensions are as follow:

• pervasiveness: a measure based on users per capita and the degree to which non-technicians are using the Internet.

• geographic dispersion: a measure of the concentration of the Internet within a nation, from none or a single city to nationwide availability.

• sectoral absorption: a measure of the degree of utilization of the Internet in the education, commercial, health care and public sectors.

• connectivity infrastructure: a measure based on international and intranational backbone bandwidth, exchange points, and last-mile access methods.

• organizational infrastructure: a measure based on the state of the ISP industry and market conditions.

• sophistication of use: a measure characterizing usage from conventional to highly sophisticated and driving innovation.

A definition of each dimension and its levels is shown in Annex 4, and Singaporean values for these dimensions are shown below:

Pervasiveness is rated at level 4, *Pervasive*. Estimates of the number of users vary widely depending on frequency of use, access location, age group and other factors. Surveys made between June-September 2000 put the number of Internet users at

Figure 5.1: State of the Internet in Singapore

Dimension	Value
Pervasiveness	4
Geographic Dispersion	4
Sectoral Absorption	4
Connectivity Infrastructure	3
Organizational Infrastructure	3.5
Sophistication of Use	3.5
TOTAL	**22**
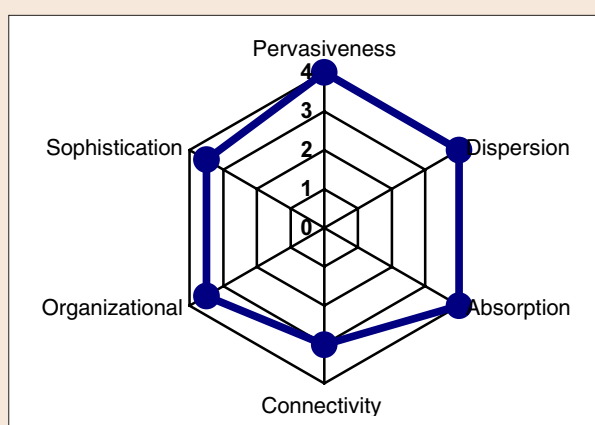
Note: The higher the value, the better. 0 = lowest, 4 = highest.
Source: ITU adapted from Mosaic Group methodology.

anywhere between 14 – 43 per cent of the population. Government data state that Singapore has the highest household Internet access penetration in the world (42 per cent).

Geographic Dispersion is rated at level 4, *Nationwide*. The Internet is available all over the island. Singapore's small size of 660 square kilometres makes this dimension easy to fulfil. Internet access is available to all telephone subscribers for the price of a local call.

Sectoral Absorption is rated at level 4, *Widely Used*. The ranking is a function of the type of connectivity in the education, business, government and health sectors. The university and research and development community have high-speed connectivity to both the nationwide broadband network as well as the second generation Internet. The *Masterplan for IT in Education* provides for Internet access from every primary and secondary school classroom by the year 2002. All teachers and pupils from Primary 4 and above will be provided with email accounts. Internet absorption in the business sector is common. Almost all firms with more than 100 employees have Internet access. Over 80 per cent of those with less than 100 employees have Internet access. Over 60 per cent of firms with more than 100 employees have a web site. Government absorption is high. All ministries and statutory boards have web sites, there is a high degree of IT knowledge and use by government employees and there is a government portal for online citizen services. In the health sector, the Ministry of Health as well as all hospitals and polyclinics are connected to the Internet. There is a lower level of access among general practitioners.

The **Connectivity Infrastructure** is at level 3, *Broad*. The *Singapore One* national backbone uses Asynchronous Transfer Mode (ATM) technology over fibre optic cable at speeds of up to 155 Megabytes per second (Mbps). The SingTel Internet Exchange (STIX) has 400 Mbps of bandwidth to the Asia-Pacific region and 405 Mbps to the United States. Besides conventional dial-up for local Internet access, broadband access is available via leased line, ISDN, ADSL and cable modem.

