The Internet and
Greater South China
(Taiwan, Hong Kong, Fujian, and Guangdong)

Global Diffusion of the Internet Project

William Foster, Seymour Goodman, Zixiang (Alex) Tan, and Grey Burkhart*
The Global Technology Information Group (GITAG)
September 28, 1999

With able assistance from Hip-Lun "Aston" Ying, Laura Randall, Kin-wai "Kevin" Chan, and Kon-heng "David" Chan

Table of Contents

I.   Introduction

Figure 1: Map of Greater South China

Greater South China is one of the most economically dynamic regions of the world and one that has significant potential for integrating the Internet in ways that will revolutionize production and distribution. Greater South China includes the Republic of China (Taiwan), Hong Kong, and China's southern provinces of Guangdong and Fujian. It is useful to analyze Internet diffusion in these four neighboring geographic entities (see Figure 1) which are bound together by major economic and cultural ties. Though all four share a Chinese heritage, their similarities diverge in terms of public policies, degree of interaction with the West, and economic capacity. For each of these entities, these similarities and differences help determine the characteristics and the potential of the Internet. The Internet, in turn, has the potential to change the character of each economy and the South China economic network that links them together, tying them into the global marketplace.

Currently, Hong Kong plays a pivotal role as the central intermediary between China and the West, and to some extent between Taiwan and the south China provinces. It remains to be seen whether the business intermediary role Hong Kong plays will become less important as the Internet enables China's provinces to participate directly in the global economy? The Internet in Hong Kong is booming. The Internet access business is highly competitive, with more than 100 providers and at least 10 viable ones. Broadband access is less so with Asynchronous Digital Subscriber Loop (ADSL) access available only through Hong Kong Telecom IMS and cable access stifled.   Hong Kong's current economic position is epitomized in the title of the book *Made by Hong Kong*.[1] Very little is actually manufactured in the city. Much of Hong Kong's

---

[1] Suzanne Berger & Richard Lester, *Made by Hong Kong*, Oxford University Press (June 1997).

manufacturing capability has shifted out of Hong Kong into Guangdong province as part of Hong Kong's effort to retain its competitive advantage in the world market of producing better, cheaper, and faster. Hong Kong is, in many ways, the ultimate intermediary. The Internet and the death of distance represent both an asset and a threat to Hong Kong. Will it be possible for new intermediaries to facilitate Chinese – Western trade without having to locate in Hong Kong with its high cost of living? As the expansion of the Internet drives dis-intermediation and re-intermediation, the question Hong Kong policymakers should be asking themselves is how Hong Kong can reinvent itself to maximize its advantage in the face of this sea change. How can government policy insure that Hong Kong's Small and Medium-sized Enterprises (SMEs)—which make up 95% of the business community—make the right investments in information technology (IT) when most of the SME's are so strongly focused on short-term profits.

Guangdong has the highest number of Internet users of any province in China. Though only 6% of China's population resides in Guangdong, 11.7% of Internet users in a recent CNNIC study came from Guangdong. The popularity of the Internet in Guangdong, relative to the rest of the country, may be explained by a number of factors including the economic prosperity of the province, the high number of emigrants, and the proximity of Hong Kong. China Telecom's Guangdong Data Communications Bureau (GDCB) dominates the commercial Internet market, providing more than 90% of the users. Through its ChinaNET "163" Network and Multimedia "169" Network services, China Telecom provides dial-up Internet access throughout the province at rates that are distance insensitive.[2] The GDCB is building out its ATM network and is aggressively promoting electronic commerce. It developed its own certificate authority, but has been forbidden to use it by central authorities pending decisions by the People's Bank and other organizations on a national strategy.

The island of Taiwan has a significantly higher number of hosts per capita than Hong Kong. There are other indications that though each government is aggressively promoting IT, e-commerce is being more rapidly adopted in Taiwan. One major difference from Hong Kong is that Taiwan has a vibrant manufacturing sector. The leadership of the electronic manufacturing industry, in particular, has actively embraced IT including recently the use of enterprise resource planning (ERP) software. The Multinational Corporations (MNC) have driven some of this acceptance. Intel, for example, takes 80% of its orders in Taiwan from distributors placing orders through a Web based system. The use of web based ordering, however, is not yet pervasive among Taiwanese distributors taking orders from end-user manufacturers. In a world where business success depends on a vast personal network, it is not clear how Taiwanese business leaders will adopt inter-enterprise technologies, such as agent technology, in ways that support their personal business networks.

Taiwanese businesses have invested heavily in manufacturing facilities in Fujian, the province that lies across the narrow Taiwanese straits. Common linguistic ties have allowed Taiwanese business in Fujian to build relationships with business and local

---

[2] The Multimedia network is known as "169" because of the phone number used to access the service. The "163" network refers to the regular ChinaNET network.

government leaders. This has overcome many of the bureaucratic and logistical obstacles to doing business in China. Fujian's leadership, in the interests of supporting business development, is now creating an advanced communication infrastructure. In building a state-of-the-art ATM network, they are leapfrogging the existing X.25 network that presently connects the province. E-mail is extensively used to communicate between businesses in Taiwan and Fujian. However, there is resistance to implementing higher levels of integration using IT. For instance, most Taiwanese businesses are not implementing advanced information technologies in their Fujian factories even though it might allow for better coordination. There is a fear that the central PRC government would be able to utilize such systems to more effectively control and tax the Taiwanese businesses located in Fujian.

The Internet will inevitably alter the economic relationships between China's provinces and Taiwan. Will the Internet facilitate the tighter integration of Taiwan and China, even if there is considerable political tension between the two or will it exacerbate such tension?

The Chinese central government is encouraging the use of business to business e-commerce as part of its national informatization drive. Therefore, much of the drive to use information technology is coming from the top down. There is also an incredibly powerful bottom-up market-based force driving the integration of more advanced uses of the Internet. Shenzen, the leading manufacturing city in Guangdong, is a node in what the Institute for the Future calls the Global Silicon Network—that web of people and organizations which create the flow of technology, money, and ideas that make up the global computer industry.[3] In order to stay connected with and competitive within the Global Silicon Network, firms must invest in the latest information technologies. Though this is most true for the computer industry, to remain competitive in other global industries such as the toy and garment industries, firms must keep up with the state-of-the-art in information technology as well. The challenge facing firms in South China is that they are driven by the global marketplace to integrate advanced information technologies, but are concerned about the impact of making their transactions more transparent.   This dynamic has a profound impact on the sophistication of use of the Internet in the Greater South China economic network and the relationship and competitive position among Fujian, Guangdong, Taiwan, and Hong Kong.

The only way to grasp the unique characteristics of the Greater South China Internet is to look individually at Internet diffusion in the two provinces, the Special Administered Region (SAR), and the Republic. Given the fact that the Internet allows people to communicate in many ways, there is no one indicator that adequately represents the Internet capacity of a nation or province. This study uses a framework that describes the state of the Internet diffusion in a nation in terms of six dimensions: pervasiveness, geographic dispersion, sectoral absorption, connectivity infrastructure, organizational infrastructure, and sophistication of use. Kiveat diagrams of the Internet dimensions for each nation provide policymakers with an easy way of comparing the Internet in different

---

[3] The Outlook Project, *The Rise of the Global Silicon Network and the Growing Importance of Asia*, Institute for the Future, Menlo Park, CA.

economies.[4]   This framework was first presented in *The Global Diffusion of the Internet Project: An Initial Inductive Study* in 1997 – 1998. Variants of this framework have been applied to over 36 countries.[5] This study represents the first attempt to apply the framework at the sub-national level.[6] An introduction to the Internet diffusion framework is included as Appendix II.

---

[4] Adapted from the framework first developed by Peter Wolcott for Peter Wolcott, Seymour Goodman, and Grey Burkhart, The Information Technology Capability of Nations: A Framework for Analysis, MOSAIC Group report.

[5] Larry Press, with Grey Burkhart, Will Foster, Sy Goodman, Peter Wolcott, and Jon Woodard, "An Internet Diffusion Framework," Communications of the ACM, October 1998, pp. 21-26. For the evaluations of 36 countries see Larry Press, "Global Diffusion of the Internet: A Global Perspective," *OntheInternet*, September/October 1998, p. 47.

[6] Seymour E. Goodman, Grey E. Burkhart, William A. Foster, Laurence I. Press, Zixiang (Alex) Tan, and Jonathan Woodard, "People's Republic of China," The Global Diffusion of the Internet Project: An Initial Inductive Study, (Fairfax, VA: The MOSAIC Group, March 1998).

II.   Hong Kong

Since Great Britain re-occupied Hong Kong after World War II, the Asian port has been a magnet for foreign and international investment. Now with its transfer to the PRC in 1997, it enters a new era. With 85% of the economy generated by services, Hong Kong is a leader in many different sectors such as financial, textiles, and international trade.   Free of any import duties and blessed with low taxes, Hong Kong serves as a gateway to mainland China.   The city is trying through "Digital 21" policy initiative, city-wide broadband implementation, and the new Cyberport to lead Hong Kong into the information age. Hong Kong's status as a Special Administered region of the PRC both raises questions about its stability and opens opportunities for providing the leadership necessary to integrate China fully into the global economy.

Table 1: Statistical Data for Hong Kong for 1999[7]	
Population (July 1998)	6,706,965
Literacy	92.2%
GDP	US$ 172.2 billion
Per Capita GDP	US$ 26,800
Telephone lines	3.75 million
Teledensity (Lines per 100 population)	56 lines per hundred
Mobile Phone	3.358 million
Pagers	459,837
International calls (in and out)	3.676 billion minutes per year

---

[7] OFTA, "Data and Statistics" <http://www.ofta.gov.hk/ined_eng1.htm> (August 2, 1999) and "World Factbook 1998."

