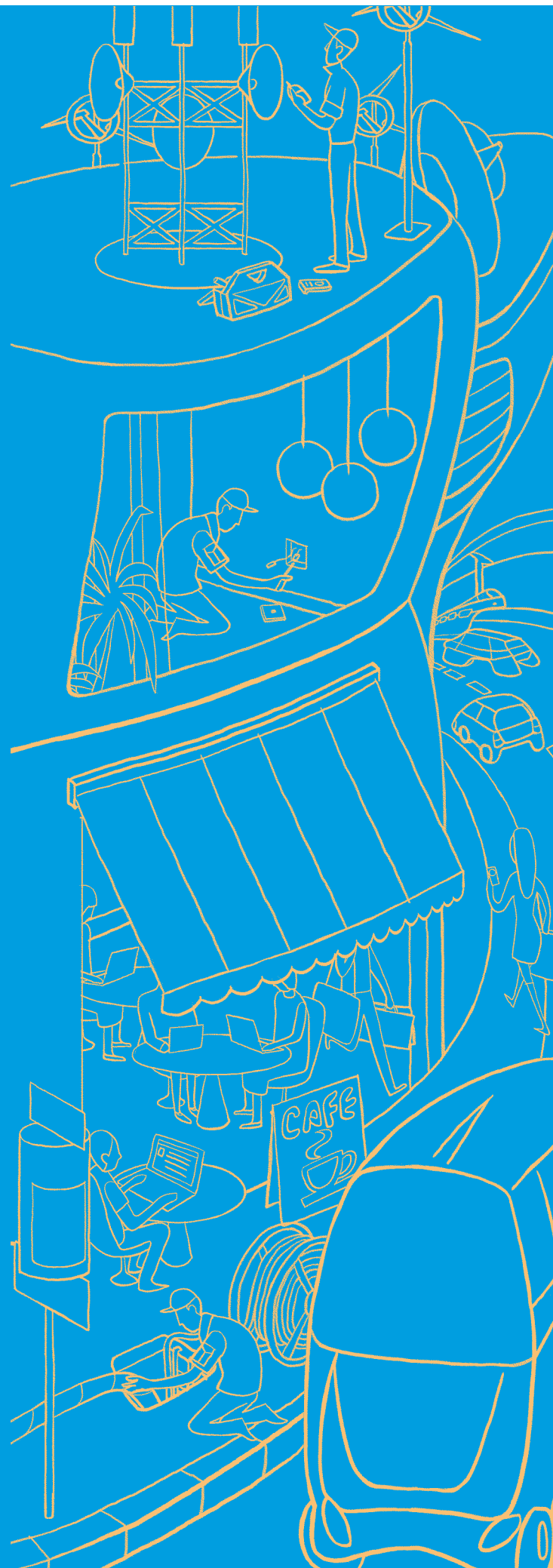


iN2015 < IMAGINE YOUR WORLD

TOTALLY CONNECTED,
WIRED AND WIRELESS
Report by the iN2015 Infocomm
Infrastructure, Services and
Technology Development
Sub-Committee

Singapore: An Intelligent Nation, a Global City,
powered by Infocomm



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Preface

As the members of the Infocomm Infrastructure, Services and Technology Development Sub-Committee embarked on our task of helping to define Singapore's next-generation infocomm infrastructure, there were times we found it overwhelming.

We were overwhelmed by the responsibility of shaping the way Singapore will live, work, learn and play in the year 2015. Consider that globally, more messages were sent by e-mail each day in 2005 than in the whole of 1992 and that more Short Message Service (SMS) messages were sent daily in 2005 than in the whole of 1998. This rapid increase could not have happened without the supporting infocomm infrastructure that had to be conceived and built beforehand.

We were overwhelmed by the possibilities. We listened to forecasts of the future from the IDA, global industry watchers and leading technology organisations. We heard both overlapping and diverse views of what would be the next "big thing" in the technology universe.

We were overwhelmed at times by the challenge – often from among ourselves – of justifying the technology capabilities, such as capacity and speed, that might be needed 10 years from now.

But it was easy to hark back 10 years and ask how that challenge could have been similarly answered: Could anyone have foreseen and justified in 1995 – when less than one person in 10 had a mobile phone – that 10 years later, nearly everyone in Singapore would carry a mobile phone?

From the start, we sought to be "pragmatically visionary". We wanted to push the envelope in differentiating Singapore in 2015. At the same time, we wanted our vision and programmes to be realistic and achievable.

To both ends, we had the benefit of drawing from the anticipated demands of the various economic sectors under iN2015.

This report summarises our year-long assessment of what is needed, what is technologically possible, and how we can get there. We present this report not as a concrete roadmap till 2015, but as a foundation for ongoing discussion.

Most importantly, we present this report as a starting point for action towards jointly realising the vision of "An Intelligent Nation, a Global City, powered by Infocomm".



Mr Willie Cheng

Chairman

iN2015 Infrastructure, Services and Technology Development Sub-Committee

iN2015 Infocomm Infrastructure, Services and Technology Development Sub-Committee

Name	Designation
Mr Willie Cheng (Chairman)	Chairman Singapore Science Centre
Mr Leong Keng Thai (Deputy Chairman)	Deputy Chief Executive and Director-General (Telecoms) Infocomm Development Authority of Singapore
Mr Robert Chew	Executive Partner, Communications and High Tech Accenture Pte Ltd
Ms Ann Emilson	President Ericsson Telecommunications Pte Ltd <i>(from March 2006)</i>
Mr Craig Gledhill	Managing Director Cisco Systems Singapore
Mr Bill Hope	Executive Vice President Networks Singapore Telecommunications Ltd
Mr Khoong Hock Yun	Assistant Chief Executive Infrastructure and Manpower Development Group Infocomm Development Authority of Singapore
Dr Lim Kiang Wee	Deputy Executive Director Science and Engineering Research Council Agency for Science, Technology and Research
Mr Low Huan Ping	Executive Vice President, Technology Singapore Press Holdings
Mr Claes Odman	President Ericsson Telecommunications Pte Ltd <i>(until March 2006)</i>
Mr Patrick Scodeller	Chief Technical Officer MobileOne Ltd
Mr David Storrie	Senior Vice President, Networks and Wholesale Services StarHub Ltd
Mr Tan Tong Hai	President and Chief Executive Officer Singapore Computer Systems Ltd
Mr Wong Heng Chew	Managing Director, Singapore Sun Microsystems Pte Ltd
Professor Lawrence Wong	Executive Director Institute for Infocomm Research
Associate Professor Wong Poh Kam	Director, NUS Entrepreneurship Centre National University of Singapore
Mr Christoph Zilian	Vice President, IT Operations, Asia Pacific T-Systems Singapore Pte Ltd

Executive Summary

An ultra-high speed, pervasive, intelligent and trusted infocomm infrastructure.

This is the Infocomm Infrastructure, Services and Technology Development Sub-Committee's (Sub-Committee) vision of Infocomm Infrastructure by 2015.

This infrastructure will provide individuals with access at gigabits speed beyond the megabits speed we are accustomed to in our homes today.

It will deliver broadband to anyone, anywhere, and anytime. In the Education and Learning sector, for instance, learners – both adults and students, will be able to access multimedia information, video-conferencing and new learning resources anywhere, beyond classrooms and lecture halls. Using their personalised devices, students will be able to customise their learning, at their own pace, over these broadband networks. Imagine what it would be like to have rich content at ultra-high speed, round-the-clock and at any place you want.

This new infrastructure will deliver real-time sensor-based information, integrated from multiple sources, beyond the data that we receive from individual sources today. Ever wondered if you would have been better off taking an alternative route when you find yourself in a traffic jam? Imagine what you could do with live traffic and road situation information, petrol-pricing, weather and Electronic Road Pricing information updated real-time to your car – you can literally ask for the “best” dynamic route as you drive, based on pricing and, or time and literally not be stuck in any traffic jam. Or imagine being able to ask which nearby carparks have the most available lots and the cheapest parking based on your anticipated parking duration? Imagine what an intelligent infrastructure can do for you.

Singapore's new infocomm infrastructure will continue to be trusted – a key differentiator which will be hard to emulate. Singapore has built an important position as a trusted hub over the years. And trust is increasingly important for businesses to offer services online, both locally and

internationally, and for consumers to want to transact in this new economy. A trusted infrastructure, for example, will be a critical enabler for a more personalised healthcare delivery system envisioned by the iN2015 Healthcare and Biomedical Sciences Sub-Committee. By raising the level of trust in the infrastructure, individuals will be more receptive to having their authorised healthcare providers update as well as access their personal health record information online. By having a more updated and holistic view of each patient's medical history, healthcare providers can in turn tailor care paths specific to the individual's conditions, needs and preferences. This trusted next-generation network will also allow other sectors in the economy – digital media companies, for instance, to collaborate and share content more effortlessly with other companies in and outside Singapore. Imagine what advantages a trusted infrastructure will bring to individuals and companies operating in Singapore.

So, with this ultra-high speed, pervasive, intelligent and trusted infocomm infrastructure, what will Singapore in 2015 be like?

It is expected that over 90 per cent of the country's households and businesses with over 10 employees will be using broadband. Imagine the network effect as households and businesses are not only able to do existing things better and faster, but also do new things not previously possible.

Communications will be brought to a new level across sectors. Besides the cited examples in education, media and healthcare, envision trusted shared services in the financial sector, computing-intensive applications for design and modelling in the manufacturing sector, or simply, downloads and sharing of bandwidth intensive music videos and online games for the joy of entertainment on-the-go. Imagine how this next-generation infocomm infrastructure will not only drive sectoral transformation in the economy, but also form the basis for some of these transformations.

While the primary beneficiaries of this infrastructure will be Singapore-based individuals and businesses, the opportunities created will not be solely domestic. It is in Singapore's best interests to adopt international standards where available, and to harmonise our policies and accreditation standards with best-practices around the world.

On one hand, international alignment will ensure that new services developed on this infrastructure are of world-class standards. To illustrate, for Singapore to be a global trusted hub, our security standards, policies and manpower accreditation standards will have to be on par with the best in the world. This level of assurance will be necessary for Singapore to attract the high-value activities of international banks, digital media companies and other enterprises.

At the same time, international alignment will help ensure that new services developed on this next-generation infrastructure are easily exportable. To this end, programmes will be put in place to assist Singapore-based as well as foreign companies to use Singapore as a test-bed and subsequent global launch-pad for new value-added services. Be it education, entertainment, financial or other enterprise services, or infocomm services such as cyber-threat monitoring services, Singapore can become the choice location for the export of next-generation infocomm-enabled as well as infocomm services.

How can Singapore realise these benefits for individuals, businesses and the international community towards 2015? The Sub-Committee has proposed two focus areas – one related to the development of the next-generation infrastructure and the other targeted at encouraging innovation

of new applications and services on the new infrastructure. Both are critical. Without a next-generation infrastructure, Singapore is constrained by realities of what can be done to enhance our lives and improve our competitiveness using today's infrastructure. Without an environment that encourages new and innovative applications, a next-generation infrastructure will be merely delivering incremental improvements to this generation's services and applications.

For the first focus area of infrastructure, the Sub-Committee has recommended the deployment of an IPv6-ready, next-generation National Fibre Network that will deliver gigabits broadband access to every home, school and business. This fixed wireline network should be complemented by a pervasive nation-wide wireless broadband network to meet the access needs of individuals everywhere and everytime.

Nation-wide Enabling Platforms, Policies and Standards (EPPS), specifically in the six areas of security, privacy, identity, payments, location and inter-operability, have also been identified to foster the development of new services. To illustrate, a National Trust Framework has been proposed to address the infocomm security and privacy challenges towards 2015. This will enable more pervasive adoption of online services such as those in the area of banking, healthcare and education.

A nationwide payments infrastructure has also been recommended to facilitate transactions of goods and services, through new payment methods such as micro-payment and mobile payment systems.