The **Organizational Infrastructure** is at level 3.5, between *Competitive* and *Robust*. There is free entry to the Internet Service Provider (ISP) market. ISPs must be licensed and pay appropriate fees to the telecommunication regulatory authority. There were 37 licensed ISPs in December 2000. ISPs are free to install their own national and international infrastructure. The ISP market has only been open to full competition for a relatively short period of time.[1] Therefore a ranking between competitive and robust has been assigned until the new regulatory and policy environment has proven itself.

Sophistication of Use is at level 3.5, between *Transforming and Innovating*. There is a rising degree of sophistication in the Singaporean Internet market. Hi-tech hubs such as Suntec City are attracting a growing number of *dot-coms*. Businesses are increasingly using the Internet to transform their internal and external interactions and e-commerce is active and growing. The National University of Singapore has a connection to the second generation Internet and is carrying out various Internet-related research projects while primary and secondary schools are increasingly integrating Internet applications into schoolwork. A noteworthy government application is the *e-Citzen* portal where users can consult information and complete some forms online. The mass media has embraced the Internet with most newspapers and radio and television stations online; there are also media-based portals and audio and video streaming. Finally, there are a growing number of users and applications on the broadband Singapore One network.

This framework has been applied in several other nations, including some in the region. The dimension values for the Special Administrative Region (SAR) of Hongkong and Taiwan-China

	Date	P	GD	SA	CI	OI	SU	Total	Source
Singapore	5-00	4	4	4	3	3.5	3.5	22	ITU
Hongkong SAR	9-99	4	4	4	3	3	3	21	Mosaic
Taiwan-China	9-99	4	4	3	3	3	3	20	Mosaic

Table 5.1: State of the Internet in Singapore compared to other economies

Note: The following dimensions are considered: Pervasiveness (P), Geographic Dispersion (GD), Sectoral Absorption (SA), Connectivity Infrastructure (CI), Organizational Infrastructure (OI), and Sophistication of Use (US). The higher the value, the better (0 = lowest, 4 = highest).
Source: ITU, MOSAIC Group, <mosaic.unomaha.edu/gdi.html>.

are compared to Singapore below. All three rank practically the same with similar strengths. Although Singapore ranked first, the surveys for the other two economies were done earlier. Furthermore, the qualitative nature of some of the dimensions makes a complete accurate comparison difficult to achieve. Nonetheless, they suggest that there is a tight race to become Asia's regional Internet hub.

5.2   Recommendations

In a country as wired as Singapore, recommendations for enhancing Internet diffusion may seem superfluous. Singapore appears to be doing so much correctly and the government is an active supporter and promoter of Information and Communication Technology (ICT). But perhaps there is too much of a push. It may be useful to sit back for awhile and ponder the results and repercussions of an increasingly wired society. Of course, that is easier said than done since the Internet moves at lightening speed and there is competitive pressure to stay ahead of regional and global rivals in the race to become a premier ICT hub. Nonetheless, there are a few areas that merit attention.

5.2.1 Health
Although Singapore's hospitals and clinics are well wired, only around

15 per cent of general practitioners have PCs and they have been slow to adopt Internet access. A Singaporean health portal tried to promote its business by giving doctors PCs bundled clinic management and medicine ordering software. There is a feeling that this initiative has not been extremely successful because general practitioners are not ICT-savvy. *This suggests there is a need to raise awareness and train general practitioners in ICT.*

The Ministry of Health is beginning to look at some of the regulatory issues associated with ICT such as privacy, ordering drugs from overseas, etc. *There is a need to accelerate the procedure for elaborating policies and a legal framework for health-related Internet issues.* There are also health concerns surrounding intense ICT usage such as repetitive stress injury, isolation, bad eyesight, etc. *There is a need for research on the ergonomic impact of heavy ICT use*.