Figure 2: Hong Kong Map[8]

Over 90% of Hong Kong's businesses are small businesses. Almost all are family owned. Though there used to be a significant amount of manufacturing in Hong Kong, most manufacturing is now done in neighboring Guangdong province or throughout Asia because of space and cost considerations. Hong Kong businesses are masters at building highly flexible supply networks that allow them to produce goods better, faster, and cheaper than anyone else in the world. Though information technology such as the phone, fax, and e-mail are indispensable to these networks, many Hong Kong businesses have been slow to invest in more advanced technologies such as EDI and ERP.

---

[8] Ibid.

Dimensions of Internet Diffusion

Table 2: Dimensions of Internet Diffusion in Hong Kong		
Dimension	**Level**	**Explanation**
Pervasiveness	(4) Pervasive	With the number of dial-up Internet accounts more than 1 in 10, the number of users approaches 2 in 10. There are 98,183 hosts in the '.HK' top level domain.
Geographic Dispersion	(4) SAR-wide	Internet access is available throughout the SAR. ISDN access is available in most places.
Organizational Infrastructure	(3) Competitive	It is a difficult call as to whether to place Hong Kong at the competitive or the robust level. With 133 licensed ISPs, Internet market is competitive, though HK Telecom is the dominant force. HK Telecom's monopoly over international circuits is being opened.
Connectivity Infrastructure	(3)	SAR's backbone consists of T3 connections to the HKIX. International connectivity does not rank at level 4. ADSL is just getting rolled out.
Sectoral Absorption	(4) Widely used	Internet use is strong in all sectors, with universities and the public sector leading the way.
Sophistication of Use	(3) Transforming	Hong Kong's leaders are committed to transforming the economy through the Internet. The SME community has been slow to invest in inter-Enterprise information technology.

Figure 2:   Kiveat Diagram of Internet Dimensions for Hong Kong
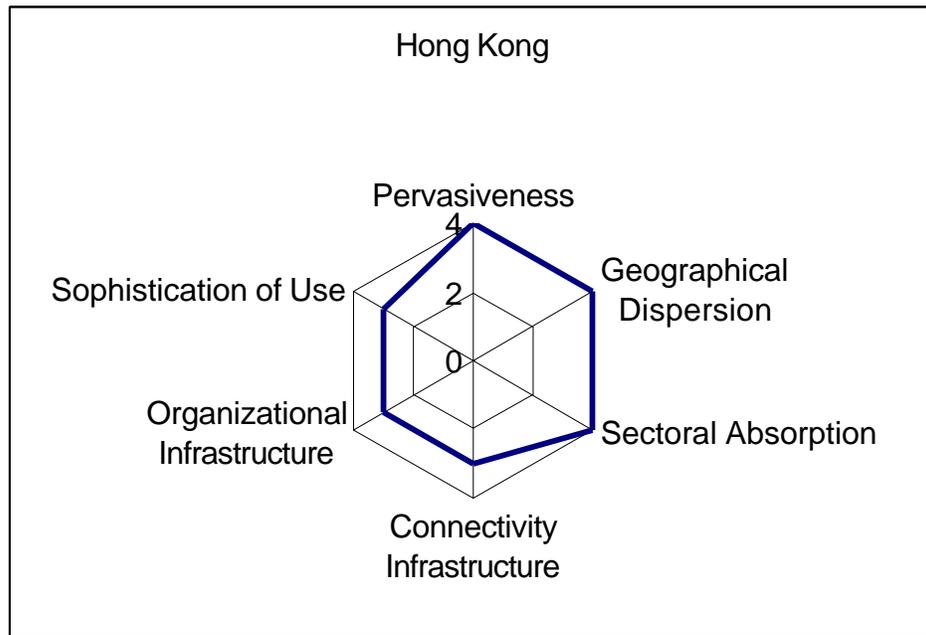
Pervasiveness

The Internet is rapidly expanding in Hong Kong. Use of the PSTN to access the Internet rose by 113% between 1998 and 1999 from 402,170 minutes to 858,176 minutes.[9] There are currently 704,493 Internet dial-up subscriptions in Hong Kong. Though it is difficult to estimate users, there are approximately 1.5 million users, 22% of the population.

Table 3: Hong Kong Internet Indicators (1999)[10]	
ISP Dial-up Accounts	704,493
Pre-Paid Calling Cards	306,555
Dedicated lines to Internet	5,314
Internet Users	850,000 (April 1998: Nielson)
Hosts in the '.HK' domain	98,183[11]

According to Network Wizards, in June of 1999 there were 98,183 hosts with the '.HK' domain name or 5 sites for every hundred users. Many companies in Hong Kong register under the '.com' top level domain. Despite this fact, the number of sites per user

---

[9] Ibid.

[10] Ibid.

[11] Source: Internet Software Consortium (July, 1999) <http://www.isc.org> (September 6, 1999)

is rather low and reflects the fact that many of Hong Kong's small businesses, which make up 95% of the economy, have yet to develop a web presence.

Geographic Dispersion

Based on the fact that Hong Kong is a city, it should come as no surprise that dial-up Internet access is available throughout the city with no additional access charges based on the distance from the POP. ISDN access is available in even remote parts of the city. There are multiple international IP links (UUNET, AT&T, and HK Telecom).

Connectivity Infrastructure

Hong Kong's exchanges are 100% digital. Though multiple networks have a great deal of bandwith capacity, the SARstill has a limited amount of international bandwith when compared with the most connected countries. Netplus, UUNET, and HKTelecom have T3 connections to the United States (see Figure XX).

Figure 4: Internet Connectivity out of Hong Kong

Created in April of 1995, the Hong Kong Internet Exchange (HKIX), run by the Chinese University of Hong Kong (CUHK), provides ISPs with low cost interconnection with other local ISPs. As a result, HKIX controls most of the routing within Hong Kong. The ATM network was installed in 1996 to handle rapid Internet growth and increased bandwidth demands. Many ISPs are now connecting to HKIX using T3s.[12]

Local access methods include 56Kbps and ISDN modems. Hong Kong Telecom is rolling out ADSL and fiber-to-the-building and its subsidiary IMS is providing Internet

---

[12] See HKIX, "Hong Kong Internet Exchange", http://www.cuhk.edu.hk/hkix (August 2, 1999).

access through them. Internet support through cable modems is becoming available after having been delayed because of regulatory and political obstacles.

Organizational Infrastructure

With 133 licensed ISPs, Hong Kong's Internet access market is competitive. There have been a number of buyouts recently, and the number of viable ISPs may be as low as 10 with Hong Kong Telecom's Integrated Multimedia Services (IMS) occupying around 50% of the market.   An ISP association (HKISPA) promotes the industry; it has raised concerns about IMS's purchase of the second largest ISP in Hong Kong and questions about whether Hong Kong Telecom's rules for ADSL resale make it possible for only IMS to sell Internet/ADSL connections. The HKISPA has also complained about the fact that IMS sells its ADSL/Internet service at prices lower than what other ISPs can buy ADSL for from Hong Kong Telecom.

Hong Kong Telecom's monopoly over international circuits will end by the year 2000 and 10 licensees have been chosen.

Sectoral Absorption

The Internet is widely used in Hong Kong in almost all sectors. Since the local Internet started in CUHK, the academic sector has the strongest presence in cyberspace. With nearly 90% representation on the web, the Hong Kong government is using the web to make government more transparent and interactive. The business sector is another heavy user with continuous requests for new communications infrastructure to meet its bandwidth demands. Local companies are expecting broadband bandwidth for multimedia and other bandwidth-intensive applications. Each year, hospital facilities and health centers are given more money to keep up with growing technologies.

Table 4: Sectoral Absorption in Hong Kong		
Sector	**Rank**	**Explanation**
Academic	3 - Common	All universities in Hong Kong have Internet access.
Commercial	2 - Moderate	10-90% of business with more than 100 employees have Internet servers
Health	2 - Moderate	10-90% of hospitals and clinics have leased line connectivity
Public	3 - Common	More than 90% of government entities have Internet servers

Sophistication of Use

The Internet is beginning to transform business processes as more than just a substitute for paper and telephone-based communication. However, given Hong Kong's status as one of the world's financial centers, one would expect that it would be leading the cyberization of markets. To the contrary. There have been very few initiatives to develop new electronic markets and intermediaries in Hong Kong. The few existing initiatives in Hong Kong have been driven primarily by Westerners.

Hong Kong's banks have been unwilling to support merchants taking orders over the Web. Some of the larger merchants have signed up with US banks, but this requires having to pay additional processing fees and to play by US business and tax rules.

Another option is being created by First Ecom.com which processess transactions through the Bank of Bermuda.[13]

EDI never really took off in Hong Kong the way it has in Singapore, which developed the sophisticated TradeNet system that used electronic document interchange (EDI) to permit trade documentation to be processed electronically by dispensing with paperwork. Singapore's system has created huge efficiency gains for agents, freight forwarders, shipping companies, port authorities, government customs agencies, and others. Singapore started in the 1980s; Hong Kong has only recently become serious about EDI.

Hong Kong's business community, which is primarily a network of small businesses, also has never embraced EDI. Many have not invested in the information systems needed to support EDI or even Web-based interfaces. E-mail is used to take and receive orders and to stay in contact with business networks, but there is little experience in applying the Internet and other information technology to business processes. Given the fact that these business processes involve many companies all over the world, and evolve very rapidly, it is less surprising that they are not automated. The question is whether the short-term profit focus of Hong Kong's businesses is resulting in a neglect of information technology that may negatively impact Hong Kong's efficiency in the future.