The Sub-Committee has recommended the deployment of an IPv6-ready, next-generation National Fibre Network that will deliver gigabits broadband access to every home, school and business. This fixed wireline network should be complemented by a pervasive nation-wide wireless broadband network to meet the access needs of individuals everywhere and everytime.

Additionally, location-platforms, together with privacy policies under the National Trust Framework, would facilitate the delivery of new value-added services such as location-based marketing, goods tracking and localised information services.

For the second focus area of applications and services, the Sub-Committee has recommended several programmes to foster an environment for the innovation, commercialisation and export of new services.

Besides developing the relevant policies and manpower to ensure the flourishing of new services, the Sub-Committee has proposed the creation of initial physical testbeds and showcases in areas such as downtown Singapore or the Fusionopolis¹. As part of the 'Stage Alpha' programme, these areas have been identified due to the higher concentration of retail, hospitality, education and medical services mix. Under 'Stage Alpha', new applications and services deployed in these showcases will then be progressively deployed nation-wide.

Further to facilitating the creation of new services, the piloting of new business models such as the provision of infocomm resources such as computing, storage and software on-demand, would also be encouraged.

In conclusion, Singapore's ability to seize the advantages of infocomm in the years to come is highly dependent on the supporting infocomm infrastructure in place. Just as the country's airport and seaports form the physical lifelines of the city's economy, the quality of Singapore's infocomm infrastructure will continue to determine its relevance in this globalised digital economy.

This report paints a vision of what is possible, drawing from the anticipated needs of our business sectors and individuals, as well as technology developments relevant for infocomm infrastructure, towards 2015. By the time Singapore's next-generation infocomm infrastructure is established, what we choose to do with this added freedom, the higher speeds and trust online will be up to each of us. These possibilities will be literally unbounded.

We invite each and every individual and business to imagine and realise these possibilities as we journey towards 2015.

Imagine your world, in 2015.

¹ To be ready by mid-2007, the Fusionopolis is a uniquely designed development in Singapore featuring a work-live-play-learn environment that serves as a vibrant hub for research, technology, media and business.

CHAPTER 1
CURRENT STATE OF
SINGAPORE'S INFOCOMM
INFRASTRUCTURE

Overview

Since the start of Singapore's first infocomm computerisation plan 25 years ago, Singapore has continually invested in her infocomm infrastructure. From the computerisation of the civil service, sector-wide electronic data interchanges for the law, medical and trade community, to the set-up of Singapore ONE – the world's first nationwide broadband infrastructure – Singapore has always viewed infocomm infrastructure as a critical enabler for the economy and society.

Singapore's investments in infocomm infrastructure have paid off to date. It was ranked first in the world in the World Economic Forum's (WEF) Global Information Technology Report 2004-2005 for readiness and usage of infocomm in businesses, government and society. For four years running now, Singapore has maintained its position in the top three economies in the index.

Figure 1-1 below shows Singapore's yearly rankings in this index.

Rank	2001 – 2002	2002 – 2003	2003 – 2004	2004 – 2005	2005 – 2006
1	USA	Finland	USA	Singapore	USA
2	Iceland	USA	Singapore	Iceland	Singapore
3	Finland	Singapore	Finland	Finland	Denmark
4	Sweden	Sweden	Sweden	Denmark	Iceland
5	Norway	Iceland	Denmark	USA	Finland
6	Netherlands	Canada	Canada	Sweden	Canada
7	Denmark	UK	Switzerland	Hong Kong	Taiwan
8	Singapore	Denmark	Norway	Japan	Sweden

Figure 1-1: Singapore's rankings in the Global Information Technology Report between 2001 and 2006

Source: World Economic Forum Global Information Technology Report

Despite having made significant progress in this area, Singapore's drop from the number one position to second in the WEF's most recent ranking shows that other countries are continually making strides as well.

To maintain its relevance in this globalised digital economy, Singapore therefore needs to maintain the foresight and planning it has put into developing its infocomm infrastructure over the quarter of a century. This is especially pertinent in the domestic and international broadband markets.

Domestic Broadband Market

Since 2000, Singapore ONE has provided nation-wide broadband access over Asymmetric Digital Subscriber Line (ADSL) and cable to households in Singapore.

Over the years, with full market liberalisation resulting in greater competition, Singaporeans have been enjoying higher-speeds broadband and even more competitively-priced broadband services. These have resulted in greater uptake of broadband. Broadband household penetration in Singapore has risen steadily from 7 per cent in December 2000 to 54 per cent in March 2006. Figure 1-2 shows the growth of household broadband penetration between 2000 and 2005.

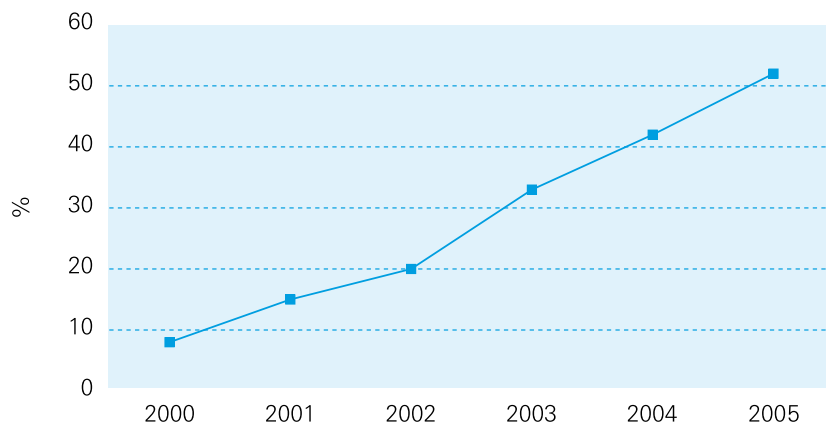


Figure 1-2: Singapore's household broadband penetration rate (as at December of respective years)
Source: IDA

Singapore's broadband penetration is one of the highest in the world, behind only a very few places, such as South Korea and Hong Kong.

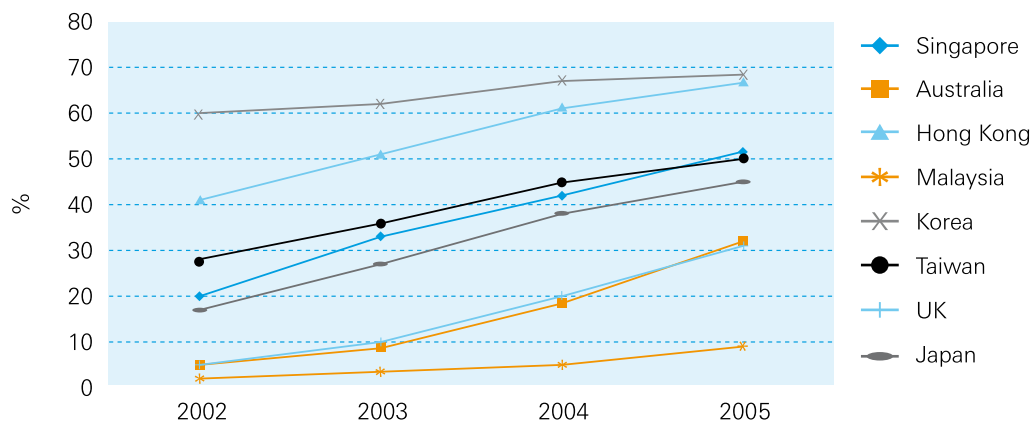


Figure 1-3: Household broadband penetration in selected economies from 2002 to 2005 (Dec of respective years)
Information Source: IDC

Wireless Market

Complementing this wired broadband market is a fast-growing wireless market with a mobile penetration of 101 per cent as at March 2006². In the month of March 2006 alone, Singaporeans sent 866 million Short Message Service (SMS) messages or an average of seven SMS messages per subscriber per day³.

Since 2005, commercial 3G services have been offered by all three mobile service providers in Singapore. There are 317,600 3G subscribers today – representing seven per cent of the population⁴. Data compiled by IT research agency Frost & Sullivan forecasts that the number of 3G subscribers here would cross the one million mark by 2008⁵.

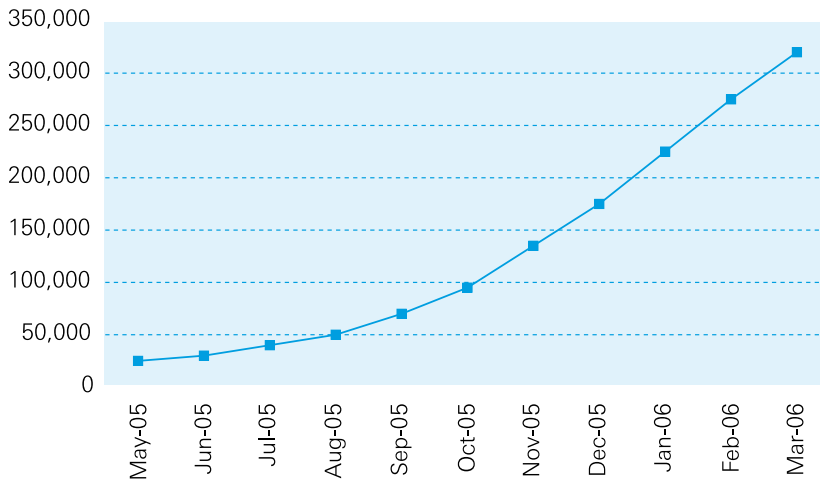


Figure 1-4: 3G subscriptions growth in Singapore

Source: IDA

2 The Government is currently working with mobile service providers to re-register all pre-paid SIM cards by May 2006, as part of an ongoing and holistic security review. There may be an initial drop in mobile penetration rates as a result of this re-registration exercise.

3 IDA

4 As of March 2006

5 "3G Subscriber base seen doubling", AsiaOne, 16 January 2006.

The promising growth of 3G will likely be driven by a number of factors including more trendy handsets and new multimedia value-added services. As in many other countries in Asia, individuals in Singapore are already starting to use value-added data services on mobile devices, beyond just person-to-person SMS. **Figure 1-5** below shows the level of usage of mobile data value-added services such as SMS/MMS for TV voting and downloading of mobile games in selected Asian economies.

Percentage of respondents who use the following services on a daily basis	Singapore	Australia	Hong Kong	Korea	People's Republic of China	Taiwan
Send person-to-person SMS	83.8	60.3	27.6	68.3	78.1	35.1
Use SMS/MMS services for						
• Voting polls, raffles, including TV votes	8.1	8.7	1.3	0.4	2.9	3.1
• Receive information listings and schedules	3.0	3.8	1.5	0.4	2.1	0.7
Download games to store on your phone	2.3	2.5	1.1	0.2	0.8	1.2

Figure 1-5: Usage of mobile data services in selected economies (percentage of respondents)

Source: Asia Pacific Wireless Consumer Survey, 2005, IDC, December 2005

In the area of broadband wireless, Singapore had an estimated 830 public wireless local area network (WLAN) locations at the end of 2005, or about 1 hotspot per square kilometre⁶. This makes Singapore the Asian economy with the highest concentration of public hotspots on a per square kilometre basis.