One focus of e-health applications on the island has been on creating electronic medical records in order to easily deliver consistent information to practitioners. One problem has been poor training in data entry. Another is that although much data is available at hospitals, so far there is not a common island-wide system. *There is a need to develop a standard, inte-*

grated, up-to-date and verified medical record for use by the entire Singaporean health community.

The Internet has not yet progressed to being exploited routinely in the health community. The main applications that are utilized are email and information searching. A significant portion of the public and even some doctors are still not aware of the Internet's benefits. *There is a need to get them used to the idea of using ICT and developing basic skills before using more advanced applications. There is also a need to build awareness and to demonstrate value to the potential user.*

5.2.2 Education

Singapore has made impressive progress in educational access and use of ICT. As a world leader in this area, it would be useful to conduct research to determine the impact of ICT on cognitive and social development. If the island wants to create an Information Society, then it needs to support continuous ICT training for its residents. *Promoting attractive broadband connectivity to educational applications from homes could facilitate this.*

5.2.3 E-commerce

The government has done much to promote e-commerce. However, there are still obstacles particularly relating to awareness, lower rates of adoption by small and medium enterprises and antiquated procedures. Recommendations include:

- Enhancing awareness of e-commerce through wider dissemination of e-commerce success stories.

- Encouragement of e-commerce by reducing the Goods and Services Tax for online purchases.

- Incentives for online submission of government documents that would trigger changes to internal business practices to become more ICT-oriented.

- Streamlining government procurement practices. The following anecdote illustrates how existing procurement procedures work against e-commerce. Existing procedures call for government institutions receiving quotations from three different entities in order to make a purchase. This procedure defeats the benefits of timeliness and efficiency of purchasing products online.

5.2.4 Pricing

Dial-up Internet access tariffs are relatively low compared to other countries. However, there is no flat rate unlimited access plan combined with no local telephone usage charges. As a result, users remain conscious of the time spent and are reluctant to stay connected to experiment. This detracts from sophistication of use and innovation. Research suggests one of the reasons countries such as Canada, New Zealand and the United States have such high Internet penetration levels is because they provide unlimited Internet access plans and no local telephone usage charges. Furthermore, broadband Internet access (cable modem and ADSL) pricing is not particularly cheap, discouraging take-up. A related pricing issue is mobile where Singapore's Receiving Party Pays system may explain why mobile take-up is lower than in economies such as Taiwan-China, Hongkong SAR or the Republic of Korea.

5.2.5 Adult Literacy

The one indicator that drags Singapore down in international comparisons is literacy. While most developed countries claim literacy rates of close to 100 per cent, according to the UNDP, the adult literacy rate in Singapore in 1998 was 91.8 per cent. Statistics Singapore recently released data from the June 2000 census showing adult literacy to be 93 per cent. There is a close tie between literacy and Internet use. Thus Singapore needs to improve its adult literacy rate if it is to achieve a universal Internet diffusion. Thus it is recommended that government infocommunications assistance target raising adult literacy as a priority.

5.2.6 Broadband

Broadband penetration is surprisingly low considering the time it has been available to virtually the entire population. The major pitch behind SingONE was to provide a test bed for forward thinking companies who would develop broadband applications. Potential investors were offered substantial incentives. An objective assessment of programs such as SingONE should be conducted.

5.2.7 Market Research

There is a vast amount of easily available information for Singapore. For example, Statistics Singapore has a web site where it provides key statistics for free. IDA also provides some important subscriber-based telecommunication statistics on its web site.[2] There are a number of market research companies that also provide some data about the Singapore Internet market. However, there are numerous limitations to the available data that hinder market analysis and hence policy-making. For example, there are scarce publicly available statistics about market value. Another problem is differences in data. For example, there are varying estimates about something as basic as the number of Internet users in Singapore. Yet another problem is that many surveys refer only to the resident population of Singapore, missing out on the growing number of non-citizens which now account for almost twenty per cent of the population. Yet another limitation is that data is not centrally available but must be obtained from numerous different sources. It is recommended that IDA, in conjunction with Statistics Singapore and others, enhance its online data offerings and market research to deal with the issues noted.