The Hong Kong government is aware of this danger. It has tried to encourage the use of IT by channeling significant amounts of money into supporting the use of IT by Hong Kong's businesses. The Hong Kong Productivity Council has developed pilots and test beds to demonstrate the power of IT. For instance, over 200 businesses remotely access an ERP system run by the Council. Nevertheless, very few businesses have invested in their own ERP systems or have begun to develop Inter-enterprise systems facilitated by the Internet.

Hong Kong is taking the lead in developing e-commerce software. Intermerchant is a package that is specifically created to allow small businesses to open and maintain web sites. It takes advantage of the new Pentium chip to support three-dimensional rotating images. It also fully supports both English and Chinese language interfaces. As this product is only six months old, it remains to be seen how rapidly it will be integrated into businesses in Hong Kong and China.

---

[13] Joel McCormick, "Hong Kong's Credit Woes," *The Industry Standard,* August 16-23, 1999.

Determinants of Internet Diffusion in Hong Kong

Table 5: Determinants of Internet Diffusion in Hong Kong	
Determinant	Dimension Impacted.
Digital 21 Initiative	Potential to influence all six dimensions.
Telecommunications Policy	Impact organizational infrastructure and through that all five other dimensions.
Cyberport	Potential to increase sophistication of use.
Open Economy with transparent legal and tax policies.	Increases pervasiveness.
Telecommunication Infrastructure	Increases pervasiveness and connectivity infrastructure.
Dual (Western / Chinese) culture	Increases pervasiveness because users can read English web sites. By giving Hong Kong a comparative advantage, increases all six dimensions.
Relationship between Hong Kong and Taiwan	Could increase sophistication of use as Taiwan manufacturers influence Hong Kong.
Relationship between Hong Kong and Guangdong	By impacting economy can influence all six dimensions.

The Role of Government

Unlike its parent neighbor China, Hong Kong has a far more transparent government and a history of open competition with low taxes or fees on commerce. In the hope of building on Hong Kong's present position as a trade and finance hub for Asia, Hong Kong's leaders are trying to lay the groundwork for Hong Kong to become a next generation E-Commerce hub.

Digital 21

The Information Technology and Broadcasting Bureau (ITBB) in conjunction with the Information Infrastructure Advisory Committee (IIAC) has formed a package of initiatives called *Digital 21* to position Hong Kong as the leader in the digital world of tomorrow. K. C. Kwong, Secretary for ITBB, stated "we have set out our vision, initiatives and targets of how Government, business, industry and the academia can work together to make Hong Kong a leading digital city in a globally connected world."[14] The proposals (see Table 6) include strategies for using a series of top down initiatives to spur informatization while encouraging market forces to drive bottom up development.

---

[14] ITBB, "Digital 21: Hong Kong SAR Information Technology Strategy, http://www.info.gov.hk/itbb/it_ps/indexdigital21.htm, (August 2, 1999).

Table 6: Digital 21 Initiatives[15]	
Initiative	**Objective**
Telecommunications Infrastructure	To enhance Hong Kong as a place for investment in telecommunications, to encourage competition and innovation under an open, fair and predictable regulatory framework, and to maintain Hong Kong's position as the pre-eminent telecommunications center in Asia.
Electronic Service Delivery Infrastructure	To provide public services to business and the community through a wide range of electronic access means.
Asia Pacific Internet Traffic Hub	To establish Hong Kong as a gateway in the Asia Pacific region with regard to Internet traffic and electronic commerce information flow.
Chinese Language Interface	To develop a Chinese language open and common interface for users in the community who prefer to communicate in Chinese.
Public Key Infrastructure	To enable safe and secure electronic transactions by providing a framework for ensuring the integrity of information exchanged and for authenticating the identity of participants in such transactions.
Regulation and Legislation	To develop a regulatory and legislative framework which will support and encourage the development of electronic commerce.
Year 2000 Problem	To minimize the possible adverse impact of the Year 2000 problem on Hong Kong.
IT in Education	To work with the Education and Manpower Bureau (EMB) and other educational organizations.
IT Manpower Supply	To work with the EMB to identify how the right quantity, quality, and type of IT professionals can be developed, attracted to, and retained in Hong Kong.
Government IT Exploitation	To develop the capacity, capability and commitment of officers and staff at all levels within government to take full advantage of the benefits and opportunities offered by new information technologies.
Asia Pacific Internet Content Hub	To encourage the development and hosting of innovative and attractive Internet sites locally, especially those that contribute to developing Hong Kong as a gateway for electronic commerce with the Mainland.
Chinese Language Applications	To encourage the development of close working ties with the Mainland to promote Chinese language software application.
IT Excellence	To encourage and promote the use of IT, especially in SMEs through public recognition and awards.
Knowledge and Awareness of IT	To promote knowledge and awareness of IT and information services.
IT Industry Support and Investment	To collaborate with the Industry Department to support the development of the local IT industry.
IT in the Community	To raise the awareness, confidence and familiarity of the community in the use of IT in all spheres of their lives.

[15] Ibid.

Telecommunications Policy

The other major government body which has a major impact on the Internet in Hong Kong is the Office of the Telecommunications Authority (OFTA). OFTA, established in 1993, is responsible for regulating the rapidly developing and increasingly competitive telecommunications industry in Hong Kong.

As Muller points out, the Hong Kong government's tradition of licensing technology has not only become more complicated with digital convergence, but this practice hinders the development of digital media.[16] One area where these complications have arisen is in the provision of Internet services through cable modems. Even though there are four companies licensed to provide fixed line services, these very same licenses have stifled competition for broadband services. In 1992 Wharf Cable, for example, received a license to offer cable services but was restricted from offering cable modems in order to protect the interests of the other fixed line license holders. Video On Demand (VOD) also created a quandary when Hong Kong Telecom conducted VOD trials in 1995, because it impinged on the benefits that Wharf argued it had purchased with its cable license. Currently ISPs need PNET licenses which require them to pay HK$ 0.042 per minute for each call they terminate. They have not been required, as Muller feared, to purchase a new license for each service they offer. However, except for IMS, ISPs do not have competitive access to broadband services.[17] OFTA faces challenges in opening up the broadband market to competition without strangling it through a licensing regime.

Cyberport

The Cyberport, a private public venture masterminded by Richard Li of the Pacific Century Group, has caught the imagination of Hong Kong as a strategy for helping Hong Kong leverage its capabilities as a transportation and financial center into becoming a center for the development of cyberspace. The Cyberport's goal is to provide the office and residential space for high tech ventures and their employees, creating a synergistic environment. The government has provided one of the last undeveloped parcels of land on the Hong Kong island for the Cyberport in return for a share in the venture. Major high tech companies such as IBM have expressed an interest in re-locating to the Cyberport. Though some have dismissed the venture as primarily a property deal, there are others who believe that the Cyberport will stimulate the development of a new generation of electronic intermediaries in Hong Kong. As noted in the sophistication of use section, Hong Kong has not been in the lead in terms of developing new electronic markets and intermediaries.

For almost any global business there are logistical and operational reasons for having an Asian electronic "hub." The question is whether that hub should be in Tokyo, Sydney or Singapore or in one of the new emerging centers such as Malaysia's Multimedia Super Corridor or Shanghai's Pudong District.

---

[16] Milton Mueller, Telecom Policy and Digital Convergence, The Hong Kong Economic Policy Studies Series, City University of Hong Kong, 1997.

[17] Ibid. Pp. 127-158.

With its redundant broadband infrastructure connected to key exchange points on the planet, the Cyberport will be an attractive, if expensive, center for running servers to support electronic services. The Cyberport will provide a relatively easy way to live and work in Asia for westerners and will give them and their Asian co-workers a sense of space not always found in crowded Hong Kong.

It is very possible that the synergies of the Cyberport, which will bring together technical, marketing, and financial people, will support the development of the next generation of electronic markets and intermediaries. Though the Internet makes "place" irrelevant, personal relationships, the key to any venture, can be nurtured by physical space. This can be seen in Silicon Valley and may well be seen with the Cyberport. The Cyberport also connects all of Hong Kong by becoming one of the lead nodes in the Global Silicon Network.

Open Economy
With low barriers to entry and free competition, the Ex-British based economy is poised to be one of the leaders in Asia in terms of investment in information technology. The lack of government barriers encourages innovation. This environment has created the prosperity to support this investment and has attracted capital from around the world.

Strong Telecommunication Infrastructure
Hong Kong is a leader in telecommunications with a strong market infrastructure. With 56 lines per 100 people, Hong Kong has the highest teledensity in Asia, except for Japan. All exchanges are digital. It is second to Japan worldwide in its rate of use of fax (8.7 fax lines per 100 telephones). It has the world's highest density of pagers with one out of every six people carrying one in 1996. The percentage has decreased with the incredible popularity of mobile phones. Currently 3.358 million people have cellular phones, one of the highest densities in the world with that number still growing by 46% a year. The volume of international calls which has been rising steadily for years, dropped in 1998 by .047 percent. It is a tough call whether this is a result of the substitution of e-mail for phone calls or a reflection of Hong Kong and Asia's economic downturn.

The Culture
With strong ties to its British heritage, Hong Kong is a bilingual (English and Chinese) society. English can be used to communicate digitally to most of the world. Conversing with neighboring communities in Chinese can bridge the language gap between China and the rest of the world. Hong Kong's openness to foreigners and different cultures allow the merging of the best of both technologies and knowledge.