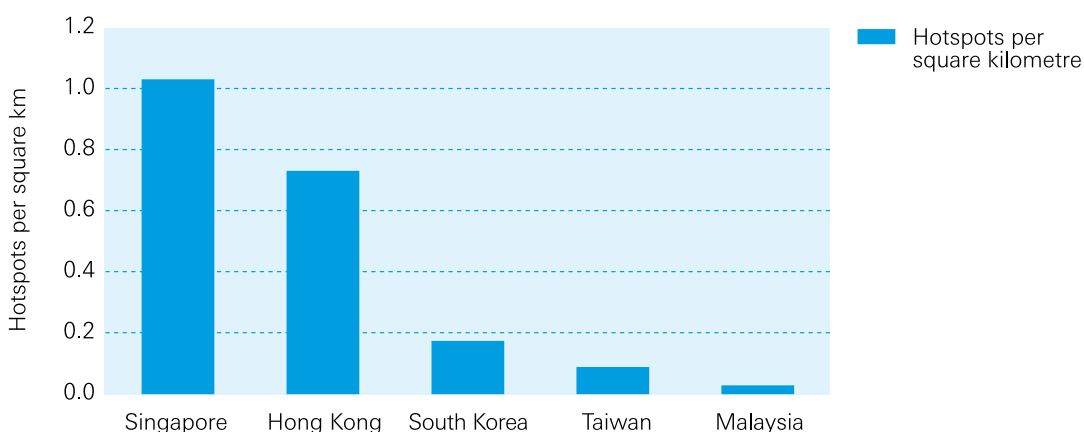


Figure 1-6: Hotspots density (at end 2005)

Source: IDC, Asian Development Bank

6 "Asia/Pacific (Excluding Japan) Hotspot LAN Equipment 2006-2010 Forecast and Analysis", IDC, March 2006

Apart from public hotspots, WLAN is also commonly found in Singapore’s Institutes of Higher Learning (IHLs), which include all universities, polytechnics and the Institute of Technical Education. In fact, all IHLs in Singapore today are fully equipped with WLAN on their campuses. These IHLs have made good use of this wireless infrastructure, putting at least half of their courseware online to facilitate learning anywhere on campus.

Surfing in the Sky

Singapore’s wireless broadband coverage has extended beyond schools, and public hotspots – indeed, it has gone beyond the island. In mid-March 2005, Singapore Airlines became one of the first carriers to offer high speed inflight connectivity service to its passengers using wireless broadband. By mid-2005, the airline topped off its Internet access offering by bringing live international TV on board, beamed through Connexion by Boeing to passengers’ laptops.

Passengers using this service onboard Connexion by Boeing-equipped SIA aircraft are able to send and receive emails, connect real-time to their corporate virtual private networks and surf the Internet via their own wireless-enabled (802.11 a/b/g) laptops.

Source: Singapore Airlines website, 2006

Beyond wireless local-area network technologies, Singapore has already started exploring alternative forms of wireless broadband technologies that would provide further broadband coverage. In 2005, the IDA auctioned spectrum in the 2.3GHz and 2.5GHz bands for the specific purpose of promoting investment in wireless broadband access (WBA) networks. Six successful bidders – Inter-touch Holdings, MobileOne, Pacific Internet Corporation, QALA Singapore, SingTel and StarHub, acquired spectrum for the purpose of WBA.

A few bidders have already begun trials or commercial offerings. In January 2006, MobileOne started a technical trial to test a mixed configuration of the pervasive Wi-Fi technology (based on 802.11) in the front-end, which was in turn supported by pre-WiMAX (Worldwide Inter-operability for Microwave Access) in the backhaul. In February 2006, QMax – a joint venture between QALA Singapore and Creative Technology – became the first company to launch a pre-WiMAX commercial service here.

International Bandwidth

Singapore’s infocomm infrastructure serves more than the domestic needs of individuals and businesses here. Its quality has been an increasingly important factor for multi-nationals choosing to set up in the country.

Today, more than 7,000 multi-nationals have some operations in Singapore, of which, over 60 per cent of them leverage on Singapore’s international infocomm connectivity to conduct some form of regional or global operations from here. With a total submarine cable capacity of 28 Terabits per second (Tbps) connecting Singapore to more than 100 countries, Singapore is today one of the most connected cities in Asia.

Country	Lit (Gbps)	Max (Gbps)
Japan	2,280	29,750
Singapore	1,161	27,971
Korea, Rep.	1,020	20,450
Taiwan	960	16,770
Hong Kong	890	17,490

Figure 1-7: Submarine cable capacity (lit and maximum) of selected Asia Pacific economies, May 2006

Source: Telegeography Research, © PriMetrica, Inc. 2006

Enablers

Enablers form critical foundations for many of the services that are delivered over existing fixed and wireless broadband networks. Examples of nation-wide enablers used in Singapore today include those in the areas of identity, security and privacy and payment services.

Security, Privacy and Identity

Since the early days of computerisation in Singapore, emphasis has been placed on the assurance of the confidentiality, integrity and availability of information, as well as the security of the underlying systems and communication networks. Infocomm security policies and guidelines have long been instituted within the government. Singapore was among the first nations in this region to establish a Computer Emergency Response Team. Singapore also established the first Public Key Infrastructure in Asia, enacted laws that recognised the use of digital signatures and proactively issued guidelines and requirements for infocomm security for the banking and finance sector in the country.

The Infocomm Security Masterplan provides the overarching plan in Singapore’s continued national efforts to enhance cyber security. Launched on February 2005, this three-year (2005-2007) strategic roadmap is the result of extensive private and public sector feedback to increase the resilience of Singapore’s critical infrastructure from cyber attacks and to maintain a secure infocomm environment for government, businesses and individuals. Today, a number of initiatives have been launched under the Masterplan, among them a national Cyber-Watch Centre, Critical Infocomm Infrastructure Surety Assessment and the Common Criteria Certification Scheme.

The Cyber-Watch Centre provides real-time cyber threats detection and response to enhance the Government’s network and information security.

This centre monitors the Government network on a 24 by 7 basis. Where imminent cyberthreats or ongoing attacks are detected, the government agencies will then be promptly notified for preventive and remedial actions to be taken.

The Critical Infocomm Infrastructure Surety Assessment project was set up to assess the infocomm security readiness of Singapore’s critical infocomm infrastructures. Led by the IDA, various infrastructure owners and operators of the country’s Critical Infocomm Infrastructure are currently working together to ascertain the adequacy of their infocomm protection measures.

The Common Criteria Scheme was established in June 2005 by the IDA to provide an infrastructure for infocomm companies worldwide to evaluate and certify their security products against the Common Criteria standard (ISO 15408) – an international security standard increasingly adopted by organisations and governments worldwide. The move aims to, in parallel, develop the capabilities of our local infocomm industry and to open new business opportunities in the growing global security solutions market.

End-users also play a key role in ensuring security in the infocomm environment. Recent statistics show that at least half the Internet users in Singapore make use of some form of security-software including virus-checking software and firewalls. More however, can be done to raise the level of awareness and usage in this area of online security.

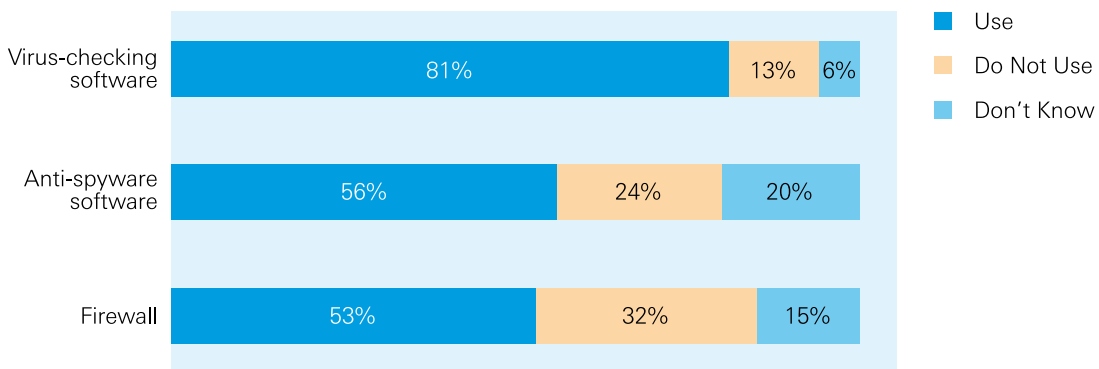


Figure 1-8: Usage of Internet security software
 Source: IDA Annual Survey on Infocomm Usage in Households and By Individuals, 2005

In the area of data protection, Singapore currently adopts a sectoral approach relying on a combination of legislation, regulation, and self-regulation. In the public sector, there are strict policies protecting the data acquired by the government. In the private sector, sectoral legislation such as the Banking Act, Insurance Act, Private Hospitals and Medical Clinics Acts regulate the different type of actions relating to the collection, use, disclosure and transfer of personal data. In 2001, a Model Data Protection Code (Model Code) was developed and subsequently adapted for use in the private and public sector. Adoption of the Model Code is voluntary.

The Singapore government is currently reviewing Singapore's data protection regime and assessing the suitability of various data protection models. The recommendations of this review are expected to be made in 2006.

Electronic Payments

Driven by technological progress and changing consumer needs, the payment landscape in Singapore has evolved from one that has been predominantly based on paper and cash, to one that now includes a diverse range of cashless payments instruments.

Today, Singapore is recognised as an advanced adopter of payment solutions. In the EIU E-Readiness 2005 report, Singapore was ranked on par with advanced e-payment-adoption economies such as Korea, Australia and Canada, and ahead of Japan, in terms of online commerce.

In terms of online identity, organisations in Singapore today use a variety of online identification methods ranging from usernames and passwords, two-factor based authentications such as token-based identifications, to biometric-based applications.

In 2003, the Singapore government launched Singapore Personal Access, or SingPass, which till today, serves as a common password for over 615⁷ government e-services. Examples of Internet services accessible with SingPass include the filing of income tax returns, renewing of passports and registration of new businesses. With SingPass, users need only remember one password to access government e-services, making it more convenient for users to transact with the government.

Countries	Score
United States	9
Singapore	8
Australia	8
Canada	8
Korea	8
Japan	7

Figure 1-9: Consumer and business adoption of online commerce (selected countries)
 Source: EIU E-Readiness Report, 2005

Electronic payment solutions here can be broadly classified into online, mobile and card-based payments solutions.

7 As of January 2006

In 2005, some 27 per cent of Internet users in Singapore made purchases online. Each shopper spent an average of S\$1,068 on Internet commerce over a year. This was double the online-spend per consumer in the previous year. The most popular products/services purchased online were travel products, clothing, footwear and sporting goods⁸.

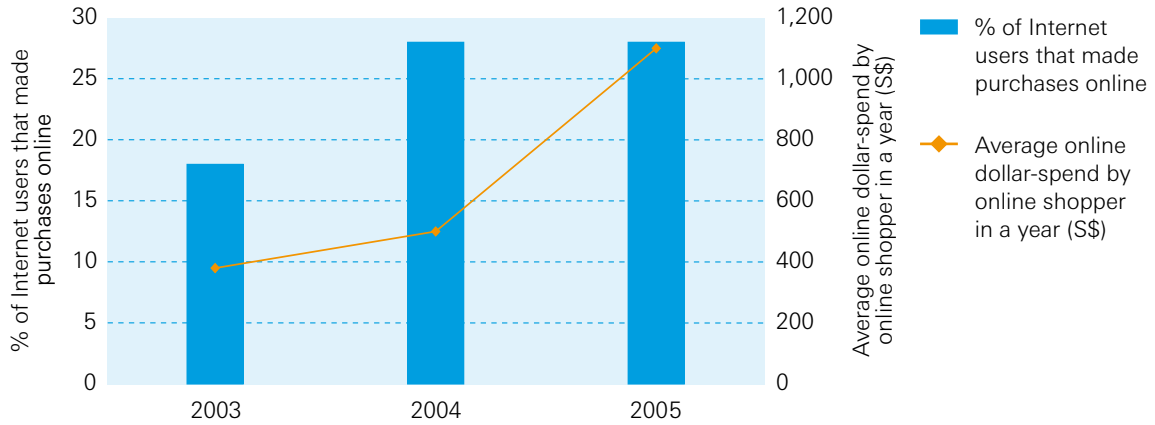


Figure 1-10: Adoption of online shopping and average online dollar-spend
 Source: Annual survey on Infocomm usage in households and by individuals 2003-2005, IDA

In the same year, 32 per cent of Internet users used Internet banking. All of the major banks in Singapore have an Internet presence offering a range of products directly to consumers. While the initial focus of the banks has been in the retail-banking sector, there is a growing range of small to medium enterprise and corporate banking products and services being offered.

In terms of mobile payments, Singapore is ranked among advanced users, alongside South Korea, Japan and Austria, according to a recent report by Arthur D. Little.

