



# Singapore

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## Overview

### Indicators

Singapore's key economic sectors continue to be in manufacturing, construction, utilities, wholesale and retail trade, hotels and restaurants, transport and communications, financial services, and business services. The country's GDP was SGD 194,359.8 million in 2005, with a per capita GDP of SGD 44,666 (SingStat 2006).

In the ICT sector, the number of households with access to a computer at home was stable at about 74 per cent from 2003 to 2005, up from 68 per cent in 2002. The proportion of households with two or more computers was at 28 per cent, up from 23 per cent in 2003. The proportion of households with access to the Internet at home was also stable at 65–66 per cent in 2003–05, up from 59 per cent in 2002. Sixty-five percent of Singapore's resident population aged 15 and above were computer users, up from 57 per cent in 2003. Of the same population 61 per cent were Internet users, up from 53 per cent in 2003. Twenty-seven percent of Internet users have made purchases online (up from 17 per cent in 2003), averaging about SGD 1,068 of Internet purchases in 2005 (IDA 2006a).

As of May 2006, the fixed telephone line population penetration is 42.4 per cent, and fixed-line household penetration is 97.8 per cent. Mobile phone penetration is 99.3 per cent, and household broadband penetration is 55.6 per cent (IDA 2006b).

Since the downturn in 2002–03 as a result of the SARS outbreak and the global economic slowdown, the Singapore economy has made significant strides in restoring the strength and competitiveness of the economy. New initiatives have been

Total population	4,483,900 (2006)*
GDP per capita	SGD 44,765 or USD 29,091.23 (1 USD = 1.53878 SGD)
Key economic sectors	Manufacturing, Construction, Utilities, Wholesale and retail trade, Hotels and restaurants, Transport and communications, Financial services, Business services
Computers per 100 inhabitants	64.48 (2006)
Household computer	78 per cent household with at least one penetration computer (40 per cent with 1 computer, 38 per cent with 2 or more computers) (2006)
Fixed-line telephones per 100 inhabitants	41.2 per cent (November 2006)
Mobile phone subscribers per 100 inhabitants	101.5 per cent (November 2006)
Internet users per 100	34.1 per cent assuming dial-up users only inhabitants (November 2006); 50.77 per cent if dial-up subscriptions + broadband subscriptions/population
Domain names registered under ".sg"	898,762 (July 2006)
Broadband subscribers per 100 inhabitants	16.7 per cent ( <i>Household penetration</i> : 61.1 per cent)
Internet international bandwidth	28 Tbps submarine cable capacity (end 2005); 20 Gbps direct international Internet connectivity (June 2005)
Sources: Statistics Singapore 2006; World Bank 2001; Infocomm Development Authority of Singapore 2006; Internet Systems Consortium, Pyramid Research.	
Note: *The total population comprises all citizens and permanent residents with local residence and foreigners staying in Singapore for one year or more. Singapore residents refer to citizens and permanent residents with local residence.	

announced even amidst efforts to contain rising costs and to streamline for greater efficiency. The ICT or infocomm sector, composed of international and local players in a vibrant and competitive market, remains strong.

### Technology infrastructure

It has been 25 years since Singapore embarked on its infocomm journey in 1981 with the creation of the then National Computer Board. In 1997, new cellular and paging operators were introduced in the market to compete with the incumbent operator. In 1998, Singapore ONE, the nation's broadband network with a core fibre and ATM backbone and access through cable and ADSL, was made commercially available nationwide. In 2000, after the creation of the Infocomm Development Authority of Singapore (IDA), the country's telecommunications market was completely liberalized, with competition in both the mobile and fixed-line segments and the lifting of equity restrictions on foreign operators. By 2002, submarine cable capacity was at least 21 Tbps and there was direct Internet connectivity to over 30 countries, and at least 2,250 Mbps of international Internet connectivity. In 2005, 3G services were commercially rolled out by mobile operators. By 2006, total submarine cable capacity was 28 Tbps and direct international Internet connectivity was 20 Gbps.

Under the iN2015 Masterplan (*discussed later*), the Singapore government intends to put in place a Next Generation National Infocomm Infrastructure by 2012. The aim is to have

pervasive connectivity around the country, comprising complementary wired and wireless networks to provide seamless connectivity. The envisioned wired infrastructure will deliver symmetric broadband access speeds of up to 1 Gbps, and will be Internet Protocol Version 6 (IPv6) compliant. The ultra high-speed network will connect all homes, schools and businesses, and it is expected to enable new broadband-enabled services applications, such as immersive learning experiences, telemedicine, high definition TV, video conferencing and grid computing (IDA 2006c).

To achieve this vision, the government has issued a Request-for-Concept to solicit proposals from local and international telecommunications providers and hardware and software vendors. The submissions reflect the need for an infrastructure with open access, with fibre commonly proposed to provide ultra high-speed broadband access. Innovative business models were also proposed to provide competitive end-user pricing to consumers (IDA 2006d).