Relationship between Hong Kong & Taiwan
Hong Kong is the major intermediary between Taiwan and the Mainland in terms of trade and investment. No direct trade or other direct forms of commercial or official contact have been allowed between Taiwan and the Mainland since the Communist victory in 1949. Though Taipei allowed the resumption of direct trade in the 1980s, no direct shipping is allowed. Over 3,000 Taiwan-controlled companies operate in Hong

Kong, and an estimate 50,0000 Taiwan nationals work in Hong Kong. These companies account for the bulk of the estimated US$25 billion that Taiwan invests in mainland China and are the principal conduit for US$20 billion in trade. As Taiwan integrates Internet-enabled inter-enterprise information technology, the technology may diffuse through some of these companies to Hong Kong firms.

Relationship between Hong Kong and China

Hong Kong plays a very significant role in trade between China and the West. In the next section on Guangdong we will examine this relationship.

III.   Guangdong

Figure 5: Map of Guangdong

Guangdong province, with Fujian to the east, and Hong Kong to the south is the largest province in southern China. It occupies 170,760 square kilometers and has 20 cities, 77 countries, and 41 city districts. It was set up in 1370 AD with Guangzhou as its capital. Its population is about 71.4 million, the fifth most populous province in China. It has the highest number of Internet users out of all provinces.[18]

The Central government, through its Open Door policy, has given Guangdong a significant degree of economic autonomy. As a result, three cities from Guangdong, Shenzhen, Zhuhai and Shantou, were designed as special economic zones. In 1988, the central government allowed Guangdong to experiment with economic reforms throughout the province allowing it to develop into an export-oriented economy. Guangdong is regarded as China's frontier to the outside world. Many Hong Kong businesses have shifted manufacturing to Guangdong cities like Shenzhen.

The Gross Domestic Product (GDP) grew by 30% from 609.7 billion RMB (US$ 74.35 billion) in 1996 to RMB 793.7 (US$ 96.79 billion) in 1997. The economy was growing very quickly in 1996 and 1997. Exports grew 20% from US$ 59.346 in 1996 to US$ 75.724 in 1997. However, with the Asian crisis, exports only increased by 4% between 1997 and 1998.[19] While this slowdown was a source of anxiety among policymakers and businessmen, the doubling of this rate of increase in exports to 8% in 1999 has eased many fears.

---

[18] According to the CNNIC survey Beijing, a municipality, has the highest percentage of users in China. Source: "CNNIC July 1999 Internet Survey" (english translation) < http://www.virtualchina.com/matrix/survey-799.html> (Sept. 6, 1999).

[19]"1998 Guangdong Statistical Report from the Guangdong Statistical Bureau," Guandong Statistical Bureau

Table 7: Statistical Data on Guangdong in 1998[20]	
Population	71.43 million
Internet Users	800,000
Internet Users per 100	1.12
Telephones per 100	21.11
Micro-computer Production	748,200
GDP	RMB 793.723 billion, US$ 95,86 billion
Export	US$ 75.724 billion
Import	US$ 54.279 billion
College Students	185,000 regular and 146,400 adult ed.
Graduate Students	8043
Literacy (age 6 and over)	82%

Since 1994, Guangdong has rapidly embraced the Internet. The provincial arm of China Telecom built one of the first provincial backbones and the Guangdong Information Center has put up a significant amount of government information on the Web.

---

[20] Ibid.

Internet Dimensions of Guangdong

Table 8: Internet Dimensions for Guangdong		
Dimension	**Level**	**Explanation**
Pervasiveness	(3) Common	1.11 users for every 100 people
Geographic Dispersion	(4) Provincewide	"163" and "169" networks available in 23 cities. There is no distance chare from rural areas.
Organizational Infrastructure	(2) Controlled	China Telecom is the primary provider of Internet access and controls international circuits. There are many Internet content providers some of whom provide access. Golden Bridge network and CERNET provide commercial and educational access.
Connectivity Infrastructure	(3)	ATM backbone is being constructed. Supports Frame Relay and IP. There is an Internet Exchange and connectivity to Honk Kong and the world.
Sectoral Absoption	(2) Moderate	Internet leased line connectivity is available in most universities but not secondary schools. State Information Office runs web site that provides access to information from various sections of the government.
Sophistication of Use	(2) Conventional	Internet is primarily being used as a substitute for voice and fax. E-mail is very popular. There is some top down efforts to change business processes such as the Golden Projects.

Figure 6:   Kiveat Diagram of Internet Dimensions for Guangdong
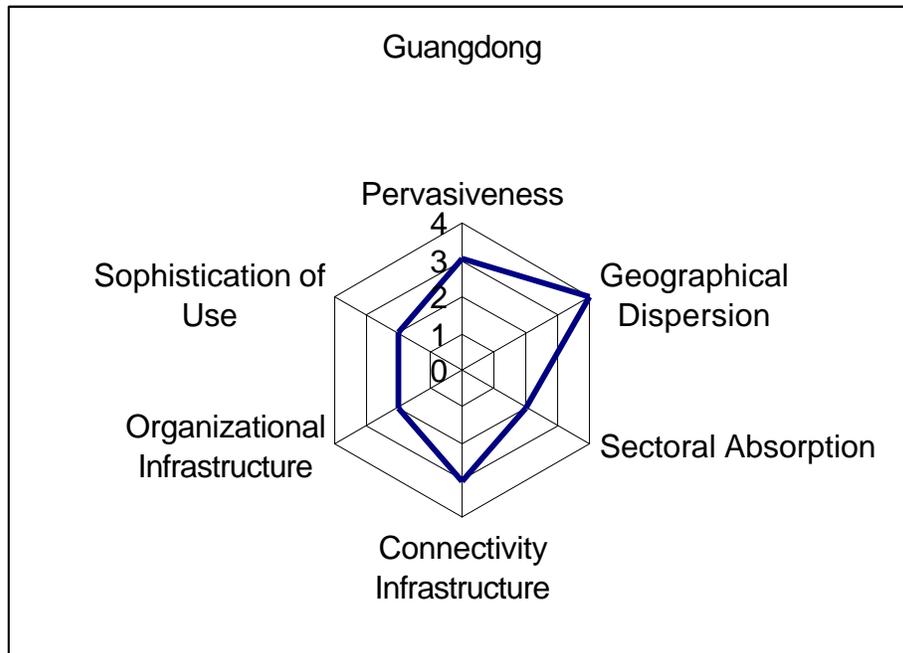
Pervasiveness

As of July 1999, CNNIC reported that 11.7% of the respondents to its survey of Internet use came from Guangdong province.[21] This can be extrapolated into 468,000 users in Guangdong based on the assumption that there are 4,000,000 users in China. The Guangdong Steering Committee of NII estimates that there are 800,000 users in Guangdong.[22] Using the Steering Committees numbers means that Guangdong's Internet users-per-capita is 1.11 for every 100 users.

It is important to keep in mind that counting users in China is difficult because many Chinese Internet users share the same subscription. Table 9: shows the rapid growth in subscriptions to China Telecom's ChinaNET "163" Network and Multimedia "169" Network. Under the standard agreement, users who access the "169" Network have access to all Web sites in China, but do not have access to web sites outside of China. However, they do have global e-mail access.

Table 9: China Telecom Internet Dial-up Subscribers[23]		
Year	**Network**	**Subscriptions**
1997	"163" Network	46,000
1997	"169" Network	43,000
1998	"163" Network	130,000
1998	"169" Network	160,000
1999 (March)	"163" Network	190,000
1999 (March)	"169" Network	210,000

Geographic Dispersion

The Guangdong Internet is highly dispersed. As in other provinces in China, Guangdong's Internet access is connected through the four major networks. They include ChinaNET, CERNET, ChinaGBN, and CSTNet. However, unlike many other provinces in which Internet points-of-presence are confined to only the provincial capital, Guangdong's Internet points-of-presence are now located in most of the major cities in the province.

The nodes of the major networks span throughout the province. ChinaGBN provides Internet access in Guangzhou as GBNet-GZ. CERNET locates its Southern China Regional Network Centers in Guangzhou, provides Internet access to the major universities in Guangdong and nearby provinces, and operates Guangdong Education and Research Network (GDERNET), an organization that serves all the education and research community in Guangdong province.[24] ChinaNET has expanded its provincial nodes from Guangzhou and Shenzhen to cities throughout the province. Currently the "163" Network and "169" Network are available in 23 cities in Guangdong. However,

---

[21] "CNNIC July 1999 Internet Survey," Op Cite.

[22] Xu Zhi Biao, Director Guangdong Steering Committee of NII, personal communication May 25, 1999.

[23] Guangdong Data Communication Bureau, personal communication May 25, 1999.

[24] "GDERNET," <http://www.gznet.edu.cn/gdernet/index.htm> (August 20, 1999)

the phone tariffs are set up so that users accessing the Internet through the "163" Network and "169" Network do not have to pay distance sensitive prices. As a result, Internet access costs the same throughout the province.

Connectivity Infrastructure

The Connectivity Infrastructure of Guangdong is rapidly evolving.   The ChinaPAC X.25 network which can be used to access the Internet has points-of-presence (POPs) in over 21 cities in the province. Guangdong Data Communication Bureau has signed a contract with Newbridge Networks Corp to supply networking equipment for the expansion and upgrade of the province's digital data network (DDN). This upgrade will provide integrated service management of MainStreetXpress 46020 Network Managers across multiple administrations operating in urban networks in cities throughout Guangdong province.[25]

The DDN supports Frame Relay access from 12 cities in the province. Frame Relay access is currently available at speeds up to E-1 (2 MBps). The ATM protocol is used in the backbone of the network to support Frame Relay and Internet Protocol (IP) services. The China Public Multimedia Network, "169" Network, has connected to Guangzhou with large-capacity ATM. According to the GDCB, their next generation network will be based on running the IP protocol on top of the ATM protocol.[26] They are currently testing equipment from six different vendors for this next generation of network. China Telecom is also rolling out a CDPD service that provides wireless data communications. It is currently conducting an IP telephony trial service.[27]

The Guangdong Wireline TV Corp has significant potential for providing high-speed access to the home. At this point, only a few hundred cable modems have been installed as part of this trial.[28]

China Telecom is also planning on being able to install ADSL by the year 2000. Currently, however, there are legal problems engendered by the potential of ADSL to support video on demand—the domain of the TV company.[29]

---

[25] "Guangdong PTA awards DDN contract," Computerworld Hong Kong (February 1998).
[26] Guangdong Data Communications Bureau, personal communication, May 25, 1999.
[27] Ibid.
[28] Xu Zhi Biao, Op. Cite.
[29] Ibid.