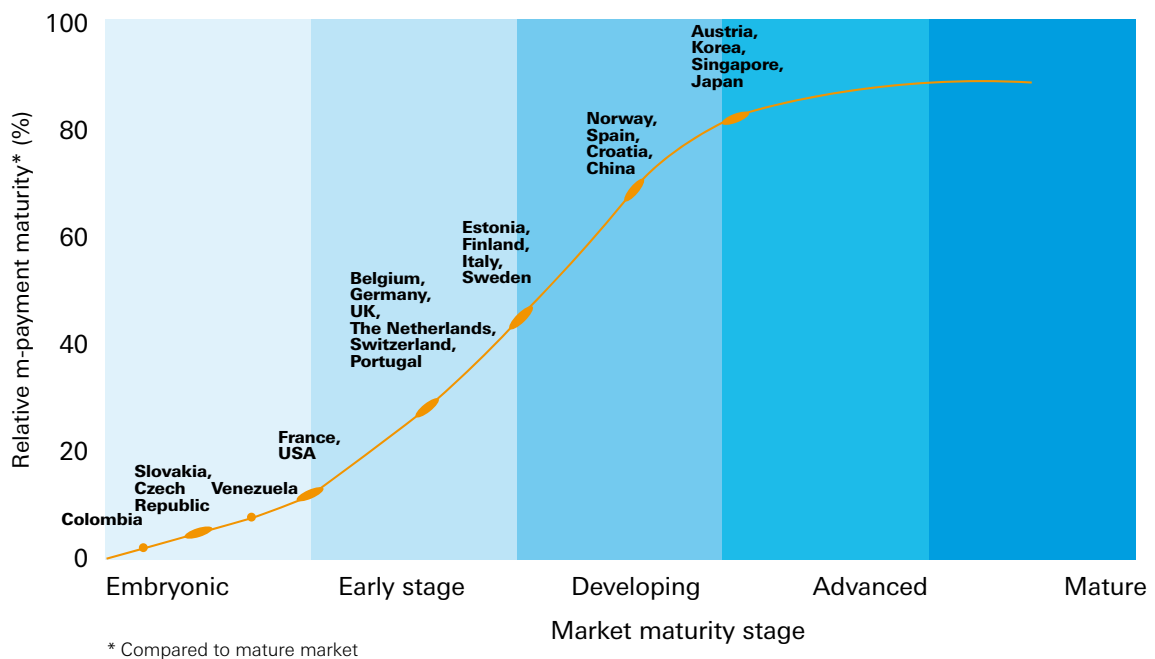


Figure 1-11: M-Payments market developments
 Source: Global M-Payments Update Report, Arthur D. Little, 2005

Mobile payment services are currently available either through direct billing by local telecom operators or through mobile banking portals and other third party providers. For example, SingTel, a local operator, allows their subscribers to pay their outstanding electronic road toll fine charges through their mobile phones. At the same time, Standard Chartered has tied up with mobile banking software provider Meridea to provide mobile banking services while OCBC, a local bank, provides mobile banking services through the iMODE service in Singapore.

In November 2005, local payments provider – Network for Electronic Transfers (NETS), embarked on a Proof-of-Concept prototype of a CashCard application that enables the mobile phone to be used for payment transactions just by simply tapping it against a payment reader. Using Near-Field Communications (NFC) – a standards-based combination of wireless and identification technologies that allows two NFC-enabled devices to communicate at close range – the implementation of this innovative application is a Singapore-first and possibly a regional first in the use of NFC technology for payment transactions⁹.

Finally, in terms of card-based payments, consumers in Singapore today are able to use their debit and credit cards to make payments at more than 30,000 points of sale. Consumers are also able to use their stored value cards for public transit payments, road tolls as well as payments at libraries, cinemas, food and beverage outlets such as McDonald's, convenience stores and self-service kiosks.

According to latest data released by the Bank for International Settlements in January 2006, each Singaporean made an average of 406 payment transactions using payment cards and electronic money in 2004. The same study showed that in the United States, each American averaged 132 payment transactions¹⁰.

Innovations have also been introduced into the cards-payment landscape. For example, prompted by the increasing number of visitor arrivals from China, NETS linked up with China UnionPay – an association for China's banking card industry, to allow consumers from China to use their UnionPay credit and debit cards here. Using their cards, these visitors can then conveniently make purchases using the NETS Electronic Funds Transfer Point Of Sale terminals at selected retail outlets and to withdraw cash from selected Automated Teller Machines¹¹.

⁹ "NETS Payments At The Tap Of Your Mobile Phone", NETS press release, 9 November 2005

¹⁰ "Statistics on payment and settlement systems in selected countries", Bank for International Settlements, January 2006

¹¹ "Fostering innovation and promoting consumer interests in retail payment systems" – Keynote Address by Mr John Palmer, Deputy Managing Director (Prudential Supervision), MAS, at NETS 20th Anniversary Dinner, January 2005

CHAPTER 2

TRENDS AND DRIVERS

Overview

Whether it is for innovation, integration or internationalisation, Singapore's infocomm infrastructure is clearly a critical component of the country's economic competitiveness and an essential factor in our lives today.

Looking towards 2015, however, Singapore's ability to leverage on our infocomm infrastructure cannot be taken for granted. Singapore's second ranking in the most recent World Economic Forum's Global Information Technology Report 2005-2006, from first in the previous year, is indicative of this.

Many economies are investing heavily to upgrade their infocomm infrastructure; leading countries such as South Korea and Japan, for example are planning to make higher-speeds broadband ubiquitous throughout their economies. When completed, these projects will yield tremendous new opportunities for these countries. To continue leveraging on infocomm as a strategic enabler, Singapore must likewise take a long-term view of our investments in infocomm.

In addition to these developments, there are also a number of drivers – primarily in terms of needs of the users and technological advances which will likely make today's infrastructure inadequate for 2015.

Need for Speed

A key demand driver is that related to the need for higher speeds. Along with increased storage needs, the transmission of new media-rich content and applications will likely require more bandwidth for transmission. Already, many consumers today have moved beyond sending text-only emails to also sharing photos online and in certain cases, sharing personal videos online. The increased exchange of rich-media content will place demands for higher bandwidth in Singapore's infocomm infrastructure.

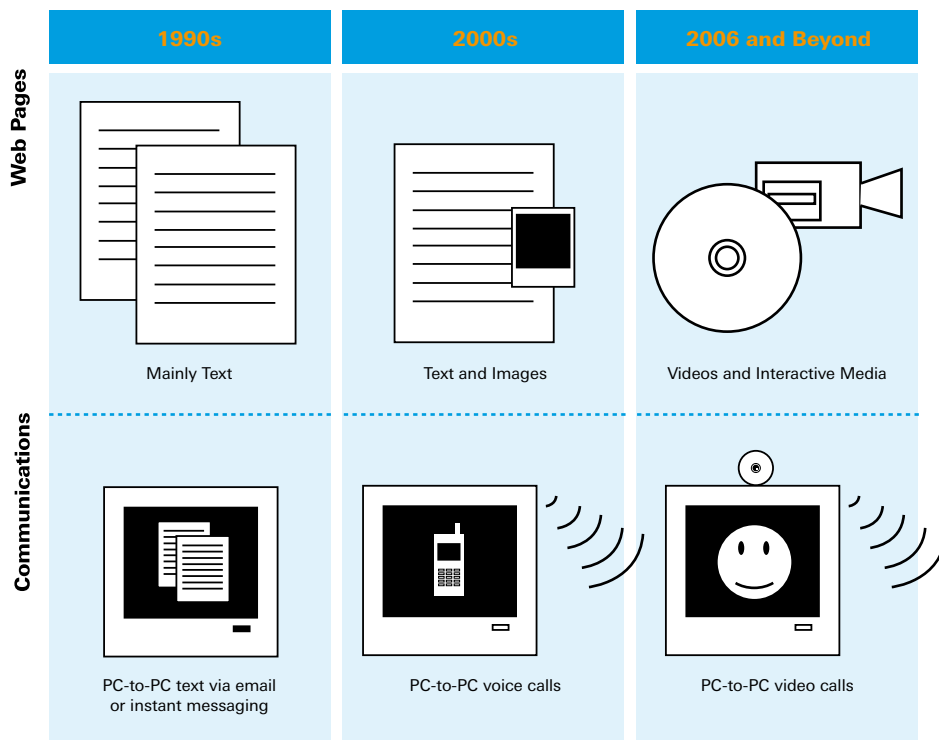


Figure 2-1: Online applications requiring greater bandwidth and speed of response

Other potential bandwidth-intensive applications in the foreseeable future include high definition TV (HDTV) over IP, interactive and richer peer-to-peer applications such as video instant messaging, video conference and blogs as well as online multimedia and learning.



Need for Increased Trust in Conducting Online Transactions

Pervasive adoption of online services such as banking, healthcare, and commerce can only happen in an environment that does not put valuable personal data at risk. The lack of trust is increasingly a key impediment to the development of the global information economy.

In January 2006, a global survey of consumer attitudes by Visa International revealed that the theft or loss of personal or financial information is the number one concern among consumers worldwide, with 64 per cent expressing anxiety over such an occurrence. The global response to theft or loss of information surpassed environmental degradation (62 per cent) and terrorism (58 per cent) as causes for concern¹².

In Singapore, IDA's Annual Survey on Infocomm Usage in Households and by Individuals for 2004 and 2005, security concerns have also been cited amongst the top three reasons for Singaporeans not wanting to purchase on-line.

Providing greater assurance and trust are thus, key issues that need to be addressed in order for Singapore to be plugged into the information economy over the next decade.

Need for Mobility

In addition, there is an increasingly strong desire for mobility. This can be evidenced through the strong take-up of mobile phone subscriptions. Worldwide, between 2001 and 2003, the growth rate of mobile subscribers was close to 50 per cent. This far surpassed the growth rate of fixed-line subscribers in the same period of 10 per cent¹³.

¹² "New Research Shows Loss of Personal/Financial Data the Number One Concern of Consumers Worldwide", www.visa.com, 25 January 2006
¹³ Source: TeleGeography, 2005

In Singapore, the same preference for mobility can be seen in comparing fixed and mobile subscriptions. Despite higher costs per minute of mobile calls to fixed-line calls, mobile phone subscriptions have been steadily rising, and today far surpasses fixed-line subscriptions. In fact, the dipping fixed-line penetration rates seen since July 2002, suggests that some households might have replaced their fixed-line phones with mobile phones.

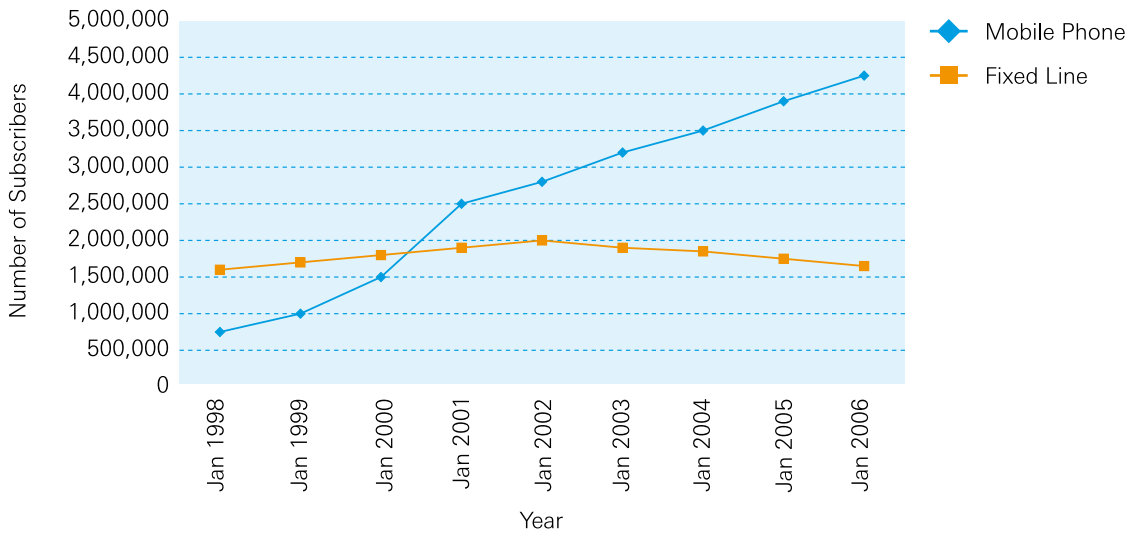


Figure 2-2: Number of fixed and mobile subscribers in Singapore
Source: IDA, 2006

While the trends above are pertinent to voice communications, it is reasonable to expect that this desire for mobility extends as well to data communications. To meet this need for mobility, Singapore’s next-generation national infocomm infrastructure must thus be pervasive. Data access to broadband must be made available and easily accessible anywhere on the island.

