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:

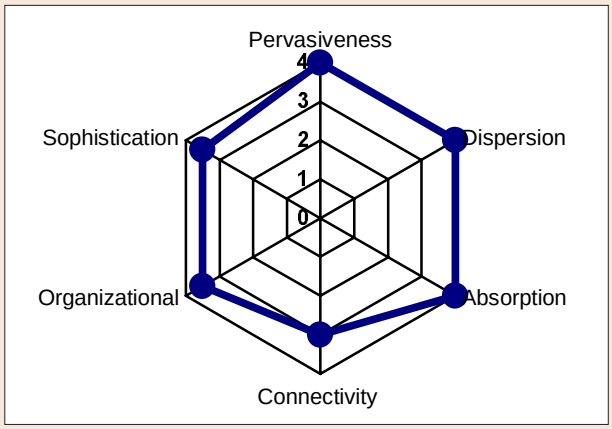
- pervasiveness: a measure based on users per capita and the degree to which non-technicians are using the Internet.
- geographic dispersion: a measure of the concentration of the Internet within a nation, from none or a single city to nationwide availability.
- sectoral absorption: a measure of the 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

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

	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

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'.

[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

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