Organization Infrastructure

The Guangdong Data Communications Bureau (GDCB), part of the Guangdong Telecom Bureau, supports 90% of all commercial users in Guangdong. The Guangdong Telecom Bureau is the provincial body of China Telecom.   Internet access is sold through the city telecom offices such as Guangzhou Telecom.

Table 10: China Telecom		
Scope	**Body**	**Web Address**
National	China Telecom	http://chinatelecom.cninfo.net
Provincial	Guangdong Telecom	http;//www.gdcb.gd.cn
City	Gungzhou Telecom	http://gztelecom.com.cn

Besides China Telecom, there are many ISPs in Guangdong (see Table 11). Most of the ISPs have built portal sites with links to sites of interests and very powerful Chinese web site search engines.

Table 11: Major ISPs and Content Providers in Guangdong	
Feihua Telecom	http://www.fhnet.cn.net/feihua
Guangzhou Netease Computer System Ltd.	http://www.nease.net
Karsing Online	http://www.kol.com.cn
Great Trend Internet Services	http://szwd.net.cn
Shenzhen Newsnet	http://newsnet.szppt.net.cn

The city branches of China Telecom have also built portal sites. Guangzhou Telecom, for instance, runs gznet.com. GDCB was a pioneer in developing the 21cn.com portal site of the "169" multimedia network. This site is one of many city and provincial sites that can be accessed through the cninfo.net domain.

Sectoral Absorption

The public sector has an extensive Web presence. This presence has been developed by the information offices of the province and each city. GDNet, run by the Guangdong Information Center, has extensive statistics on economic indicators at the provincial and national level.[30] It has global news, market prices, commerce regulations, stock quotes from the Shenzen exchange, and health care statistics. GDNet also plays a matchmaker function by providing requests for quotes from around the world. Though the information provided is extensive, it rarely links to separate web sites of the various branches of the government which gathered the information. This is probably due to the fact that most of the branches of the provincial government do not yet have their own departmental web sites. There is a separate Guangdong government domain that provides information on the various provincial decision-making bodies. This sites are maintained by the Guangdong Information Center. The city information offices also have their own websites that provide information on the city and its government. Both the provincial and city sites are part of the China Economic Information Network

---

[30] "Guangdong Information Network," <http://www.gd.cei.gov.cn> (July 28, 1999).

(CEInet) that is operated by the State Information Office. The city, provincial, and national sites all point to one another a reflection of the fact that they are all loosely organized brances of CEInet.

Table 12: Information Offices		
Network	**Body**	**Web address**
China Economic Information Network (CEInet)	State Information Office	http://www.cei.gov.cn
Guangdong Information Network	Guangdong Information Center	http://www.cei.gov.cn http://www.gdic.gd.gov.cn/xxzx_e.htm
Guangzhou Information Network	Guangzhou Information Office	http://www.203.207.178.12

Guangdong's moderate sectoral absorption is explained in Table XX.

Table 13: Sectoral Absorption in Guangdong		
Academic	2	Most universities in Guangdong have Internet access provided by CERNET
Commercial	2	10-90% of business with more than 100 employees have Internet servers
Health	1	Less than 10% of hospital and clinics have leased-line Internet connectivity
Public	2	10-90% of government entities have Internet servers

Is has yet to be seen whether the development and availability of a videoconferencing network based on an high-speed ATM exchange will have a significant impact on either the commercial or health sectors. The regional communications and network systems integrator, Datacraft Asia, will design and build a high-performance distance videoconferencing network in Guangdong. Hongkong Telecom, China Telecom and the Guangdong PTA have joined networks to sponsor the first cross-border ATM-based telemedicine trial, linking several hospitals and universities between Guangdong and Hong Kong.[31]

Sophistication of Use
Guangdong has not broken out beyond the conventional level. For the time being, sending e-mail, reading the newspaper, and accessing "169" Multimedia Network are three of the major reasons why Guangdong people are online. Regarding online newspaper readership, the web site of South China Daily group in Guangdong Province were visited by more than 400,000 people in June of 1998. Business to Business e-commerce is being talked about, but few companies have implemented it or have re-designed their business processes to take advantage of it. Only a few companies have implemented EDI, mainly in conjunction with the Golden Gate project, discussed in the next section. The GDCB is promoting digital signatures to support e-commerce.

---

[31] Megan Scott, "Hong Kong, China in telemedicine trial," *Computerworld Hong Kong* (August 1998).

Determinants

As reflected in Table 14, the dimensions of Internet diffusion in Guangdong are created through the interaction of governmental (top-down) policies with the dynamism that has been created by economic opportunity.

Table 14: Determinant Impact on Internet in Guangdong	
Determinant Quality	**Affected Dimension**
China Telecom's drive to expand infrastructure and integrate state of the art technologies.	Lowers organizational infrastructure Raises pervasiveness, geographical diffusion.
National Informatization efforts (Golden Projects)	High absorption in S.O.E.s and government. May increase sophistication of use if business process are re-engineered.
National Commitment to Education	High absorption in academic and research sectors. Large number of students increases pervasiveness. Educated student pushes sophistication of use.
Communist Party's Commitment to Economic Growth	Open Door Policy Increase in competition (China Unicom, Cable Network).
Proximity to Hong Kong	Increases pervasiveness, sophistication of use, sectoral dispersion.
Strong Economy	Increase pervasiveness, sectoral dispersion.
Electronic Industry participation in Global Silicon Network	Increases business sectoral dispersion and sophistication of use.

Role of Government

The government is an integral part of technology development. As Lovelock points out, the development of the Internet and E-commerce in China is primarily a top-down effort on the part of the Chinese government because it believes that not only will the Internet boost the economy but it will greatly enhance the central government's ability to control the country.[32]

---

[32] Peter Lovelock 'E-China: Why the Internet is unstoppable'*, China Economic Quarterly*, Vol.3, No.1, first quarter 1999, pp.19-35.

China Telecom

China Telecom is committed to building a nationwide Internet Protocol (IP) backbone and rolling out both the "163" ChinaNET and the "169" Multimedia Network. Though China Telecom continues to lose money on its IP services, it makes it up in the per minute local telephone charges for accessing the networks.[33] China Telecom, as a matter of both national and organizational interest, is plowing the huge cash flow generated by Internet services back into the network.

China Telecom's provincial arm, the GDCB, is taking the initiative in rolling out a provincial ATM backbone and developing new value added services such as IP-telephone and electronic commerce. In the interests of providing the tools to support e-commerce, the GDCB developed its own certificate authority for authenticating servers well ahead of the development of national policy. In the case of the certificate authority, the People's Bank has put a hold on its rollout by the GDCB.

Ministry of Education

The Central government's investment in a nation-wide education network (CERNET) has given almost all university students exposure to the Internet and has been one of the most effective ways through which the government has pushed Internet diffusion.

Golden Projects

In 1993, the Chinese central government embarked on a series of Golden Projects to give the central government information on and control over the rapid decentralization of decision making that was taking place as a result of the move to a market economy.

The Golden Bridge Project connects ministries and State Owned Enterprises (SOE) through an IP network and provides support for the other Golden Projects.

The Golden Card Project aims to promote the use of credit cards by providing a credit card verification scheme and an interbank, inter-region clearing system.

The Golden Tax Project computerizes work unit tax receipts and enables the electronic transfer of funds.

The Golden Gate Project aims to improve the import-export trade management by linking the Ministry of Foreign Trade and Economic Cooperation, trade organizations, and the Customs Bureau. It uses EDI and provides access to statistical databases. The Golden Gate Project aims to both make the customs process more efficient but it also aims to give the government better monitoring power over the more than 9000 trading organizations in China. It is hoped that such monitoring will reduce smuggling. Many of the SOE's that have implemented EDI as part of the Golden Gate Project have been slow to extend the use of EDI to their customers and suppliers.[34]

---

[33] Guangdong Data Communications Bureau, personal communication May 25, 1999.
[34] Ibid.

The central government is particularly concerned about improving its ability to monitor the rapidly expanding companies in Guangdong. The central government has been shaken by the ability of companies to hide massive foreign debts as in the case of Guangdong International Trust and Investment Corporation that is now bankrupt.

It is very difficult to estimate how many firms in Guangdong are resisting implementing effective information systems out of fear that the central government will be able to monitor, tax, and control them more effectively. The lack of such systems will impede the use of the Internet to support higher levels of electronic commerce.

The provincial government has a Steering Committee on the National Information Infrastructure (NII) that sets policy for the province on information technology and the Internet. The Steering Committee is appointed by local government and is associated with the Guangdong Province Information Center.[35] The Center was established in 1997 as a "co-department institution" under the Guangdong government, being controlled by the planning commission. The Center's 108 employees work with over 700 others from the 20 cities and 100 counties in Guangdong. The Center has a broad mandate to be responsible for the organization and direction of the informatization of the economy. It gathers a wide range of macroeconomic indicators and makes them available through the CEInet site GD Information Network that was discussed earlier.