New Opportunities from Three Waves of Change – Communications, Computing and Sentient

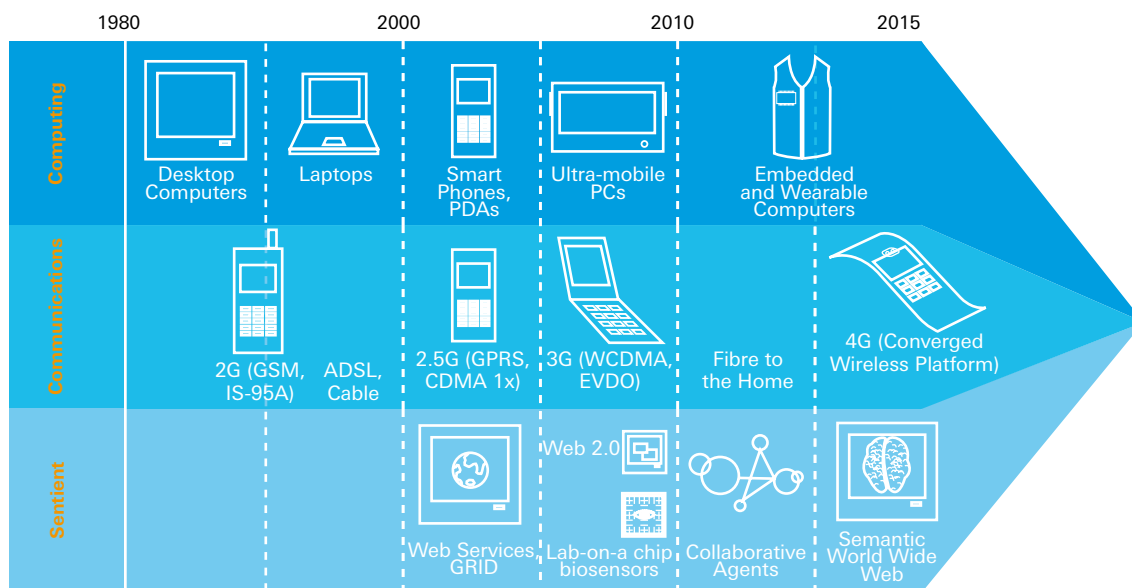


Figure 2-3: The Three Waves of Change – Communications, Computing and Sentient
 Source: Infocomm Technology Roadmap 5, IDA, 2005

Communications Wave

Over the years, society has embraced communications technologies such as the telephone, mobile phone and the Internet. And each new technology has been adopted faster than the one before.

Communication systems in Singapore today, such as the Public Switch Telephone Network (PSTN), GSM cellular networks, public Wi-Fi hotspots and broadband DSL have served the Republic well but each was designed to serve a specific need. Being independently developed, seamless inter-working across these networks is very difficult to achieve. As a result, the user has to carry many devices and maintain different log-in identities as he traverses across these networks to access the services he needs.

Moving towards 2015, a significant improvement in this situation is expected. Instead of requiring a specific end-user device for each access network, future devices and networks will be much more versatile. They will be able to independently negotiate the most appropriate protocols and access the appropriate system for the situation at hand,

without user intervention. So instead of toting multiple devices for communications, entertainment and business, and having to remember multiple user identities and passwords, the user will need just one converged device.

Computing Wave

The emergence of the personal computer (PC) in a world of room-sized mainframe computers spawned a revolution, as it made computing affordable to the general public.

There are other computing innovations that are expected to make the same quantum leap in the next 10 years. One is the highly popular and successful Google Earth application which is a free-of-charge, downloadable virtual globe program. It maps the entire earth by combining images obtained from satellite imagery, aerial photography and Geographical Information Systems (GIS). It is one of the first next-generation Internet applications to be based on Web 2.0 technologies.

This technology allows for easy and fast development of new applications, and is expected to fuel an explosion of new and innovative applications over the next few years.

Other new technologies being developed in universities and research laboratories include grid computing and intelligent software agents. Grid computing is an emerging computing model that can aggregate the resources of many separate computers connected by a network (usually the Internet) to solve large-scale computation problems. Intelligent software agents are software entities capable of acting with a certain degree of autonomy in order to accomplish tasks on behalf of a user.

Computing Grids and Utility IT infrastructures are also expected to become a reality by 2015. These will enable computing and software to be delivered as a utility or service, like water and electricity. This is expected to bring down prices of software and services, and introduce billing on a pay-per-use basis.

On the user device front, computing hardware has faithfully followed Moore's law in the last 20 years and is likely to continue to do so, boosted by nanotechnology. This is expected to shrink the physical size of computing platforms significantly by 2015. So much so that what is now available on a desktop will be available on a device small enough to be worn on the person.

Sentient Wave

While the computing wave makes computers more affordable for the masses and the communication wave brings greater network connectivity, the sentient wave promises systems and devices with basic consciousness. These will be intelligent enough to collect information about the surroundings and their context, and to make judgments based on this information.

When used in connection with the Internet, for instance, these applications would be able to analyse the growing amount of information there, synthesise and present it, so a user gets only what he wants.

All these trends, coupled with developments in other countries, point towards a common theme: Singapore needs to plan ahead and innovate in order to ensure that our infocomm infrastructure remains relevant, cost-competitive and continues to add value for our individuals and businesses. On the demand side, the desire for greater speed and mobility will require new capabilities in the country's infocomm infrastructure. At the same time, the use of this infrastructure must come at a competitive price. On the supply side, technology trends indicate that Singapore can meet these demands – provided it makes considered investments in the short term, while bearing long-term interests in mind.

CHAPTER 3

VISION OF INFOCOMM INFRASTRUCTURE IN 2015

Vision

Taking into account the above demand and supply trends and drivers, the iN2015 Infocomm Infrastructure, Services and Technology Sub-Committee recommends the development of a next-generation infocomm infrastructure to prepare Singapore for digital opportunities towards 2015. This infrastructure of 2015 will be ultra-high speed, pervasive, intelligent and trusted.

Vision of Singapore's National Infocomm Infrastructure in 2015:

Ultra-high speed, pervasive, intelligent and trusted.

	Today	Imagine your world in 2015 with ...
Speed	High-speed (Megabits per second)	Ultra-high speed (Gigabits per second ¹⁴)
Reach	Broadband to premises (such as homes, schools and offices)	Seamless broadband to anyone, anywhere, anytime
Intelligence	Stand-alone data from individual sources	Real-time, sensor-based, integrated information from multiple sources
Trust frameworks	Organisation-centric	National and global

Figure 3-1: Vision of Infocomm Infrastructure in 2015

In this vision of 2015, over 90 per cent of Singapore's households as well as over 90 per cent of all businesses with more than 10 employees will be using broadband. For these households and businesses, this new infrastructure will not only enable them to do existing things better and faster, it will as importantly, enable new applications and services.

14 1 Gigabit = 1,000 Megabits

Possible Scenarios

The illustration below depicts a few new possibilities enabled by this infrastructure.

Learning Beyond Classrooms

Learners can choose to learn anytime and at any place, even in outdoor places such as the zoo. They will use pervasive ultra-high speed, wired and wireless broadband connectivity for always-on access.

Immersive Entertainment and Communication On-The-Move

Downloads and sharing of bandwidth-intensive music videos and online games and richer communication with our loved ones and business contacts, will be made possible with this next-generation infrastructure.

Creation and Delivery of Digital Media

Singapore's next-generation National Infocomm Infrastructure will also provide the necessary connectivity to support the creation, including research and production, of new digital media and entertainment technologies, content and services.

Personalised Healthcare Delivery

A trusted infocomm infrastructure will enable seamless and secure information exchange among hospitals, clinics, and even patients at home.



Besides learning beyond classrooms, immersive entertainment and communication on-the-move, collaboration in digital media production and distribution and personalised healthcare services, one can envision other services such as new trusted shared services in the financial sector and computing-intensive applications for design and modelling in the manufacturing sector. Indeed, infocomm infrastructure will be a key enabler for sectoral transformation in the economy towards 2015.

While the primary beneficiaries of this infrastructure will be Singapore-based individuals and businesses, the opportunities created will not be solely domestic. The Sub-Committee has established that it will be in Singapore's best interests to adopt international standards where available, and to harmonise our policies and accreditation standards with best-practices around the world.

On one hand, international alignment will ensure that new services developed on this infrastructure are of world-class standards. To illustrate, for Singapore

to be a global trusted hub, our security standards, policies and manpower accreditation standards will have to be on par with the best in the world. This level of assurance will be necessary for Singapore to attract the high-value activities of international banks, digital media companies and other enterprises.

At the same time, international alignment will help ensure that new services developed on this next-generation infrastructure are easily exportable. To this end, programmes will be put in place to assist Singapore-based as well as foreign companies to use Singapore as a test-bed and subsequent global launch-pad for new value-added services. Be it education, entertainment, financial or other enterprise services, or infocomm services such as cyber-threat monitoring services, Singapore can become the choice location for the export of next-generation infocomm-enabled as well as infocomm services.

CHAPTER 4

REALISING THE VISION

Overview

The Sub-Committee has put forward two key strategies to realise the vision of an ultra-high speed, pervasive, intelligent and trusted infocomm infrastructure.

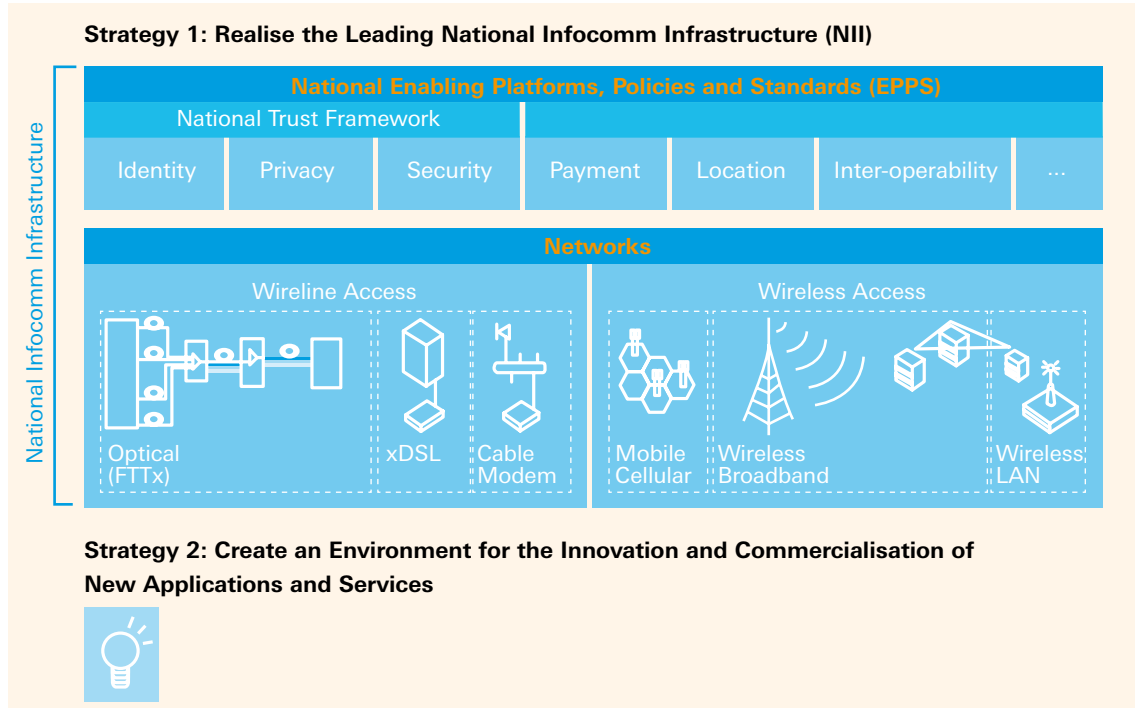


Figure 4-1: Proposed strategies to deliver on the Sub-Committee's vision

Strategy 1: Realise the Leading National Infocomm Infrastructure

The first strategy involves the realisation of Singapore’s next-generation National Infocomm Infrastructure (NII), which comprises of two fundamental ‘building blocks’.