Following the Call for Collaboration on the wireless network, the government awarded three service providers contracts to provide free basic 512 Kbps wireless at public places in key catchment areas for at least two years, with a second tier of higher bandwidth access speeds for paid subscribers. While Wireless Fidelity (Wi-Fi) will be deployed, the SGD 100 million project will also trigger enhancements to existing deployment of WiMAX (Worldwide Interoperability for Microwave Access) and High-Speed Downlink Packet Access (HSDPA). The project, dubbed Wireless@SG, will complement and extend to public places broadband access currently available in homes, offices and schools, and will enable access to Internet-based services like email, instant messaging, online games and Voice over Internet Protocol (VoIP) calls (IDA 2006e).

## Online services

### e-Payment

A collaboration between IDA, the Land Transport Authority (LTA) and industry players aims to enable seamless electronic payments (e-payments) for a range of daily needs through the new Singapore Standard for Contactless ePurse Application, or SS 518 CEPAS. The standard is aimed at creating a nationwide interoperable micro-payment platform for use across different sectors, including transit and retail. Establishing a standard aims to encourage more card issuers, such as banks and merchants, to participate in e-payment, allowing existing multi-purpose stored value schemes to interoperate and giving consumers the convenience of using a single card rather than multiple cards for different purposes. This will reduce the number of paper-

based transactions and double the annual value of electronic transactions. Enterprises will be encouraged to use the standard. Its development is a pioneering effort as there are no international standards in this area yet (IDA 2006f).

### e-Government

After the successful implementation of two previous e-Government Action Plans, the Singapore Government has announced iGov2010, a new SGD 2 billion five-year Masterplan developed in consultation with the public and private sectors.

Through the earlier plans, all government services that can be placed online are already available on the Internet. A survey in March 2006 indicated that nearly nine out of 10 customers had transacted with the government electronically at least once in the last 12 months. The new Masterplan aims to transform backend processing to achieve front-end efficiency and effectiveness. There would be greater emphasis on transcending organizational structures, changing rules and procedures and integrating government services around customer and citizen's needs.

The iGov2010 Masterplan has four main thrusts:

- *Increasing Reach and Richness of e-Services*—Government e-services will be made more accessible to a larger population and opportunities will be created for more innovative services. Given the high mobile penetration rate, use of the mobile channel will be increased. More proactive, responsive, user-friendly and integrated e-services will be delivered. For those without Internet access or who need help in transacting online, the CitizenConnect Centres at Community Clubs will be expanded from five to 25 centres.
- *Increasing Citizens' Mindshare in e-Engagement*—The government will actively engage citizens in the policymaking process, and strengthen its relationship with citizens through the use of infocomm technologies. The Government Online Consultation Portal will be enhanced to meet the needs of different groups more effectively.
- *Enhancing Capacity and Synergy in Government*—The government will take further steps to transform its business and operating model to make the government more agile and efficient, capable of achieving a higher level of service delivery. Agencies will streamline common functions and integrate backend processes (for example, in human resource and finance). The use of unique identifiers across different agencies for companies, businesses, societies and non-profit organizations will create greater efficiencies.
- *Enhancing National Competitive Advantage*—The government will continue to collaborate and partner with the private sector through various infocomm projects to allow the

co-creation, development and export of iGov solutions. The government will allow intellectual property ownership to be retained by companies to enhance their business and solution export opportunities (IDA 2006g).

An e-Government Leadership Centre jointly set up by IDA, the National University of Singapore's Institute of Systems Science, and the Lee Kuan Yew School of Public Policy was launched in June 2006 to build on the country's leadership in e-government developments and to share knowledge with foreign governments keen on leveraging e-government to further their countries' developmental goals. Topics related to public policy, ICT policy and management, and innovative case studies in e-government in Singapore will be covered to meet the varying needs of different organizations (Computerworld 2006).

A showcase known as the 'Government Executives in the New Information and Knowledge Era' (GENIE Showcase) demonstrated how government would use new infocomm technologies through partnerships with industry. Solutions expected in the near future include authentication through biometrics; a rich integrated user interface that is self-learning, adaptive and predictive of the content required; integrated communication services; and self-recovery and diagnostics for computers (IDA 2006n).

### Web services

IDA launched the WEAVE Programme (Web Services Add Value to Enterprise) in 2003 to promote Web services to industry. A Web Services Chapter was also set up under the Singapore infocomm Technology Federation (SiTF) to accelerate the adoption of Web applications and services. Various initiatives under the Chapter are designed to realize business opportunities and enhance interoperability. As of August 2006, an industry rate adoption of over 28 per cent has been achieved. In terms of capability development, there are now more than 3,000 professionals trained in Web services, with a third attaining certification through IDA-endorsed courses. Altogether, about 65 industry projects have been supported by IDA, among them well-known companies like Singapore Airlines, PSA (formerly Port of Singapore Authority) and United Premas. The total value of investments in the industry is estimated to be SGD 246 million.