The Steering Committee contracts with the Center to implement various projects. The Center is responsible for building the networks for the provincial government and the Communist Party, and supporting their office automation. In this role, there has been some tension with China Telecom over the extent of resources China Telecom should provide to the government. The Center has also been responsible for the development of databases for a wide range of organizations including the Shenzhen Union Exchange and the GD Highways Company. The Center runs the GDIX, an Internet Exchange that connects the research, provincial government and educational networks with ChinaNet. Presently, the GDIX is testing a connection to HKIX, the Internet exchange in Hong Kong.

As mentioned earlier the Center's GD Information Network has a great deal of information drawn from many sectors of the government and the economy. It is an open question as to how individuals and businesses in Guangdong are utilizing this rich data environment. Another interesting question is why the GD Information network is much richer than the information services provided by Fujian and other provinces. The influence of Hong Kong and the sophistication of Internet use in Guangdong can be seen in the quality of the GD Information Network.

According to Xu Zhi Biao, now the Director of the office of the Guangdong Steering Committee of NII, the government's strategy for promoting the informatization of the province involves these steps:

---

[35] "Guangdong Province Information Center," (english) < http://www.gdic.gd.gov.cn/xxzx_e.htm > (July 25, 1999).

- Putting government information on line
- Reforming laws and regulations to support e-commerce
- Encouraging vendors to do business with the government electronically[36]

The Steering Committee has embarked on a project promoting enterprises to go on-line which starts with getting an e-mail account and progresses to getting a web page. The Steering Committee is also concerned about providing an infrastructure that will support the spread of the Internet and informatization.

Open Door Policy

Though the provincial government has easily adopted information technology, Guangdong's rapid absorption of the Internet relative to the other provinces can primarily be attributed to its economic growth as a result of the Open Door Policy. In 1979, the State Council gave Guangdong permission to implement special economic policies. As a result, three cities from Guangdong, Shenzhen, Zhuhai and Shantou were designed as special economic zones. In 1988, the central government allowed Guangdong to experiment with economic reform province-wide. Guangdong has developed into an export-oriented economy and is regarded as China's frontier to the outside world. The relative prosperity of the province has allowed people to purchase Internet services. In addition, the Internet represents a significant opportunity for time and cost savings for those individuals and companies involved in international trade and, through the web, opens up access to highly valuable information.

Migration

Guangdong's open door policy and the resulting economic boom have attracted entrepreneurial and technical talent from throughout China. Guangdong and its private companies are often the destination for the cream of China's youth that fail to land positions in Beijing and Shanghai. Many of these migrants have an aptitude for technology and have been early adopters of the Internet. In addition to attracting risk takers from throughout China, Cantonese culture has traditionally been commerce friendly and has been a fertile ground for entreprenurial Internet companies.

Over 20 million people have emigrated out of Guangdong to Hong Kong and other countries. These overseas Chinese still have connections and influence with their family and friends who remained in Guangdong. E-mail is being extensively used to support those connections.

High-tech Multinational Companies

Multi-national companies have been attracted to Guangdong as a gateway for both manufacturing and selling in China. The Institute for the Future recognizes Shenzen as a key node in the Global Silicon Network. As part of doing business with these high-tech multinational firms, Guandong's businesses are exposed to the latest in information technology and are sometimes required to implement it as part of the their trading agreements. Multi-national companies also see Guangdong as a major market for their technologies and a gateway into the rest of China. For example:

---

[36] Xu Zhi Biao, Op. Cite.

- Cisco Systems and Lucent Technologies are upgrading Guangdong's telecommuications infrastructure .
- Intel is making special chips that allow Guangdong users to share the same online subscription.
- Compaq is building the first E-commerce Technology Center in Guangzhou.
- Microsoft is making Chinese software and implementing Web TV in Guangdong.

Relationship between Hong Kong and Guangdong

Guangdong's attractiveness to Hong Kong as a base for manufacturing operations could create one of the most symbiotic partnerships in Asia. This interconnection is happening across most sectors of Chinese society.

The main push for connectivity between Guangdong and Hong Kong is to expand research capabilities. Universities can share electronic libraries or expand joint research programs to better understand their objective. For instance, a joint program with Chinese Academy of Sciences and the Chinese University of Hong Kong is conducting a Joint Laboratory for GeoInformation Science (JLGIS). The technology plays a key part in sharing and promoting geographical information. Some of the participating cities include Beijing, Shanghai, Taipei, Kao-Hsiung, Tianjin, Chongqing, Guangzhou, Shenzhen and the Hong Kong Special Administrative Region.[37] The Joint Universities Computer Center Limited HARNET connects the eight main universities of Hong Kong to other international institutions primarily in China.[38]

The government is strongly pushing information technology. Plans such as Digital 21 have included goals for connectivity to the Mainland from Hong Kong. The first to be implemented is the trial dedicated circuit between the Guangdong Internet Exchange run by the Guangdong Information Office and HKIX.

Guangdong companies must have e-mail if they want to continue doing business with Hong Kong. It is an open question as to how quickly Hong Kong businesses will build inter-enterprise resource planning systems that use information technology to distribute decision making across the virtual enterprise.

Surprisingly, the health sector is keeping up with technology. Through the help of strong Telecom giants like Hong Kong Telecom, China Telecom, and Guangdong Posts

---

[37] Academic Exchange, Joint Laboratory for GeoInformation Science (JLGIS) <http://jlgis.geo.cuhk.edu.hk/Index_e.htm>(April 28, 1999).
[38] "HARNET," http://www.khu.hi/jucc/harnet.html , (April 28, 1999).

and Telecommunications the health sector has explored new applications and telemedicine trials across ATM technology.

IV. Republic of China (Taiwan)

Figure 7: Map of Taiwan

Approximately four fifths of Taiwan's 22 million people are decendents of Chinese imigrants. This imigration started in the 17th century. Following the victory of the communists on mainland China in 1949, 2 million Chinese nationalists immigrated to Taiwan. Taiwan has become a center for manufacturing particularly in the electronics industry and its GDP per capita has reached $14,200.

Table 15: Taiwan Statistics December 1998	
Population	21,908,135
GDP	US$ 308 billion
GDP Per capita	US$ 14,200
Main Lines	11,220,000
Mobil Phones	4,261,000
Pager	4,261,000
ISDN	11,000
Literacy	92.65%

Dimensions of Internet Diffusion in Taiwan

Table 16: Dimensions of Internet Diffusion in Taiwan		
Dimension	**Level**	**Explanation**
Pervasiveness	(4) Pervasive	1.6 Internet users per hundred population. 676,623 hosts in either '.TW' or 'HINET.NET' domains.
Geographic Dispersion	(4) Nationwide	No premium for accessing Internet from remote areas.
Organizational Infrastructure	(3) Competitive	The three government related ISPs dominate industry.
Connectivity Infrastructure	(3)	Chuangua operates a 155 Mbs nationwide ATM backbone. There are 301.34 Mbs of international IP bandwith. ADSL and Cable modems are being rolled out this year.
Sectoral Diffusion	(3) Common	Sectoral dispersion is evolving towards the widely used level. Internet access is being rolled out to all classrooms and is available in all universities.
Sophistication of Use	(3) Transforming	Being driven by their multinational partners, electronic companies are reworking business processes to leverage the Internet.

Figure 8:   Kiveat Diagram of Internet Dimensions for Tawian
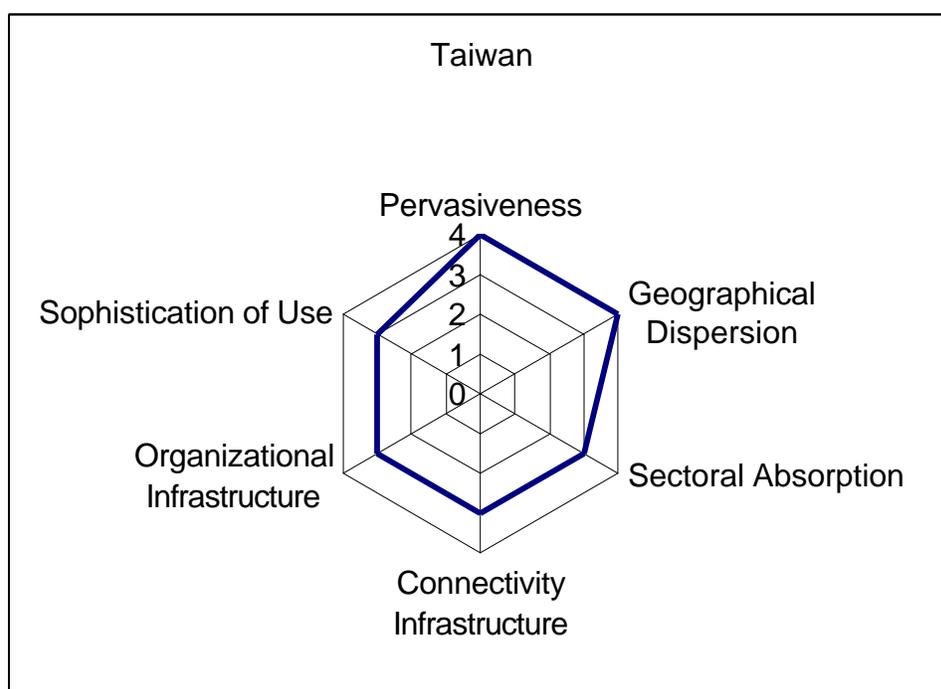
Pervasiveness

Taiwan's Internet user base continues to grow rapidly. As of June l997, the population of Internet users was about 4,300. By the beginning of 1999 the population had reached 3 million and by June of 1999 the number of Internet users had reached 4 million.[39]