Networks The networks layer provides the pre-requisite underlying physical infrastructure to support all enabling platforms, and applications and services. It will comprise the following:

- Wired access networks: An ultra high-speed fibre network supporting new high-bandwidth applications and services; and
- Wireless access networks: A pervasive wireless broadband network supporting new mobile and location-aware services.

National Enabling Platforms, Policies and Standards (EPPS) Building on the network layer, the National Enabling Platforms, Policies and

Standards act as a “middle-layer” to enable multiple applications and services. For efficiency, this layer aggregates common enabling services which may otherwise be replicated, potentially in an incompatible manner, across each application. At this layer, six critical nation-wide platforms have been initially identified. They are:

- Identity, security and privacy¹⁵
- Location
- Payment
- Inter-operability

Networks

Wired Networks

As highlighted earlier, Singapore’s existing broadband infrastructure has largely met the current needs of individuals and businesses in Singapore. However, demand trends for data and connectivity imply that the network will be likely inadequate to meet future needs in the 5 to 10 year timeframe.

To this end, the Sub-Committee proposes the development of a National Fibre Network (NFN) that will offer high-speed access of over 1Gbps – compared to the Mbps speeds that individuals are enjoying today. This fibre-based network will connect all homes, schools and businesses in Singapore.

The Sub-Committee has also recommended that the NFN be an open-access carrier-neutral fibre network, leveraging on existing infrastructure where possible. This will allow other service providers to use the network to deliver their services to their customers, creating service-based competition.

Recommendation 1:

Deploy a next-generation, gigabits speeds National Fibre Network

¹⁵ Identity, security and privacy are distinct but closely-intertwined aspects of “trust” – and were grouped by the Sub-Committee as the National Trust Framework

Wireless Networks

While the NFN fulfils the promise of ultra-high speeds, the Sub-Committee recognises that a wired network alone will not deliver the broadband pervasiveness needed to fulfill the mobility needs of individuals. Beyond high-speeds, Singapore's new National Infocomm Infrastructure needs to be accessible anywhere on the island: beyond homes, schools, and hospitals, to even business parks, places of interests for tourists, major shopping malls, MRT stations, bus interchanges and even lobbies of commercial buildings and hotels.

It is likely that a multitude of wireless technologies will be required to meet the needs of all users. For example, wide area wireless technologies such as 3G and High Speeds Packet Data Access (HSPDA) will provide more pervasive coverage nation-wide. They, however, will not match the bandwidth that is offered by local area or metropolitan area wireless networks such as Wi-Fi or WiMAX. Wi-Fi today also has the advantage that many computer notebooks and PDAs have in-built capabilities to connect to the network. However, public Wi-Fi networks are not pervasive today.

To this end, the Sub-Committee recommends making Singapore a wireless hot zone where there will be a co-existence of relevant wireless technologies to serve the needs of individuals. While new applications will continue to be promoted on existing mobile networks such as 3G, more can be done to make high speed wireless broadband networks, such as Wi-Fi, more pervasively available in major public areas.

As a start, more can be done to leverage on Wi-Fi to provide coverage for selected "catchment" areas. These catchment areas could include places which are accessible to the general public, have a high volume of human traffic and where there is a high concentration of commercial activities. Given the pervasiveness of Wi-Fi-enabled notebooks and PDAs today, this will help catalyse the use of wireless broadband by familiarising users to wireless broadband on the go. By helping develop a base of users and subscribers, service providers will be incentivised to roll out the wireless broadband infrastructure quickly.

As other wireless broadband technologies such as WiMax become more mature, these alternatives could also be explored as either last-mile access or for backhaul use.

Recommendation 2:

Deploy a nationwide pervasive Wireless Broadband Network

Besides the above characteristics, the Sub-Committee also proposes that Singapore's next-generation wired and wireless networks be IPv6-ready. Besides significantly increasing the addressing space for networked devices, IPv6 provides built-in support for QoS and better routing performance and security. This capability is deemed necessary for Singapore to cater for new possibilities of IP-based applications such as wireless data devices, IP telephony and IP television.

Developments in IPv6 Globally

Since the 1990s, there have been a number of discussions internationally revolving around the need for a migration from IPv4 to IPv6. It was however, not till late that more widespread IPv6 deployments have seemed more certain.

In 2003, the US Defense Department mandated that all of its network hardware and software must be IPv6 compliant by 2008. On August 2005, the Office of Management and Budget (OMB) Office of E-Gov and IT issued OMB Memorandum 05-22, "Transition Planning for Internet Protocol Version 6 (IPv6)," directing all Federal government agencies to transition their network backbones to the next generation of the Internet Protocol Version 6 (IPv6), by June 2008.

Similar deployments are expected closer to home. To illustrate, South Korea plans to provide all-IPv6 based services by 2010. The Japan Government created a tax credit program to exempt the purchase of IPv6 capable routers from corporate and property taxes.

This combination of IPv6-ready, next-generation wired and wireless networks will form a foundation for the leading NII of Singapore.

National Enabling Platforms, Policies and Standards

The National Enabling Platforms, Policies and Standards (EPPS) provide a trusted, seamless and cost-effective environment for the development of new services on Singapore's National Infocomm Infrastructure. The Government, in particular the IDA, can play a key role in putting these in place.

As a start, six focus areas of identity, security, privacy, location, payment and inter-operability have been identified by the Sub-Committee.

National Trust Framework – Issues relating to identity, security and privacy will be addressed under the National Trust Framework (NTF). The NTF will complement the other national infocomm security initiatives, including the Infocomm Security Masterplan and existing programmes for infocomm security, as described in Chapter 1.

As pointed out earlier, pervasive adoption of online services such as banking, healthcare, and commerce

can only happen in an environment that does not put valuable and personal data at risk. The lack of trust is increasingly a key impediment to the development of the global information economy. To continue successfully leveraging on infocomm and for Singapore to continue maintaining its trusted hub reputation, Singapore must tackle the infocomm security and privacy challenges in tandem with the development of the next-generation National Infocomm Infrastructure.

There are three key inhibitors of trust that need to be addressed in order to fully realise the potential of a ubiquitous networked environment:

- **Security** – Cyberattacks compromise the security, reliability and integrity of systems and data
- **Privacy** – Data privacy infringements undermines consumer confidence and trust in online services
- **Identity** – Identity theft leads to unauthorised access of online assets and resources

Building on the existing national infocomm security initiatives and our policies, legislation and standards in the area of security, privacy and identity, the Sub-Committee has recognised that more needs to be done to further entrench Singapore as a Trusted Hub towards 2015. To this end, the recommended NTF will focus on the development of 'hard' and 'soft' trusted infrastructure in the following areas:

- **National Authentication Framework** to catalyse e-business through the pervasive deployment of strong authentication infrastructures across key sectors.
- **National Privacy Infrastructure (NPI)** to support innovation of personalised e-services and biomedical research through the lawful and ethical usage of personal data. This effort will build on the results of the earlier-mentioned government's review of Singapore's data protection regime.

The authentication and privacy infrastructures are pivotal to strengthening Singapore's competitive advantage as the choice regional trusted hub for secured, personalised e-services and biomedical research activities.

- **Infocomm Security Health Scorecard** to assess the level of readiness to mitigate disruptions caused by cyberattacks to business operations through a set of minimal infocomm security standards that benchmark the integrity of all infocomm systems.
- **Information Systems Assurance initiative** to facilitate purchasing decisions by governments and businesses through international assurance certifications for infocomm security solutions (e.g. Common Criteria and Business Continuity/ Disaster Recovery). This builds on existing work under the Infocomm Security Masterplan on the Common Criteria (CC) and other related security standards.

Singapore can become the preferred location for CC certification for Asia. Besides cost-competitiveness and proximity, Singapore also presents a neutral ground for the issuance of such certificates.

- **National Cyberthreat Monitoring Centre (NCMC)** will build on the current efforts undertaken by the Cyber-Watch Centre (CWC), to provide the Government, and eventually the nation, with the capability to respond to infocomm security events.

Specifically, the NCMC will provide the capability to proactively monitor, collect, collate and analyse information and data on cyber-threats on a 24 by 7 basis. As cyber-threats are not constrained by geographic boundaries, there will be collaboration with similar functions in other countries.

The NTF further strengthens Singapore's position as a Trusted Hub for premium services where security, credibility, reliability, and integrity are the norm, and in so doing, attract international investments, businesses and visitors here.

Some degree of Government mandate may be necessary to implement some of the measures for cyber-security and data privacy. Through regulations, measures can be put in place to safeguard and manage users' digital assets and identities. An example of regulatory intervention could be the enactment of a National Cyber Security & Privacy Act to govern the following aspects:

- Data protection through the lawful and ethical collection and usage of online personal data.
- The use of international certification standards like Common Criteria to provide assurance on the reliability of infocomm security products and systems.
- The establishment of business rules and legal agreements, including liability and dispute resolution, to support the National Authentication Framework.
- Benchmarking and audits of infocomm security systems for businesses and national critical infrastructure to ensure a desired level of system assurance.

Electronic Payments — The increasing demand for online and real-time payments has spurred the development of new and innovative products for electronic payments. Innovations in payment systems have the potential to reduce costs of handling cash and reconciling payments, increase efficiency by streamlining processes, and increase convenience by enabling remote payments.

Initiatives in this area will aim to support the development of a nation-wide electronic and mobile payment infrastructure. As part of the programme, it is recommended that the IDA:

- Ensure that the right standards and policies are put in place through co-ordinating payment standards and reviewing government policies
- Support the development and piloting of innovative payment solutions
- Encourage collaboration amongst electronic payment players to implement a next-generation National Electronic Payments Infrastructure

Inter-operability — To meet the vision of a seamless infocomm infrastructure in an increasingly converged wired and wireless technology world, inter-operability will become a basic expectation and requirement. Inter-operability can be effected at different levels:

- Technology compatibility (equipment standards, certification, etc.)
- Services and network inter-operability (or inter-working)
- Forging of partnerships (business rules, mutual recognition, etc.) not just within a country but across national boundaries

Seamless access to networks such as mobile roaming and seamless access to services provide important benefits to end-users and infocomm service providers alike. Users are able to access their familiar services when they are outside the network coverage of their primary service provider. Through inter-working arrangements, a service provider can also better serve its customers' mobility needs, retain and strengthen customer relationships, and gain the businesses of its partners' clients who "roam" into its networks.

The Sub-Committee has also identified the importance of inter-operability between strategic telecoms services to promote greater competition in the telecoms sector. This may include for example, the setting up of a carrier-neutral mobile number portability infrastructure. Such an infrastructure may subsequently be expanded to include fixed-mobile number portability.

Another area for inter-operability is that of computing resources and storage systems. To illustrate, grid computing technology enables us to aggregate huge computing resources from commonly available computing resources, providing new capabilities to solve, until recently, unsolvable computation challenges. This opens a new set of capabilities in design, simulation, visualisation and research.