Government has also made significant headway in the use of Web services, making it more convenient for businesses and the public to transact with government. For example, four licensing agencies (the Health Sciences Authority, Media Development Authority, National Environment Agency and Public Utilities Board) have implemented 40 strategic Web services that

enable real-time integration of services in the Online Business Licensing Service portal. In many cases, this effectively reduces the turnaround time for businesses to obtain their licenses from a few weeks to a few working days, or even within the same working day.

The government will be extending Web services to the private sector. Through the Government Web Services Exchange, businesses will be able to leverage common e-government services to save time and effort. For a start, the Web services currently available include the business-related services offered by the Accounting and Corporate Regulatory Authority, the carpark-related services offered by the Housing Development Board and Urban Redevelopment Authority, the library book catalogue services offered by the National Library Board under the Ministry of Information, Communications and the Arts (MICA), and National Servicemen (NSmen)-related services offered by the Ministry of Defence (MICA 2006).

### e-Lifestyle

A survey has indicated that in addition to the Internet being a tool for work, six in 10 Internet users aged 15 years and above also use the Internet for leisure, including playing computer games, downloading or uploading digital photos, listening to online music, reading publications and watching films over the Internet. Almost six in 10 Internet users made an online transaction with the government within a 12-month period and four out of 10 Internet users have made other online transactions. The most popular online application was online banking. (IDA 2006i)

## Industries

The Singapore infocomm industry's revenue grew by 8.9 per cent in 2005, reaching SGD 37.89 billion (about USD 24.75 billion). External demand grew by 11 per cent. The export market drove most of the industry's growth in 2005.

There was little change in industry composition from 2003 to 2005. More than half (51 per cent) of the total revenue in 2005 was attributed to hardware, 19 per cent to telecommunication services, 14 per cent to software, 9 per cent to IT services and 7 per cent to content services. Growth in software was 5.5 per cent in 2005, compared to -14.9 per cent in 2003. Growth in IT services in 2005 was -3.4 per cent, compared to -25.3 per cent in 2003. Growth in content services was 0.9 per cent compared to 19.0 per cent in 2003.

The export market contributed more to the total revenue compared to the domestic market (58–42 per cent) in 2005. In the domestic market, 29 per cent of the revenue was attributed

## Online gaming

Online gaming, with its high potential for growth, fits well into Singapore's objective of being a hub to host and manage regional games. The interest in this sector started in 2001 from the government's e-Celebrations campaign to promote infocomm adoption and e-lifestyle. It has since grown to be a rapidly emerging sector, with the market for Asian gamers expected to hit SGD 23 billion (about USD 15 billion) by 2009.

Surveys indicate other benefits to online gaming, including broadening a person's knowledge of various subjects, such as history, military strategy, economics and sports; stimulating creativity; and developing interest in computers and software skills.

Singapore has established the Games Exchange Alliance (GXA) to localize and deliver games to Asian gamers. With 25 members, the GXA provides a comprehensive spectrum of resources to take games from the development stage to full deployment, including 'last-mile' commercialization to 13 countries in Asia. Some successes include the creation of a cross-platform MMORPG (massively multi-player online role-playing game) that is playable on both computers and mobile phones in real time. GXA's bundling of complementary games services among its members allows for an integrated value-chain approach and greater economies of scale through the wider spectrum of services.

Government initiatives such as Games Bazaar (a scalable hosting platform for games companies, publishers and distributors to test and deploy games regionally), Games Market Access Programme (a suite of services of regional deployment, hosting and distribution, community building and marketing support for a fixed monthly price), and GXA aim to attract more game publishers and developers to base themselves in Singapore. Benefits to companies include shortening time-to-market of the games they develop (IDA 2004, 2006h).

to hardware, while 41 per cent was attributed to telecommunication services. In the export market, 66 per cent of the revenue was attributed to hardware, with 3 per cent attributed to telecommunication services. In software, the domestic market contribution was only 4 per cent compared to 22 per cent in the export market. In IT services, it was 16 per cent of the domestic market and 4 per cent of the export market. A tenth (10 per cent) of the domestic market was attributed to content services compared to 5 per cent in the export market. The domestic market rebounded from its negative growth in 2004 to register a positive growth in 2005 (IDA 2005a).

## Key national initiatives

### Singapore iN2015 Masterplan

Launched in June 2006, the new 10-year Infocomm Masterplan named iN2015 aims to achieve by 2015 the vision of Singapore as an Intelligent Nation and Global City powered by infocomm. The government cited innovation, integration and internationalization as the basis of the Masterplan which was formulated with inputs from the government, the public, as well as specific industry sectors such as education, health care, manufacturing and logistics, finance, tourism and retail, and digital media.