Table 17: Growth of Internet Users in Taiwan

Growth of Internet Users in Taiwan

Internet users in thousand

Source: FIND/ITPD, III
NII project, supported by DOIT (Department of Industrial Technology), MOEA
http://www.find.org.tw/
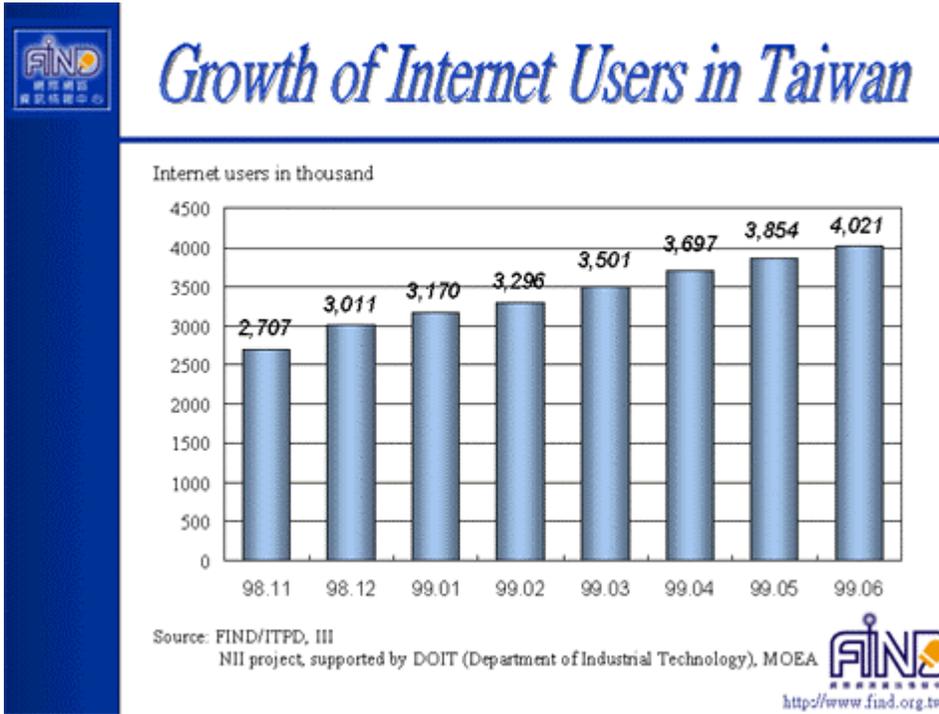
According to Network Wizard, there were 424,209 hosts in the .TW domain.[40] In contrast there were 252,414 hosts connected to the domain of Taiwan's largest ISP, "HiNet.net", making it the 23rd largest network in the world.[41] Combining the two numbers results in over 676,623 hosts.

Geographical Dispersion

Dial-up Internet usage is available throughout Taiwan and on the surrounding islands. There is no premium charged for access to the Internet from remote areas for it is government policy to promote universal availability. HiNet, the ISP of state owned

[39] "Growth of Internet Users in Taiwan" < http://www.isoc.org.tw/how_many/199906_01.htm> (September 6, 1999).
[40] "Top Level Domain Names," (July 1999) http://www.isc.org/dsview.cgi?domainsurvey/index.html (September 6, 1999).
[41] "Second Level Domain Survery," (July 1999) http://www.isc.org/dsview.cgi?domainsurvey/index.html (September 6, 1999).

Chunghwa, has built out its network accordingly. Both HiNet and SeedNet have built out ATM networks that span the Taiwan Island. Though most of the international connectivity comes through Taipei to the north, there are some international IP lines running into Kaosung in the south.

Organizational
Though there are 50 Internet access providers, the 3 government owned ISPs dominate the marketplace. HiNet, the arm of state owned Chunghwa, has over a million users, 50% of the dial-up commercial users, over 2000 dedicated connections, and 63,000 dial up ports. Chunghwa Telecom was established in 1996 as a state-run enterprise, separate from the regulatory body of the Directorate General of Telecommunications (DGT). Chunghwa inherited all DGT customers, telecom networks, and exclusive rights (currently under reconsideration) over the local loop. SeedNet was formerly separated from the government in June, 1999. Seednet was formed in July 1994, but has its roots in a pilot project of the Ministry of Economic Affairs dating back to 1989. It has 510,000 users on 8,800 ports. It is the largest web hosting service in the country and currently hosts over 700 web sites. It has developed merchant and payment facilities based on micro-payments, SSL, and SET. TANet, the networks of the universities, was founded in June of 1992. It has over 1.1 million users. As we noted earlier, university students get an account as part of enrollment with no charge for use.

Taiwan, with its 50 ISPs, has many of the characteristics of a competitive organizational infrastructure. HiNet, Seednet, and TANet, three of these ISPs, have the strongest government ties. By dominating the market they have a negative impact on competition.

Connectivity Infrastructure
Taiwan's connectivity infrastructure is expanding rapidly. There is currently 301.34 Mbps of IP bandwith between Taiwan and the rest of the world. The National Backbone is 155 Mbps ATM backbone of Chunghwa, soon to be upgraded to 655M bits per second.
During 1998 and 1999, Chunghwa installed eight ATM backbone switches and 11 ATM access switches to cover the entire island with an high-speed backbone for public data communications including support for HiNet. Chunghwa has not made any major commitments to IP over DWDM primarily due to concerns about quality of service. They are planning trials of DWDM, but primarily as transport for SDH and ATM. The fact that no competitors are rolling out IP over DWDM with its intrinsic cost saving over IP/ATM solutions partly explains this lack of interest in a technology that is taking other parts of the world by storm.
There is a Taiwan Exchange that provides interconnection for some of the more than 54 ISPs in Taiwan. The exchange also provides interconnection with HiNet.
Chunghwa currently has 500 ADSL users in a multimedia trial offering video on demand, karoke, and high speed internet. It issued a tender in January 1999 for DSLAM capability for 20,000 ports. In addition, there is also the commitment in 1999 to offer high schools and primary schools access to the Internet through ADSL. These lines for schools are discounted at over 50%.

Koo's Group began offering cable modem access to the Internet in 1999. The cable modems which are manufactured by 3Com depend on a PSTN modem for the upstream connection. Taiwan's cable TV industry has more than 80 percent penetration, making Taiwan one of the most heavily cabled markets in the world. Two groups dominate Taiwan's cable TV industry: the United Communications arm of Koo's Group and China Rebar Corporation's Eastern Multimedia. Though there were originally 618 cable TV operators, Koo's Group and China Rebar are now the major players and control 26 and 20 cable operators respectively. Both are expected to be major players in bids for new fixed telecommunications network service (FTNS) licenses.[42]

Sectoral Dispersion

Sectoral dispersion in Taiwan is rapidly moving from common to widely used. All universities in Taiwan are connected through the TANet. Though this network at times can be slow, it does provide basic Internet access to almost all college students in Taiwan.

The government has allocated money to build elementary school Internet classrooms and promote information education this year. June of 1999 was the target date for all elementary schools to have established Internet classrooms. One of the innovations being introduced is "Tele-Homework" in which homework is communicated to parents over the Internet along with other necessary communications from the parents.

Business connectivity for businesses with over 100 employees is at the moderate level. More than 10% of business have leased line connectivity, though penetration rates are still well below 90%. Businesses are realizing the importance of having a web presence and providing Internet connectivity to their employees.

Hospitals and clinics are being integrated into the net. The government has a strong web presence. Four hundred and forty seven government agencies have leased lines and 5,374 dial-up accounts have been provided to various agencies.[43]

Sophistication of Use

Business-to-business e-commerce in Asia to date is being spearheaded mainly by multinational corporations, such as Intel and Cisco. They are pushing their customers and suppliers in the region to embrace the Internet for order taking. Microprocessor giant Intel, for example, is already doing over 80% of its sales to Taiwan over the Web. However, Synnex, an Intel distributor, is still a ways from taking all orders via the Internet.

Taiwan's hardware manufacturing is integrating information technology much more rapidly than other industries. There is a story circulating about a company which

---

[42] P. Reali, W. Sheppard, "Cable versus xDSL in Taiwan: The Battle for Survival Begins," Dataquest, 12 February 1999, http://advisor.gartner.com/ninbox/hotcontent/hc 2241999.html, (June 8, 1999).

implemented ERP and was able, through the use of new technology, to manufacturer products within four days. Managers of these companies are willing to re-engineer business processes to take advantage of information technology. Much of Taiwan's hardware industry is made up of small manufacturers linked together through highly flexible business relationships. It is these business networks that give Taiwan its speed and agility. As information technology is integrated into the enterprise, it will also be integrated into the inter-enterprise. Taiwan's hardware manufacturing industry should be watched closely for signs that the inter-enterprise relationships are being automated.

Business to consumer e-commerce is developing fastest in the on-line stock brokerage industry. There are over 20 on-line stock brokerages in Taiwan and trading is a particular favorite of Internet users.

Determinants

Table 18: Determinants of Internet Diffusion in Taiwan	
Determinant	**Dimension Impacted**
NII Plan	Potential to influence all six dimensions.
Telecommunications Policy	Impact organizational infrastructure and through that all five other dimensions.
Computer/Electronics Industry strength	Increases sophistication of use and sectoral diffusion.
Telecommunication Infrastructure	Increases pervasiveness and connectivity infrastructure.
Ties to Global Silicon Network in terms of flows of technology, money, people, and ideas.	Increases sophistication of use.
Competition between Hong Kong and Taiwan to be Internet hub	Increase investments in connectivity infrastructure.
Relationship between Taiwan and Fujian	By impacting economy can influence all six dimensions.