5.2.8 Technical Assistance

Singapore has much to teach other nations about Information and Communication Technology. It has been extremely successful at translating government plans into realities. It is also at the forefront of broadband networking. Singapore is involved in the ICT activities of regional and international organizations. However, its ICT status — particularly as an atypical developed nation — suggest that it could play a larger role in efforts to bridge the 'Digital Divide'.

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[1]   The Internet access service provision market was liberalized in October 1998, international Internet exchange services liberalized in July 1999 and foreign equity limits lifted in September 1999.

[2]   Hopefully IDA will be able to maintain the timeliness and completeness of the data as the number of operators increases.

Annex 1: List of meetings

S/No.	Appointment With	Time	Date
1.	Prof. Bernard TanChairman, *National Internet Advisory Committee*.	1000-1100	July 24th 2000
2.	Dr Soon Teck Wong, Director, Economic Accounts,*Singapore Department of Statistics*	1100 - 1200	July 24th 2000
3.	Mr Terence Seah,Chief Executive Officer,*The Internet CallCentre Pte Ltd*	1200 – 1300	July 24th 2000
4.	Mr Daneel Pang, Acting Deputy Director, Technology Exploitation and Mr Desmond See, Manager, Information Infrastructure Development, *IDA*	1400 - 1500	July 24th 2000
5.	Mr Andrew Haire,Senior Director, Policy and Regulations, *IDA*	1500 – 1600	July 24th 2000
6.	Mr Wong Wai Meng, Business Development Director, *IAspire.net.Pte Ltd*	0900-1000	July 25th 2000
7.	Mr Tan Yap Kwang, Director, Educational Technology,*Ministry of Education*	1400-1500	July 25th 2000
8.	Associate Professor Chua Tat Seng, Department of Computer Science,*National University of Singapore*	1515–1615	July 25th 2000
9.	Mr Kyong Yu, General Manager and Mr Lim Seow Tong, Deputy General Manager, *StarHub*	0900-1000	July 26th 2000
10.	Ms Yap Siew Luan, Assistant Manager (Market Research and Analysis), *SPH AsiaOne*	1100-1200	July 26th 2000
11.	Mr Darren Choo, Research and Planning Manager,*Singapore Cablevision*	1400-1500	July 26th 2000
12.	Mr Leong Shin Loong, Chief Executive Officer (Multimedia Services), *Singapore Telecommunications* and Mr Yeo See Kiat, Deputy Director (Sales & Marketing and Business Development), *Wholesale Internet Exchange Business*.	1615-1515	July 26th 2000
13.	Mr Chiang Siew Kay, Chief Executive Officer, *AsiaStockWatch.Com Pte Ltd*	0900-1000	July 27th 2000
14.	Dr Choong May Ling,Director, Info-Communications Technology Division and Mr Ng Cher Pong, Deputy Director, Info-Communications Technology Division, *Ministry of Communications and Information Technology*	1200-1300	July 27th 2000
15.	Ms Jenny Yeo, Principal, *Radin Mas Primary School*	1330-1430	July 27th 2000
16.	Ms Ling Pek Ling, Director, Policy and Planning and Mr Jason Hoong, Assistant Director, New Media, *Singapore Broadcasting Authority*	1500-1600	July 27th 2000
17.	Associate Professor Tan Tin Wee, Director, Bioinformatics Centre, *National University of Singapore*	1630-1730	July 27th 2000
18.	Mr Lim Chin Tong, Group Managing Director, and Ms Eileen Tan, Personal Assistant to Managing Director, *i-One Net International*	1000-1100	July 28th 2000
19.	Mr Zoran Vasiljev, Vice President (Business Development), and Ms Lena Lee (Business Development Executive), *Swiftech Automation Pte Ltd*	1115-1215	July 28th 2000
20.	Ms Vivien Chiam, Business and Partnership Development Manager, and Ms Maria Ng, Senior Program Officer, *IDRC*	1330-1430	July 28th 2000
21.	Ms Lum Yoke Wah, Executive IT Manager, *Ministry of Health* Dr Colin Quek, Chief Information Officer, *National Healthcare Group*, Ms Chng Wong Yin, Chief Information Officer, *Singapore Health Services*	1500-1600	July 28th 2000