Among the specific targets for 2015 are:

- for Singapore to become a global leader in harnessing infocomm to add value to the economy and society;
- a two-fold increase in value-added of the infocomm industry to SGD 26 billion;
- a three-fold increase in infocomm export revenue to SGD 60 billion;
- 80,000 additional jobs;
- at least 90 per cent of homes using broadband; and
- 100 per cent computer ownership for all homes with school-going children.

The plan not only addresses national economic competitiveness; a digital inclusive angle also ensures that the elderly, the less-privileged and those with disabilities can benefit and have opportunities for development.

Four key strategies are outlined in the Masterplan:

- Spearhead the transformation of key economic sectors, government and society through more sophisticated and innovative use of infocomm;
- Establish an ultra-high speed, pervasive, intelligent and trusted infocomm infrastructure;

- Develop a globally competitive infocomm industry; and
- Develop an infocomm-savvy workforce and globally competitive personnel in infocomm industries.

Initiatives to strengthen domain and technology capabilities within the industry, and to nurture local companies to expand and grow internationally, are expected. The infocomm competencies of the general workforce will also be raised. Techno-strategists who have both the technical and business expertise will be groomed to achieve business and organizational goals through the strategic and innovative use of infocomm. Top-ranking students in schools will be encouraged to take up infocomm as a career.

Innovative and personalized services will be developed to achieve sectoral transformation in financial services, manufacturing and logistics, tourism, hospitality and retail, e-government, digital media entertainment, education, health-care and biomedical sciences (IDA 2006j).

### Interactive and digital media

The Singapore Research, Innovation and Enterprise Council (RIEC), which is chaired by the Prime Minister, has approved plans in three strategic research sectors, including Interactive and Digital Media (IDM). The overall goal is to build up core research and development (R&D) capabilities in selected areas and to attract and develop talent to sustain advanced research activities for the long term. The approved IDM programme will build on Singapore's multicultural, multilingual identity with a strong infocomm infrastructure to create new niches in this area, including games and edutainment. This is expected to increase jobs and value-added in the sectors, resulting in broader economic benefits.

The fund allocation for the three strategic research programmes over the next five years is SGD 1.4 billion; SGD 500 million of the total is earmarked for IDM. The funds will be held in the National Research Fund and administered by the National Research Foundation (NRF).

To foster R&D, innovation and creativity, RIEC also approved the creation of a Campus for Research Excellence and Technological Enterprise (CREATE), with the Singapore-MIT Alliance for Research and Technology (SMART) Centre as the first centre within the Campus. These initiatives will develop the ability to build linkages with global institutions, to enhance relationships with other centres of research in Europe and the US, and to incubate a more inventive, innovative and entrepreneurial economy. Joint research efforts with other top universities are expected to provide the foundation to nurture a pool of new talent (NRF 2006).

### Broadcasting

The Media Development Authority (MDA) is preparing the country to embrace high-definition TV (HDTV). Singapore media companies are developing new applications and solutions for HDTV, Internet Protocol TV (IPTV) and Digital Audio Broadcasting (DAB). Local service providers and content developers are being encouraged to develop and deliver compelling high-definition content and services. Trials are ongoing to bring content to the country while allowing local service providers to explore different business models.

Singapore aims to serve as a test bed for global companies seeking to test new concepts. MDA, through its Digital Technology Development Scheme, provides funding support to the broadcasting industry for the development of original and innovative products or processes that will help bring about value-added services, products and technology. Singapore-made applications are also actively promoted to the international broadcasting industry. The Scheme champions the development of innovative and experimental work to encourage more media talent to aim for greater international exposure and commercial success (MDA 2006a).

### Bridging the digital divide

Recognizing the need to ensure access to technology at all levels of society, the government is aiming to improve access to infocomm for the elderly, low-income students and people with disabilities. This is in recognition of the fact that even as Singapore becomes increasingly digitally-enabled, there are some pockets of society where access to technology remains unaffordable. As part of the plan, the government will ensure that no student is denied computer and Internet access, and that the less tech-savvy are able to get connected through 'infocomm bridges'.

The 'infocomm bridges' include the NEU PC Plus programme, which seeks to provide highly-subsidized computer ownership and Internet access to 10,000 low-income households. Industry members have already committed SGD 31 million to assist in this programme. The Infocomm Accessibility Centre, another 'infocomm bridge', aims to provide people with disabilities infocomm training and employment opportunities. Specialized training and course materials at different levels of competency can lead to industry certification. Assistive technologies will be used to aid trainees with different disabilities and workshops and infocomm industry-relevant apprenticeship programmes seek to enhance the employability of disabled citizens. For the elderly, the Silver Infocomm Initiative provides workshops on the use of mobile devices, promoting an enhanced

digital lifestyle and helping other senior members learn and adapt to technology.

The government's digital divide efforts have drawn the support of many industry players, and would be an essential complement to other national initiatives to achieve an all-inclusive digital society (IDA 2006a).