Location — The emergence of location-based services will enable context-driven information services to meet consumers' needs at anytime, anywhere. New applications beyond those deployed today will be possible:

- **Public safety** such as the provision of information about the proximity of dangerous substances and situations.
- **Tracing services** such as the provision of emergency locations to direct first-aid quickly and safely to the location of an emergency, provision of location information for roadside assistance and tracking of stolen vehicles.
- **Information services** such as the provision of localised yellow pages, events, attractions, map services.
- **Resource management** such as in-fleet management, service staff deployment, telematics, network planning.
- **Navigation** including vehicle navigation and pedestrian navigation.

To catalyse the development of a whole new class of innovative online location aware services, the Sub-Committee recommends putting in place the necessary conditions and infrastructure to enable location information to be made available to service providers in a cost effective manner, complying with national and international security and privacy practices.

Recommendation 3:

Establish National Enabling Platforms, Policies and Standards such as the National Trust Framework

Strategy 2: Create an Environment for the Innovation and Commercialisation of New Services

To promote the development of new services and applications, the Sub-Committee proposes the creation of ‘showcases’ of innovative applications, deployed in a live, commercial environment.

Under the ‘**Stage Alpha**’ programme, the development of infocomm infrastructure will be phased to take into account the creation of these showcases, so that successful applications and services from these showcases may be re-deployed in other parts of the island, or be exported overseas. These showcases will be in various localities such as Downtown Singapore and Fusionopolis at Buona Vista. Some examples of flagship applications and services to be piloted in these areas include:

- “Digital Nervous System” — An integrated system of advanced infocomm, high-performance computing and research resources and inter-operable multi-disciplinary software services.
- Business connectivity anywhere — Workers will be able to access their corporate data over broadband connections enabled by Wi-Fi Mesh networks.

- Digital Media Grid — A media grid infrastructure which interconnects distributed heterogeneous resources such as media servers, network storage, computer clusters, across a large community into a large-scale virtual organisation to provide quality-of-service adaptive streaming services over networks.

Fast track adoption — The Sub-Committee also recommends the engagement of key anchor users to ensure that the National Infocomm Infrastructure meets the needs of the market. Examples include working with the media industry for the secure delivery of bandwidth-intensive content, homeland security agencies for security and location-based related information, transport companies for traffic-related sensors information, schools for pervasive broadband access and hospitals for privacy-related infrastructure.

Recommendation 4:

Create an environment to pilot and showcase innovative applications on Singapore’s next-generation infocomm infrastructure

Infocomm Resource Marketplace — Innovation can also be derived from business models. In many aspects, new business models of infocomm usage will also provide infocomm businesses here with opportunities to do things more efficiently and effectively. Many major infocomm companies, expect basic computing and storage resources to be available “on tap”, in the same way that electrical energy is available from a power outlet. This can be a new business delivery model for delivering the infocomm services. Today, infocomm resources, such as computers, storage and software, are dedicated to companies, departments or even projects. As these resources are never utilised 100 per cent of the time, savings can be achieved within an enterprise if these resources were aggregated.

Such new business delivery models can be realised on a larger scale, with several companies sharing the resources. The Sub-Committee has mooted the possibility of establishing a marketplace for buyers and sellers of such resources. This concept of an “Infocomm Resource Marketplace” – a vibrant regional marketplace for congregation of buyers and sellers of infocomm resources – can potentially change the way users purchase infocomm services.

Recommendation 5:

Encourage innovation of new business models for infrastructure services

Other Recommendations

While the Sub-Committee focused primarily on identifying the requirements of infocomm infrastructure towards 2015, it also acknowledged that recommendations under the two key strategies would take time to develop.

In view of this, the Sub-Committee also engaged in focus groups to discuss interim initiatives that may be undertaken, in the lead-up to Singapore’s development of our next-generation NII.

The following recommendations were made by the focus groups in relation to Singapore’s existing wired and wireless infrastructure:

Wired Infrastructure

- Review the need for an Open Exchange for all Internet Exchange Providers to interconnect and consider funding the linking up of the submarine cable landing stations as a way to enable lower access costs to international bandwidth providers.
- Consider powerline communications as an alternative access means to inject competition in the market in the short term.
- Review the business model to commoditise bandwidth and consider assistance for service providers to move into managed and value-added services.

Wireless Infrastructure

- Examine ways to further exploit 3G to encourage the deployment of Internet Protocol Multimedia Subsystem and High-speed Downlink Packet Access and facilitate inter-working between 3G and Wi-Fi.
- Promote sensor networks for innovative applications and study the inter-operability of sensor networks and identification of applications for vertical economic sector adoption.
- Consider ways to encourage the industry to work on a revenue share model conducive for mobile content developers to develop innovative content and services.

Concurrent to the Sub-Committee’s recommendation on IPv6 for Singapore’s next-generation infrastructure, the Sub-Committee also proposes that the government evaluate a timeline for the mandating of government procurement of network equipment – both wired and wireless, to be IPv6-compliant.

CHAPTER 5

CONCLUSION

Ten years ago, most of us were probably satisfied with corresponding by sending physical letters, or with searching for information using library catalogues and encyclopaedias. Ten years ago, there were only 140,000 Internet subscribers in Singapore – and all 140,000 of them were using dial-up for Internet access. At average dial-up speeds of 56 kbps, an average web page including images, sized around 50 kilobytes, would have taken around 7 seconds to completely load in the browser.

None of us would have anticipated then how we would have grown to be so reliant on infocomm in a decade. From online search engines that literally give us answers in seconds, to e-mail and photo- and video-sharing online, most of us today will be hard put to imagine life without the quality of infocomm infrastructure we have now.

It would be difficult therefore to prescribe what all individuals and businesses will be doing 10 years from now. Instead, the Sub-Committee has started with what our needs will be from trends that have been observed. The desire for mobility, higher speeds and trust, for example, have been consistent desires of individuals.

By the time Singapore's next-generation infocomm infrastructure is established, what we choose to do with this added freedom, the higher speeds and trust online will be up to each of us. Be it high-definition IP TV, rich multimedia interactive learning at home or doing free video conferencing from home, the possibilities will be literally unbounded.

To this end, the Sub-Committee would like to invite each and every individual and business to create these possibilities as we journey towards 2015. If we set aside our existing paradigms and constraints that have been created by today's infrastructure, how can we do things cheaper, better and faster with tomorrow's infrastructure?

Imagine your world, in 2015.

CHAPTER 6

EPILOGUE

The Infocomm Development Authority, together with the relevant government agencies, is reviewing the recommendations put forward by the Infocomm Infrastructure, Services and Technology Development Sub-Committee (Sub-Committee).

The Sub-Committee's recommendations pertaining to Singapore's next-generation wired and wireless infrastructure have highlighted the importance of such infrastructure to Singapore's long-term competitiveness. Clearly, the lack of such an infrastructure will undermine Singapore's ability to meet the social and economic needs of individuals and businesses towards 2015.

To this end, the Singapore government has set aside the investments necessary to work with the private sector in developing a next-generation National Broadband Network that will offer gigabits speeds bandwidth, as well as a pervasive Wireless Broadband Network by 2015.

In his 2006 Budget speech on 17 February 2006, Prime Minister Lee Hsien Loong, announced that Singapore intends to put in place "a new national broadband network that is much faster than what is available today. It will offer fast, efficient connectivity to all – in schools, in offices and homes, and even on the move. It will help us plug into the global knowledge grid, and stay competitive with other cities."

At the subsequent Committee of Supply debate in Parliament on 3 March 2006, the Minister for Information, Communications and The Arts, Dr Lee Boon Yang explained that as Singapore moves into the next decade, the country will need a next-generation National Infocomm Infrastructure (NII) that can support the future high-bandwidth and mobile broadband applications and services we envisage in the various user sectors.

Dr Lee also highlighted, "As the National Broadband Network will be a key infocomm infrastructure, the Government will work with the private sector to put in place an infrastructure that is future-proof, cost-effective and which minimises technological risk. We will use a public-private partnership model. The Government is prepared to provide some funding to kick-start the project and to ensure that this ultra-high speed broadband service will be viable, affordable and sustainable for the longer term."

Announced as part of iN2015 in early-2006, the deployment of the next-generation wired and wireless broadband networks has and will continue to adhere to the schedules listed in **Figure 6-1** and **Figure 6-2** respectively.

Timeline	Milestones
23 March 2006	Request for Comments was sent out to industry to gauge market response and feedback on the NBN
2006	Request for Proposal (RFP) expected to be called. Specifications for the infrastructure to be also released by the IDA
2007	Evaluation of RFP to be completed
2007	Award of wired National Broadband Network (NBN) contract to a private sector partner
2012 / 2013	Completion of project

Figure 6-1: Timeline for the deployment of Singapore's next-generation wired National Broadband Network

Timeline	Milestones
March 2006	Issuance of a Call for Collaboration for proposals by IDA to the industry
December 2006	Commencement of commercial services
September 2007	Completion of network deployment

Figure 6-2: Timeline for the deployment of initial phase in Singapore's Wireless Broadband Network

Annex A: Acknowledgements

Infocomm Infrastructure, Services and Technology Development Focus Group Members

Name	Designation
Mr Willie Cheng	Chairman Singapore Science Centre
Mr Jimmy Chew	Director International Carrier Sales & Solutions T-Systems Singapore Pte Ltd
Mr Robert Chew	Executive Partner Communications and High Tech Accenture Pte Ltd
Dr Michael Chia	Director Communications and Devices Agency for Science, Technology and Research
Associate Professor Chua Kee Chaing	Vice-Dean (Research) Faculty of Engineering National University of Singapore
Mr Guy Cross	Director Linux Business Development Oracle Corporation, Asia Pacific
Mr Francis Fong	General Manager IBM Global Services IBM Singapore Pte Ltd
Mr Craig Gledhill	Managing Director Cisco Systems Singapore
Mr Goh Wai Pheng	Vice President Comms Solutions Business Unit Singapore Technologies Electronics Ltd
Mr Marko Keskinen	Director Technology & Portfolio Management Customer and Market Operations, Asia Pacific Nokia Pte Ltd
Mr Hunsen Law	Senior Director Consumer Services Asia Pacific Real Networks Singapore Pte Ltd
Mr Alfred Lie	Deputy CEO Managed Computing Competency Centre
Mr Low Huan Ping	Executive Vice President Technology Singapore Press Holdings
Mr Ng Long Shyang	Director Electronic Business Division Samsung Asia Pte Ltd
Mr Tom Ng	Director Chief Technology Officer – Asia Asia Deutsche Bank AG

Name	Designation
Mr Claes Odman	President Ericsson Telecommunications Pte Ltd <i>(until March 2006)</i>
Mr Patrick Scodeller	Chief Technical Officer MobileOne Ltd
Mr Soh Kok Hang	Deputy Director Engineering MobileOne Ltd
Mr Tan Seow Nguan	Director Network Planning Singapore Telecommunications Pte Ltd
Mr Tan Tong Hai	President and Chief Executive Officer Singapore Computer Systems Ltd
Ms Tan Yen-Yen	Managing Director Hewlett-Packard Singapore Pte Ltd
Dr Roger Tay Yew Siow	Director Advance Engineering Motorola Electronics Pte Ltd
Mr Teo Han Yong	Director Service & Technology Innovation Bridge Mobile Pte Ltd
Ms Wan Mee Fem	Country Manager Open Computing Centre IBM Singapore
Mr Wong Heng Chew	Managing Director, Singapore Sun Microsystems Pte Ltd
Professor Lawrence Wong	Executive Director Institute for Infocomm Research
Associate Professor Wong Poh Kam	Director NUS Entrepreneurship Centre National University of Singapore
Mr Christoph Zilian	Vice President IT Operations, Asia Pacific T-Systems Singapore Pte Ltd

IDA Secretariat for Infocomm Infrastructure, Services and Technology Development Sub-Committee