Annex 2: Acronyms and abbreviations

APEC	Asia Pacific Economic Cooperation Forum
ASEAN	Association Of South East Asian Nations
ATM	Asynchronous Transfer Mode
DOS	Department of Statistics
ICT	Information and Communication Technology
IDA	Infocomm Development Authority
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IT	Information Technology
LAN	Local Area Network
MCIT	Ministry of Communications and Information Technology
MITA	Ministry of Information and the Arts
MOE	Ministry of Economy
MOF	Ministry of Finance
NCB	National Computer Board
NSTB	National Science and Technology Board
NUS	National University of Singapore
NUS	National University of Singapore
PAGI	Parents Advisory Group for the Internet
SBA	Singapore Broadcasting Authority
SCV	Singapore Cable Vision
Singapore Dollar (S$)	The currency used in Singapore. At 30 June 2000, one United States Dollar was equivalent to 1.73451 Singapore Dollars.
SINGAREN	Singapore Advanced Research and Education Network
SME	Small and Medium Enterprises
SMS	Short Messaging Service
SPH	Singapore Press Holdings
TAS	Telecommunication Authority of Singapore
TDB	Trade Development Board
WAP	Wireless Access Protocol
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Annex 3: Useful links

Organization	Website
Main government-related ICT organizations	
Ministry of Information and Communications Technology	<www.mcit.gov.sg>
Infocomm Development Authority of Singapore	<www.ida.gov.sg>
Ministry of Information and the Arts	<www.gov.sg/mita>
Singapore Broadcasting Authority	<www.sba.gov.sg>
Main ICT providers	
Mobile One	<www.m1.com.sg>
Pacific Internet	<www2.pacfusion.com/sg>
Singapore CableVision	<www.scv.com.sg>
Singapore Telecom	<www.singtel.com>
StarHub	<www.starhub.com.sg>
Mass media	
Singapore Press Holdings	<www.sph.com.sg>
MediaCorp	<radio.mediacorpsingapore.com>
Broadband networks	
Singapore One	<www.s1.net.sg>
Singapore Advanced Research and Education Network	<www.singaren.net.sg>
Academic	
Ministry of Education	<www1.moe.edu.sg>
National University of Singapore	<www.nus.edu.sg>
Health	
Ministry of Health	<www.gov.sg/moh>
Electronic commerce	
IDA e-commerce site	<www.ec.gov.sg>
Portals	
Singapore government	<www.gov.sg>
e-Citizen	<www.ecitizen.gov.sg>
i-One.net	<www.i-one.net>
AsiaOne	<www.asia1.com.sg>
Other	
Statistics Singapore	<www.singstat.gov.sg>

Annex 4: Framework dimensions

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

Table 2: Geographic Dispersion of the Internet	
Level 0	*Non-existent*. The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country. A country may be using UUCP connections for email and USEnet.
Level 1	*Single location*: Internet points-of-presence are confined to one major population centre.
Level 2	*Moderately dispersed*: Internet points-of-presence are located in at least half of the first-tier political subdivisions of the country.
Level 3	*Highly dispersed*: Internet points-of-presence are located in at least three-quarters of the first-tier political subdivisions of the country.
Level 4	*Nationwide*: Internet points-of-presence are located in all first-tier political sub-divisions of the country. Rural dial-up access is publicly and commonly available and leased line connectivity is available.