### Multilingual support

In line with Singapore's aim to be a regional infocomm hub and building on Singapore's multiracial and multilingual society, the Singapore Network Information Centre (SGNIC) has conducted a trial to provide users the option of adopting multilingual domain names or Internationalized Domain Names (IDNs). This allows Chinese and Tamil characters to be used as part of the domain name, for the benefit of Chinese and Tamil-speaking audiences. For Malay-speaking audiences, this is not an issue because Malay is based on Roman characters. The IDN approach allows a non-English speaking person to more easily access domain names, while also offering service providers the opportunity to brand themselves using local languages. The IDN test bed was intended to gauge public response to IDN; allow the domain name registry and registrars to gain operational experience; and address technical, operational and policy issues concerning IDN. The implementation was based on established international IDN standards. Although the trial has been concluded, further plans have yet to be announced (IDA 2005; SGNIC 2006).

## Enabling policies

### Cyber security

The Singapore government has announced a series of new initiatives to help secure the national infocomm environment. The move is considered an important one for a country that is heavily dependent on infocomm technologies for managing its day-to-day activities.

The Infocomm Security Masterplan unveiled in March 2005 was developed after a series of consultations with the public and private sectors. This multi-agency effort led by IDA identified the key areas that need to be enhanced and proposed strategies to raise the level of awareness and preparedness against cyber attacks. Deficiencies such as lack of experienced professionals in infocomm security, difficulties faced by businesses in formulating and complying with IT security and best practices, and absence of awareness among employees were flagged for remedial action.

The Masterplan includes six integrated strategies: securing the people sector, securing the private sector, securing the public sector, developing national capability, cultivating technology and R&D and securing the national infrastructure. The approach adopted for implementing these strategies is based on current best practices adopted by the public and private sectors. The plan will focus on building capabilities, resources and skills in:

- information protection assurance and risk mitigation measures (including risk assessment, vulnerability analysis and reduction, authentication and technology assessment);
- enhanced situational awareness and contingency planning assurance (including round-the-clock vigilance and business continuity preparedness); and
- human and intellectual capital development (including cyber security awareness of Internet users, development of professional skills, and promotion of R&D in infocomm security).

Among the projects being planned are a National Authentication Infrastructure for online transactions, a Business Continuity Readiness Assessment Framework for public sector agencies, a national Cyber-Watch Centre (CWC) to monitor cyber-threats to government networks and provide early warning of impending cyber-threats round-the-clock, and an Infocomm Vulnerability Study of National Critical Infrastructure to assess the security readiness of key national infrastructures (IDA 2005b, 2006m).

### Human resources development

An annual survey conducted in 2005 found that infocomm personnel in Singapore grew by 3.1 per cent to reach 111,400 in 2005. This number was higher by 5.5 per cent than during the Internet boom period of 2000. Half of infocomm personnel worked in infocomm organizations, while the other half are in end-user organizations. Job vacancies more than doubled from 2,100 in 2004 to 5,700 in 2005, in particular for skills in software development, infocomm security, database management, IT project management and Web services. Demand for high-end jobs and qualified infocomm personnel is expected to grow.

The survey results indicate that Singapore's infocomm workforce is highly educated: 83 per cent had tertiary education, 44 per cent possessed a Bachelor's degree, 24 per cent had a diploma and 15 per cent had postgraduate qualifications (postgraduate diplomas, Master's and doctorate).

IDA has a SGD 120-million Infocomm Manpower Development Roadmap designed to develop a globally competitive and infocomm-savvy workforce. The effort includes establishing

a Student Infocomm Outreach programme for school children through Infocomm Clubs. Since January 2006, some 30 schools offer such clubs as part of their co-curricular activities and students earn points for joining them. Credit exemption may also be offered to students who subsequently pursue IT diplomas. The aim is to have more than 150 schools with Infocomm Clubs by 2008, and about 50 per cent of their members joining the infocomm profession eventually (IDA 2006k). The National Infocomm Scholarships will be expanded under the Outreach programme to include overseas studies with top universities. The scheme includes work opportunities with leading infocomm multinational companies who are partners with IDA under the programme.

For the general workforce, a series of activities named 'Infocomm Skills@Work' or 'InSkills@Work' targets the development of infocomm competencies in key economic sectors. Existing competency training programmes intended for infocomm professionals will also be expanded to include non-infocomm professionals.

Infocomm professionals will also be able to refer to a competency framework that sets the competency requirements and step-by-step certification process of an infocomm professional's career. The Graduate Career Development Programme equips local infocomm undergraduates with certifications for critical and essential skills needed by the industry to complement their academic qualifications (IDA 2005c).