Name	Designation
Mr Ling Keok Tong	Deputy Director Infocomm Infrastructure Development
Ms Ong Lay Peng	Deputy Director Infocomm Security and Trust
Mr Fong Young	Assistant Director Wireless Development
Ms Priscilla Lai	Assistant Director Infocomm Security and Trust
Mr Clemence Lim	Assistant Director Infocomm Infrastructure Development
Mr Ng Lup Houh	Assistant Director Infocomm Security and Trust
Mr Louis Tan	Executive Consultant iN2015 Secretariat, CEO's Office
Mr Derek Lim	Senior Consultant iN2015 Secretariat, CEO's Office
Mr Ong Kian Lin	Senior Consultant Network Technologies, Technology and Planning
Mr Lester Ng	Manager Wireless Development
Ms Tan Poh Ling	Consultant iN2015 Secretariat, CEO's Office

Annex B: Glossary

Term	Definition
Backhaul	In the context of communications, backhaul means getting data to a point of aggregation, where smaller lines interconnect into a larger transmission line or network backbone.
Blog	On the Internet, a blog is a personal journal that is frequently updated and intended for general public consumption. The author of a blog is often referred to as a blogger.
Dial-up	Dial-up access is an inexpensive but slow form of Internet access in which the client uses a modem connected to the computer and a telephone line to the Internet Service Provider's (ISP) node to establish a modem-to-modem link, which is then routed to the Internet. It is currently regarded as a legacy technology given the advent of widely available broadband Internet access.
Firewall	A firewall is piece of hardware or software which functions in a networked environment to prevent communications forbidden by the security policy, and protects the resources of a trusted network from users of other un-trusted networks.
Global Positioning Systems (GPS)	The Global Positioning System, usually called GPS, is a fully functional satellite navigational system. A constellation of satellites that orbit the Earth makes it possible for people with ground receivers to pinpoint their geographic location. The location accuracy is anywhere from 100 to 1 meters for available equipment. GPS equipment is widely used in science, and has now become sufficiently low-cost for the general public to own GPS receivers.
Global System for Mobile Communications (GSM)	Global System for Mobile Communications (GSM) is a digital mobile telephone system that is widely used in Europe and other parts of the world. The ubiquity of the GSM standard makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world.
Grid computing	Grid computing is a computing model that provides the ability to perform higher throughput computing by taking advantage of many networked computers to model a virtual computer architecture. Grids use the resources of many separate computers connected by a network to solve large-scale computation problems. Grids provide the ability to perform computations on large data sets, by breaking them down into many smaller ones, or provide the ability to perform many more computations at once than would be possible on a single computer, by modelling a parallel division of labour between processes.
High Definition TV (HDTV)	High-Definition TV (HDTV) is a television display technology that provides picture quality with a higher resolution than traditional formats (NTSC, SECAM, PAL). HDTV generally uses digital rather than analog signal transmission. HDTV provides a higher quality display with a vertical resolution from 720p to 1080i and beyond. These rates translate into a frame rate of approximately 60 frames per second, twice that of conventional television. Another prominent feature of HDTV is its wider aspect ratio (the width to height ratio of the screen) of 16:9, compared to the current format of 4:3.
Identity	It refers to the electronic representation of a real-world entity, to be used in a distributed network interaction with other machines or people. The purpose is to restore the ease and security human transactions once had, when we all knew each other and did business face-to-face, to a machine environment where we are often meeting each other for the first time as we enter into transaction over vast distances. A digital identity only needs to be as complete as a particular transaction requires.
Inter-operability	Inter-operability is the ability of a system or a product to work with other systems or products without special effort on the part of the customer. Products achieve inter-operability with other products using either of both approaches: by adhering to published interface standards or by making use of a "broker" of services that can convert one product's interface into another product's interface on demand.

Term	Definition
IPTV (Internet Protocol Television)	IPTV (Internet Protocol Television) describes a system where a digital television service is delivered to subscribing consumers using the Internet Protocol over a broadband connection. IPTV enables a more customised and interactive user experience. It uses a two-way signal sent through the provider's backbone network and servers, allowing viewers to select content on demand, timeshift, and take advantage of other interactive TV options.
Location-based Service (LBS)	A location-based service (LBS) is a service provided to end-users based on their current geographical location. Most often the term implies the use of a radiolocation function built into the end-user's device, which may use GPS or triangulation between the known geographic coordinates of cellular base stations through which communication takes place.
Mobile Payment	Mobile payment is paying for goods or services with a mobile device such as a phone, Personal Digital Assistant (PDA), or other such device. They can be used in a variety of payment scenarios. Typical usage entails the user electing to make a mobile payment, being connected to a server via the mobile device to perform authentication and authorisation, and subsequently being presented with confirmation of the completed transaction.
Multimedia Messaging Service (MMS)	Multimedia Messaging Service (MMS) is a communication technology, developed by 3GPP (Third Generation Partnership Project) that allows users to exchange multimedia communications between capable mobile phones and other devices. An extension to the Short Message Service (SMS) protocol, MMS defines a way to send and receive, almost instantaneously, wireless messages that include images, audio, and video clips in addition to text.
National Authentication Framework (NAF)	Framework to realise the vision of a nationwide infrastructure for authentication that can be leveraged by all verticals. Consisting of both physical and soft infrastructure, the National Authentication framework aims to provide a common user experience to arrest the issue of market fragmentation from proprietary, "in-silos" deployments of authentication systems. National Authentication Framework is a part of the National Trust Framework.
National Enabling Platforms, Policies and Standards (EPPS)	Consists of nationwide platforms that enable new services to be deployed in the Infocomm Infrastructure. EPPS complement the capabilities of the wireless and wired networks. EPPS include physical infrastructure, standards, policies or regulations that can be leveraged on or referenced by multiple service providers. Initial sets of EPPS identified include those in the area of privacy, identity, security, location, payment and inter-operability.
National Fibre Network (NFN)	The National Fibre Network (NFN) is the wired component of the NII. NFN is an ultra-high speed wired network that is that is capable of access speeds of 100 Mbps to 1 Gbps. The next generation network will be IPv6-ready, open-access and carrier-neutral. It will be opened to all service providers, so that they can reach out to connected customers or consumers. This will lower the entry barrier for service providers and costs to consumers.
National Infocomm Infrastructure (NII)	The National Infocomm Infrastructure or NII, is Singapore's new digital super-highway for super connectivity. NII will entrench Singapore's Infocomm hub status and open the doors to new business and social growth for the country. It consists of both the physical infrastructure and soft infrastructure. The physical Infrastructure has two components: a wired broadband network (NFN) that will deliver ultra-high broadband speeds to all homes, offices and schools, while a wireless broadband network (WBN) will offer pervasive connectivity around Singapore. The soft infrastructure includes policies and standards pertaining to those in the National Enabling Platforms, Policies and Standards.
National Privacy Infrastructure (NPI)	A set of reference architecture, technology standards and business rules pertaining to online data privacy.

Term	Definition
National Trust Framework (NTF)	<p>Framework consisting of nationwide enabling platforms of privacy, security and identity. The NTF was developed to enable, on a national scale, the exploitation of infocomm technologies for economic competitiveness through a multi-pronged response to cyber-attacks, privacy infringements and identity theft.</p> <p>The National Trust Framework is part of the National Enabling Platforms, Policies and Standards under the National Infocomm Infrastructure.</p>
Near Field Communications (NFC)	Near Field Communications is a combination of identification and wireless technologies that enables two NFC-enabled devices to 'talk to each other'. NFC is based on an industry and ISO standard jointly developed by Philips and Sony initially and subsequently by the NFC Forum comprising major phone manufacturers.
Number portability	Local Number Portability is the ability to take an existing telephone number assigned by a local exchange carrier or a mobile phone provider, and reassign it to another telephony provider.
Peer-to-Peer (P2P)	A peer-to-peer computer network is a network that relies on the computing power and bandwidth of the participants in the network rather than concentrating it in a relatively low number of servers. P2P networks are typically used for connecting nodes via largely ad hoc connections. Such networks have become increasingly common for sharing content files (file sharing) in digital format.
Pervasive	A pervasive network is a ubiquitous "fabric" of computing, information, entertainment and telemetry capability all tied together by high-speed wired and wireless networks. The concept of pervasive networks takes the "anytime, anywhere" concept of mobility to its logical end – "all the time and everywhere".
Privacy	Privacy is the ability of an individual or group to stop information about themselves from becoming known to people other than those whom they choose to give the information.
Public Private Partnership (PPP)	<p>An arrangement between the public and private sectors established for the purpose of providing an essential service or facility to the public.</p> <p>PPP is part of the Singapore government's Best Sourcing framework, where the public sector will engage private sector providers to deliver those services which the private sector can provide more effectively and efficiently. Through PPP, the public sector seeks to bring together the expertise and resources of the public and private sectors to provide services to the public at the best value for money.</p>
Radio Frequency Identification (RFID)	RFID is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal or person. The advantage of RFID is that it does not require direct contact or line-of-sight scanning.
Seamless	The ability for the user or other entities to communicate and access services irrespective of changes of location or technical environment. The degree of service availability may depend on several factors including the Access Network capabilities, service level agreements between the user's home network and the visited network (if applicable). Seamless mobility includes the ability of telecommunication with service continuity, when switching between networks.

Term	Definition
Security	The protection of information systems against unauthorised access to or modification of information, whether in storage, processing or transit, and against the denial of service to authorised users or the provision of service to unauthorised users, including those measures necessary to detect, document, and counter such threats.
Short Message Service (SMS)	SMS (Short Message Service) is a service for sending messages of up to 160 characters typically to mobile phones.
Singapore ONE	Launched in 1988, Singapore ONE (One Network for Everyone) is a collaboration effort between the government and the industry to enable the roll-out of a nationwide broadband infrastructure that encourages the development of interactive broadband multimedia applications and services accessible through a high-speed, high-capacity ATM backbone.
Virtual Private Networks (VPN)	A virtual private network (VPN) is a network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organisation's network.
Wearable Computer	A wearable computer is a small portable computer that is designed to be worn on the body during use. Wearable computers are usually either integrated into the user's clothing or integrated into everyday objects that are constantly worn on the body, like a wrist watch.
Web Service	Web Service, according to W3C, is a software system designed to support interoperable machine-to-machine interaction over a network.
WiMAX	WiMAX is an acronym that stands for Worldwide Interoperability for Microwave Access. It is a standards-based wireless technology that provides high-throughput broadband connections over long distances. WiMAX can be used for a number of applications, including "last mile" broadband connections, hotspots and cellular backhaul, and high-speed enterprise connectivity for business.
Wireless Broadband Network (WBN)	The Wireless Broadband Network (WBN) is the wireless component of the next-generation NII. With the Wireless Broadband Network, users out of their homes, schools and offices can conveniently access wireless broadband services using data-centric computing devices. The WBN will offer access or download speeds of at least 512 kbps.
Wireless Fidelity (Wi-Fi)	Wi-Fi is a set of product compatibility standards for wireless local area networks (WLAN) based on the IEEE 802.11 specifications. The term is promulgated by Wi-Fi Alliance. Any products tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as inter-operable with each other, even if they are from different manufacturers.

Infocomm Development Authority of Singapore

IDA is committed to growing Singapore into a dynamic global Infocomm hub. IDA uses an integrated approach to developing info-communications in Singapore. This involves nurturing a competitive telecoms market as well as a conducive business environment with programmes and schemes for both local and international companies.

For more information, visit www.ida.gov.sg

Singapore Computer Society

SCS, established since 1967, is the premier professional body for IT practitioners and IT users in Singapore. With a membership of over 22,000, it is an invaluable network for its members. SCS administers various certification programmes that help individuals gain professional recognition for career development.

For more information, please visit their website at www.scs.org.sg

Singapore infocomm Technology Federation

SiTF is Singapore's national infocomm industry association. It brings together 500 corporate members from MNCs and local companies, who collectively account for over 80% of the industry revenue. The SiTF assists its members in business development, market intelligence, overseas trade missions, networking and alliances.

For more information, please visit their website www.sitf.org.sg

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