Table 3a: Sectoral Use of the Internet			
Sector	**Rare**	**Moderate**	**Common**
Academic - primary and secondary schools, universities	>0-10% have leased-line Internet connectivity	10-90% have leased-line Internet connectivity	>90% have leased-line Internet connectivity
Commercial-businesses with > 100 employees	>0-10% have Internet servers	10-90% have Internet servers	>90% have Internet servers
Health-hospitals and clinics	>0-10% have leased-line Internet connectivity	10-90% have leased-line Internet connectivity	>90% have leased-line Internet connectivity
Public-top and second tier government entities	>0-10% have Internet servers	10-90% have Internet servers	>90% have Internet servers

Table 3b: The Sectoral Absorption of the Internet		
Sectoral point total	**Absorption dimension rating**	
0	Level 0	*Non-existent*
1-4	Level 1	*Rare*
5-7	Level 2	*Moderate*
8-9	Level 3	*Common*
10-12	Level 4	*Widely used*

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

Table 5: The Organizational Infrastructure of the Internet	
Level 0	*None*: The Internet is not present in this country.
Level 1	*Single*: A single ISP has a monopoly in the Internet service provision market. This ISP is generally owned or significantly controlled by the government.
Level 2	*Controlled*: There are only a few ISPs because the market is closely controlled through high barriers to entry. All ISPs connect to the international Internet through a monopoly telecommunications service provider. The provision of domestic infrastructure is also a monopoly.
Level 3	*Competitive*: The Internet market is competitive and there are many ISPs due to low barriers to market entry. The provision of international links is a monopoly, but the provision of domestic infrastructure is open to competition, or vice versa.
Level 4	*Robust*: There is a rich service provision infrastructure. There are many ISPs and low barriers to market entry. International links and domestic infrastructure are open to competition. There are collaborative organizations and arrangements such as public exchanges, industry associations, and emergency response teams.

Table 6: The Sophistication of Use of the Internet	
Level 0	*None*: The Internet is not used, except by a very small fraction of the population that logs into foreign services.
Level 1	*Minimal*: The small user community struggles to employ the Internet in conventional, mainstream applications.
Level 2	*Conventional*: The user community changes established practices somewhat in response to or in order to accommodate the technology, but few established processes are changed dramatically. The Internet is used as a substitute or straight-forward enhancement for an existing process (e.g. e-mail vs. post). This is the first level at which we can say that the Internet has "taken hold" in a country.
Level 3	*Transforming*: The user community's use of the Internet results in new applications, or significant changes in existing processes and practices, although these innovations may not necessarily stretch the boundaries of the technology's capabilities. One strong indicator of business process re-engineeering to take advantage of the Internet, is that a significant number (over 5%) of Web sites, both government and business, are interactive.
Level 4	*Innovating*: The user community is discriminating and highly demanding. The user community is regularly applying, or seeking to apply the Internet in innovative ways that push the capabilities of the technology. The user community plays a significant role in driving the state-of-the-art and has a mutually beneficial and synergistic relationship with developers.

Annex 5: Bibliography

IDA. *IT Household Survey 1999*. Available on the IDA web site <www.ida.gov.sg> under Infocomm Facts and Figures, Survey Results.

IDA. *Info-communications Technology (ICT) Usage Survey 1999*. January 2000. Available on the IDA web site <www.ida.gov.sg> under Infocomm Facts and Figures, Survey Results.

IDA. *Infocomm Manpower & Skills Survey 1999*. March 2000. Available on the IDA web site <www.ida.gov.sg> under Infocomm Facts and Figures, Survey Results.

Ministry of Information and the Arts. *inform.educate.entertain@sg: Arts & Media in Singapore*. September 2000. http://www.gov.sg/mita/bksams.htm

Nielsen//NetRatings. "Singapore Internet Audience Activity for June 2000." *Press Release*. 4 August 2000. http://209.249.142.22/press_releases/pr_000804_sg.htm

Press, Larry. *The Internet in Singapore: A Benchmark Report*. March 2000. Available at http://mosaic.unomaha.edu/SINGAPORE_2000.pdf

Singapore Telecom. *Annual Report*. Various years.