## Regulatory environment

### Spam Control Bill

The Singapore government has conducted two consultations concerning a proposed Spam Control Bill that will include both email and mobile phone-based spam. The inclusion of mobile spam reflects a need resulting from the high penetration and usage of mobile messaging. The Bill contains a number of important features:

- It focuses on the real problem of egregious bulk spammers and prohibits the use of dictionary attacks or address harvesting software to indiscriminately send unsolicited e-mail.
- It requires bulk spammers to clearly label their unsolicited commercial electronic messages by including <ADV>, subject and header information that is not misleading and efficient contact information (e-mail, telephone).
- It adopts a pragmatic 'opt-out' regime through quick and workable unsubscribe requirements.

- It establishes a solid basis for enforcement by providing for a private right of action for either actual or statutory damages.

The Bill protects civil rights and provides for remedies for anyone who suffers loss or damage from spam, including statutory damages of SGD 25 per spam message subject to a cap of SGD 1 million. An opt-out approach has been recommended under the Bill, both for e-mail and mobile spam. Unsolicited fax and telemarketing are excluded. Improvements suggested by the industry during the consultation include:

- clarifying the definition of an 'unsolicited' commercial electronic message, so as to take into account pre-existing business relationships;
- encouraging the deployment of anti-spam technologies; and
- ensuring a tougher deterrent effect by allowing for increased enforcement (IDA 2005d).

### ETA review

The Singapore government has undertaken a three-step exercise to review the Electronic Transactions Act (ETA) and its regulations, and to identify areas that need to be improved. The ETA was first enacted in 1998 to facilitate e-commerce transactions and to provide legal recognition of electronic signatures and records. With newer technology and solutions available since the initial enactment of the law, the consultation seeks to obtain public feedback on areas where ETA amendments are needed. Views are also sought on approaches to the regulation of certification authorities (IDA 2005e).

### VoIP framework

The Singapore government announced a new policy framework governing Internet Protocol (IP) Telephony, a form of VoIP service in which a user can potentially use any broadband Internet access connection to make and receive local or international voice, data and video calls (regardless of location), with a phone number. Such solutions allow consumers to make local and international voice calls at a rate typically cheaper than rates for traditional fixed-line telephone calls. Under the framework, IDA will issue licenses and phone numbers for IP telephony services. The growth in IP telephony is expected to reduce the cost of providing telephone services, reduce prices and provide more choices for businesses and consumers in the long term. Facilities-based operators and services-based operators in Singapore can be licensed to provide the service. IDA's framework is intended

to include minimal regulatory obligations so as to encourage the adoption of the emerging technology (IDA 2005f).

### Telecommunication Competition Code

IDA released the amended Telecom Competition Code in February 2005. The amendment is part of a review every three years and takes into consideration feedback from the public and the industry on the state of competition in the Singapore market.

The basic principles of telecommunication competition remain unchanged. They are: reliance on market forces and proportionate regulation; regulation for effective and sustainable competition; minimum rules for consumer protection; technology neutrality; and efficient, transparent and reasoned decision-making. In the area of transparency, IDA will undertake public consultations in the review of regulatory frameworks and issue preliminary decisions on material policy or regulatory issues for comment by the public or interested parties. Greater clarity of procedures and standards will also be achieved through the publication of guidelines that stipulate the IDA processes.

The definition of dominance has been changed to one based on economic consequences, compared to the previous definition based on control over bottleneck facilities and ability to restrict output or raise prices above competitive levels. The new definition considers a player as dominant if it has operational control over facilities that are costly or difficult to replicate, or if it can exercise significant market power in providing telecom services in Singapore. Dominant licensees are now required to publish their prices on their websites, including all prices that have been approved by the regulator, such as discount structures, service availability, eligibility and termination clauses. IDA will also identify circumstances where dominant licensees have to offer services at wholesale prices and consult the public before mandating such prices. In segments where there is effective competition, wholesale services provided by licensees need to be provided at fair, reasonable and non-discriminatory prices.

IDA has also issued guidelines on dispute resolution and consolidation (that is, mergers and acquisitions) which set out in detail the framework and procedures that IDA will undertake in these circumstances, including how licensees may approach IDA to reconsider regulatory decisions (IDA 2005g).

### Number portability

Following a public consultation in September 2005, IDA announced in August 2006 the implementation of a true number portability regime in Singapore so that consumers can benefit from greater choice and flexibility in mobile and fixed-line

services. From the fourth quarter of 2007, consumers can switch between telecom service providers easily while maintaining full use of their existing number, rather than having to update family members, friends and business contacts about a new one. Beyond this, the new solution will result in greater competition among telecom service providers and more business opportunities in Singapore’s telecom market.

The three key changes to the present regime, in place since April 1997, include:

- A common centralized database approach for operators to provide number portability for fixed-line services and post-paid and prepaid mobile services. The centralized database will be independently run and have open access.
- One number is all consumers will have when they switch between mobile service providers. Switching between mobile operators should also take about one day, compared with five days at present.
- Fixed-line operators must stop recurring monthly porting service charges. Consumers who want to port their fixed-line telephone number to a new fixed-line service provider will pay only a one-time administrative charge. Mobile service providers stopped such recurrent charges in June 2003 (IDA 2006i).

### Internet regulation

As a multiracial society, Singapore places significant emphasis on maintaining a harmonious environment for different races and religions even on the Internet. Thus, MDA and its predecessor, Singapore Broadcasting Authority, have put in place since 1997, a class licensing scheme to address content issues in cyberspace. With rapid technology evolution, in 2005–06 the National Internet Advisory Committee (NIAC) also undertook a comprehensive review of the licensing scheme to take technological and market trends into account. An area given consideration was the application of the licensing regime to blogs. Declaring that blogs are no different from other types of content, NIAC applies the licensing scheme to blogs as to all other websites. Peer pressure and community norms would continue to play an important role in dealing with private blogs that may carry irresponsible or extreme views. NIAC also felt that the licensing framework should not apply to mass e-mail, so as not to stifle the *bona fide* use of e-mail as a form of communication.

Recognizing the growing pervasiveness of mobile phone usage and the availability of Internet access on mobile phones, NIAC also commended a ‘Voluntary Code for Self-Regulation of Mobile Content’ developed by the major mobile phone operators



in March 2006 as a step forward to protect users from undesirable Internet and new media content (MDA 2006b).

## Open source movement

Singapore continues to adopt a technology-neutral and pro-competition approach to the open source movement. Both open source and commercial software solutions are deployed in the industry and the government in a complementary manner. Software choices and selections are made by individual purchasers based on individual needs, merits and requirements. Purchasers recognize the benefits and strengths of both open source and commercial software. While many installations continue to use commercial software, a notable user of open source software is the Ministry of Defence, which is increasingly using OpenOffice in place of other commercial office suites. The National Library has also conducted trials of Linux desktops.

The Singapore Open Source Alliance (SOSA) has also been established. It is a consortium of global and local IT vendors such as Apple, Hewlett-Packard, IBM, Intel, Novell, Oracle, Red Hat, Resolvo Systems and Sun Microsystems, whose goals include maintaining an updated list of locally supported open source software and a hardware compatibility matrix, inviting CIOs for regular discussions to provide industry feedback on macro policies, and highlighting applications of open source systems (Computerworld 2005).

The Linux User Group of Singapore continues to be a resource for users regarding open source trends and issues.

## Research and development

The Singapore government has announced that it will commit SGD 7.5 billion from 2006 to 2010 to sustain innovation-driven growth through economic-oriented R&D supporting the key industry clusters. The plan is set out in the Ministry of Trade and Industry's (MTI) Science & Technology Plan 2010 (STP2010). The broad programmes under the Plan include:

- developing the research talent in Singapore;
- strengthening and deepening our research capabilities;
- promoting private sector R&D; and
- providing infrastructure support.

The initiative is part of the broader strategy to make more substantial investments in R&D in order to increase the national R&D spending to 3 per cent of GDP. The National Research Foundation will coordinate the different research areas under the larger national framework and develop policies and plans

to implement the strategic thrusts for the national R&D agenda. The promotion will be done through the Agency for Science, Technology and Research (A\*STAR) and the Economic Development Board. A\*STAR will develop and sustain a substantial pipeline of research talents to meet industry needs. It will also build concentrations of R&D in areas that are most relevant to developing key industry sectors. A\*STAR will also encourage the integrated management and commercialization of the intellectual property arising from research at the research institutes to optimize their economic impact (MTI 2006).

## Future trends

IDA has unveiled its Fifth Infocomm Technology Roadmap (ITR5) which sets out the infocomm landscape over a 10-year period. The Roadmap, which was developed through research involving visionaries, industry players, academics and government leaders, sets out how major technologies can be deployed to help Singapore address the key challenges of economic growth, national security and population demographics in the next decade. It identifies innovations in nanotechnology and biotechnology, key areas that will enable people-centric technologies. Context-aware sensors and intelligent agents will automate, analyze, synthesize and present personalized information. The result will be the creation of a world of things that think, transforming the way we live, learn, work and play. Sentient technologies are expected to make a dramatic difference and improve key sectors such as health care. They would also create smart homes and entertainment applications.

The Roadmap highlights the coming of three waves:

- *The Computing Wave*—PCs would disappear by 2015, and mainframes would be accessible through nanotechnology.
- *The Communications Wave*—The world would be covered by fibre with almost unlimited capacity. Broadband would be available everywhere.
- *The Sentient Wave*—The first two waves combined will create intelligent devices that can sense and interact with each other (IDA 2005h).

## References

- Computerworld. (2005). *Dear SOSA*. Retrieved 22 January 2007 from <http://computerworld.com.sg/ShowPage.aspx?pagetype=2&articleid=1893&pubid=3&issueid=56>
- Computerworld. (2006). *Singapore to set up e-Government Leadership Centre*. Retrieved 22 January 2007 from <http://www.computerworld.com.sg/ShowPage.aspx?pagetype=2&articleid=3844&pubid=3&tab=Home&issueid=92>

- Infocomm Development Authority of Singapore. (2004). *World cyber games 2004*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050718123855.aspx?getPagetype=21>
- Infocomm Development Authority of Singapore. (2005a). *Annual survey on Infocomm industry for 2005*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/Publications/20061205102839.aspx>
- Infocomm Development Authority of Singapore. (2005b). *Three-year Infocomm Security Masterplan unveiled*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050712110643.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005c). *Grooming talent to make it happen*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050705154150.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005d). *IDA & AGC seek second round views on proposed Spam Control Bill for Singapore*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050705172846.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005e). *IDA and AGC review Electronic Transactions Act*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050706162941.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005f). *IDA launches new policy framework for Internet Protocol (IP) telephony*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050706170936.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005g). *Telecoms competition code offers greater regulatory transparency and clarity*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050712112923.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005h). *IDA shares vision of infocomm landscape with inauguration of 10 Year Infocomm Technology Roadmap*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050711175041.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2005i). *Multilingual domain names now available for six-month trial!* Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050706153720.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006a). *Annual survey on infocomm usage in households and by individuals for 2005*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/Publications/20061207182001.aspx>
- Infocomm Development Authority of Singapore. (2006b). *Statistics on telecom services for 2006*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/Publications/20061205181639.aspx>
- Infocomm Development Authority of Singapore. (2006c). *Singapore iN2015 Masterplan offers a digital future for everyone*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050703161451.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006d). *IDA invites private sector to propose concepts for Singapore’s next generation national broadband network*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20060417173050.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006e). *Two years of free Wi-Fi for Singapore*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20061013120532.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006f). *Singaporeans to enjoy the convenience of one card for electronic payments—IDA, SPRING Singapore, LTA, and Industry launch world’s first nationwide interoperable micro-payment platform using Singapore Standard SS 518 CEPAS*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050829100306.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006g). *Singapore’s e-government on the next lap with iGov2010*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050704121154.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006h). *Singapore delivers games to Asia’s \$14billion video game market*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050704144250.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006i). *IDA survey also shows Singaporeans are becoming more sophisticated in Internet usage*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050705120931.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006j). *iN2015*. Retrieved 22 January 2007 from <http://www.in2015.sg>
- Infocomm Development Authority of Singapore. (2006k). *Number of Infocomm professionals reached new high in 2005*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050705104523.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006l). *IDA enhances number portability regime to benefit consumers*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050829134538.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006m). *Real-time response to cyber-threats by government*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050906111323.aspx?getPagetype=20>

- Infocomm Development Authority of Singapore. (2006n). *Government continues to invest in technology-enabled work environment*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20050829143504.aspx?getPagetype=20>
- Infocomm Development Authority of Singapore. (2006o). *Bridging digital divide*. Retrieved 22 January 2007 from <http://www.ida.gov.sg/News%20and%20Events/20061212162944.aspx?getPagetype=21>
- Media Development Authority. (2006a). *Singapore pavilion at Broadcast Asia presents the latest in digital technology*. Retrieved 12 August 2006 from <http://www.mda.gov.sg/wms.www.thenewsdesk.aspx?sid=719>
- Media Development Authority. (2006b). *NIAC emphasis co-ordinated and multi-pronged approach in making Internet safe for all*. Retrieved 26 October 2006 from <http://www.mda.gov.sg/wms.www.thenewsdesk.aspx?sid=721>
- Ministry of Information, Communications and the Arts. (2006). *Opening address by Dr Vivian Balakrishnan at the 10th Infocomm Commerce Conference*. Retrieved 5 September 2006 from [http://www.mica.gov.sg/pressroom/press\\_060817.htm](http://www.mica.gov.sg/pressroom/press_060817.htm)
- Ministry of Trade and Industry. (2006). *MTI announces Science & Technology 2010 Plan*. Retrieved 12 August 2006 from <http://app.mti.gov.sg/default.asp?id=148&articleID=2461&intViewCat=1&intCategory=4&txtKeyword=&txtStart=&txtEnd=&intOrderBy=1&intYear=&intQuarter=0>
- National Research Foundation. (2006). *The biopolis of Asia*. Retrieved 12 August 2006 from [http://www.biomed-singapore.com/bms/sg/en\\_uk/index/newsroom/pressrelease/year\\_2006/7\\_jul\\_-\\_research\\_.html](http://www.biomed-singapore.com/bms/sg/en_uk/index/newsroom/pressrelease/year_2006/7_jul_-_research_.html)
- Singapore Network Information Centre. (2006). *Internationalised domain names (IDA) test bed*. Retrieved 26 October 2006 from <http://www.idn.sg>
- Statistics Singapore. (2006). *Key stats—annual statistics*. Retrieved 12 August 2006 from <http://www.singstat.gov.sg/keystats/annual/indicators.html>