Role of Government
The government has sought to drive information technology through the National Information Infrastructure project, a supra-ministry endeavor that has been able to drive investment and decision making through many different ministries. The NII plan has had five goals:

1. Promoting the use of Internet with the target of reaching three million Internet users in three years from 1997
2. Putting every middle school and every primary school on Internet
3. Developing Taiwan as an Asia-Pacific regional hub for Internet
4. Establishing a "Global Chinese Content Center"
5. Developing new industries of network and multimedia

The NII Steering Committee, which includes all the ministries, commissions, councils, and agencies of the Executive Yuen or Cabinet, was founded in August 1994.

The NII Steering Committee facilitates NII development through deregulating telecommunications and improving related laws. It also aims to expedite network construction through the development of network exchanges, broadband networks, and interconnection of the telecommunication and CATV networks. It aims to integrate computer and network education into all academic levels. The government is committed to extending the application of information technology, developing net-related industries, and enhancing research and development.

The Committee realizes the importance of projecting itself internationally through cooperation with international bodies and projects associated with the Internet. Finally, the government seeks to prevent computer crime and pornography by improving the detection and prosecution ability of the "Center for Preventing Computer Crime" in the Prosecutor's Office of the Supreme Court and the "Computer Crime Detecting Team" in the Department of Police Administration. It seeks to improve the function and skill of the Taiwan Computer Emergency Response Team (TWCERT). There is a public component of information security and the plan calls for invoking the power of the masses to create an environment conducive to security. The plan also recognizes the importance of international cooperation.

Information Hardware Manufacturing
The information hardware industry in Taiwan reached 30.4 billion US dollars in 1997. Taipei is a node in what the Institute of the Future calls the Global Silicon Network. Because many managers in this industry were educated in America or worked in Silicon Valley, these Taiwanese firms have strong investment ties with electronics firms in the US and around the world. They are aware of the latest developments in hardware manufacturing including the use of information technology to re-engineer business processes. Not surprisingly, it is the information hardware manufacturing industry that is making the most sophisticated use of the Internet in Taiwan.

Domestic Content
There is a significant amount of domestic content in Chinese in Taiwan. There are a relatively large number of hosts so many organizations are gotten on the Web. This in turn increases pervasiveness as users go on-line to access the Web.

Familiarity with the West
Because of Taiwan's ties to the Global Silicon Network, many Taiwanese have been exposed to the West. They have studied English in school and can utilize the English resources of the Web.

Competition with Hong Kong
There is a desire on the part of Chunghwa, the national government, and even some businesses to make Taiwan a hub of the Internet. Some degree of national pride is

involved, finding expression in the deployment of international IP circuits both to the US and to other regional counties.

V.   Fujian

Figure 9: Map of Fujian

Fujian lies north of Guangdong between longitudes 115°50' and 120°43' east and between latitudes 23°30' and 28°22' north. On the east, the narrow Taiwan straits separate Fujian from Taiwan. Fujian province has seven municipalities (Fuzhou, Xiamen, Putian, Sanming, Quanzhou, Zhangzhou and Namping) and two administrative prefectures (Ningde and Longyan). The population is 32.39 million in 1995, about 2.67% of the national total.

Table XX: Statistics for Fujian 1998[44]	
Population	32.39 million in 1995
GDP	333 billion RMB (US$ 40.6)
GDP per capita	10,280 RMB per person (US$ 1,254)
Phone Lines per 100 Population	16.56
Export	US$ 12.073 billion
Import	US$ 7.147 billion
PCs Manufactured	156,650
College Students	85,100 (regular) + 59,500 (adult ed.)
Graduate Students	3281
Literacy (for above age 6)	82%

---

[44] "98 Fujian Statistical Report", <http://cities.fz.fj.cn/Fujian_w/jianjie/c-index.html> (August 4, 1960)

Internet Dimensions of Fujian

Table 20: Internet Dimensions of Fujian		
Dimension	**Level**	**Explanation**
Pervasiveness	(2) Established	
Geographical Dispersion	(2) Moderately Dispersed	X.25 is available throughout the province. New ATM network will have nodes in nine cities.
Organizational Infrastructure	(2) Controlled	Fujian Telecom dominates Internet access market and international connectivity.
Connectivity Infrastructure	(2)	Level will soon rise as Fujian Telecom is upgrading X.25 network to ATM network..
Sectoral Dispersion	(2) Moderate	Internet is most integrated in research and academic communities.
Sophistication of Use	(2) Conventional	Internet is being used to replace voice and fax. E-mail is the major application
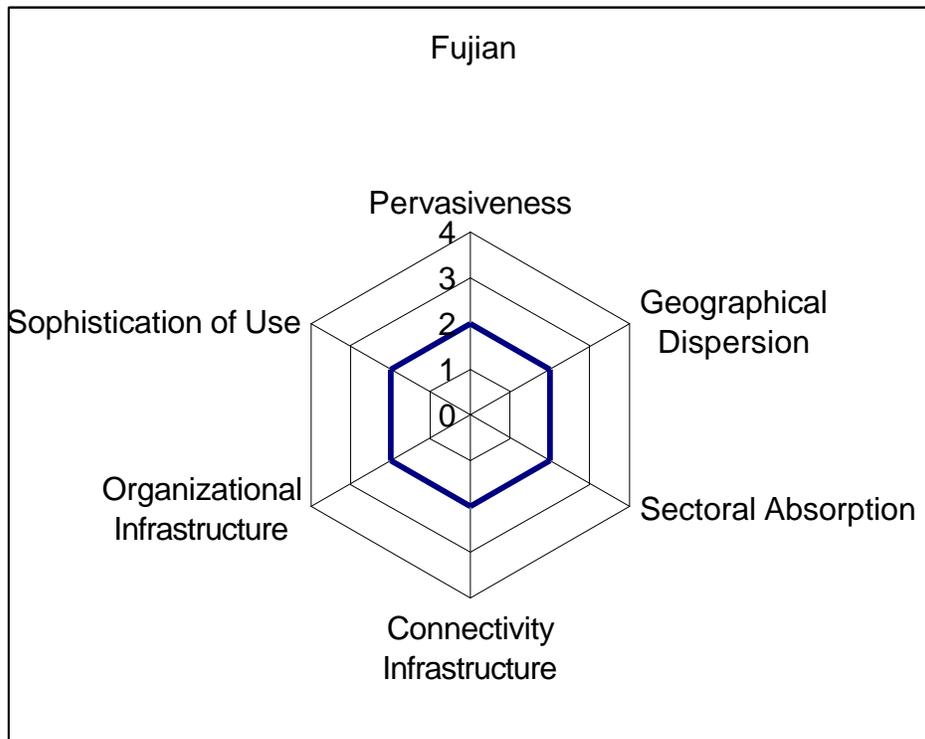
Figure 10:   Kiveat Diagram of Internet Dimensions for Fujian

Pervasiveness

The CNNIC survey in July 1999 estimated that 3.72% of respondents resided in Fujian. Taking the CNNIC estimate of the number of users at 4 million for the whole country, we can extrapolate that there are approximately 148,800 users in Fujian. The number of users within Fujian is probably higher though the boundaries are within an order of magnitude.

Geographic Dispersion

The existing X.25 network covers the whole province and can be used to access the Internet. Computers and LANs can also connect to the Internet through the DDN network. This network is being superseded by a new ATM network. The initial ATM network deployment will include the installation of switches in nine different locations. Fuzhou, Xiamen and Quanzhou interconnect at 155Mbps, while the rest of the municipalities have to connect to either Fuzhou or Xiamen.[45]

Connectivity

Fujian Post and Telecommunication Authority supports Internet access through two Cisco 4500 routers in Fuzhou and one in Xiamen. Fuzhou connects via an E1 connection to Shanghai and one 448k circuit to Guangzhou.

Fujian is making a major technology leap with the installation of a province-wide ATM network. Instead of just building an IP network on top of DDN with its maximum speed of 2 MBps, the Fujian Post and Telecommunication Authority has decided to deploy an ATM network with the IP capability. This backbone has a speed of 155Mbps and it will become the backbone of the "169" network.

Fujian considered but chose not to integrate a "super router" strategy that would save the cost of the ATM switches by running the IP protocol directly on fiber without ATM. Their justification for doing so was because this technology is still new and does not support quality of service. Given the interest in IP over DWDM in China this year, this strategy of implementing IP on top of ATM will be second guessed.

Fujian has implemented DWDM. In 1998, Fujian Posts and Telecommunications Administration choose Lucent Technologies' WaveStar™ optical networking technology to create a state-of-the-art network.

Organizational Infrastructure

As in Guangdong, the Fujian arm of China Telecom offers Internet access through its "163" and "169" dial-up services. Though there are private ISPs, 90% of the customers in Fujian are serviced by the PTT. Because most ISPs must buy Internet connectivity from China Telecom at prices that make it difficult to compete, the organizational infrastructure in Fujian can still be said to be controlled.

---

[45] http://netcity.fz.fj.cn/newspaper/magazine/magazine/98k10/1.htm (April 20, 199)

Sectoral Absorption

As it is throughout China, the Internet is most integrated in the research and academic communities. Web sites are not uncommon among export oriented companies. Some, but not many, businesses with over 100 people have leased line connectivity. Health sector connectivity is rare.   The provincial government has a fairly developed web presence.

Sophistication of Use

In Fujian the Internet is being used as a substitute for more traditional communication such as fax and telephone. Business processes have yet to be redesigned around the Internet. None of the export oriented web sites show any sign that they are integrated into enterprise databases.

As in Guangdong, there is a top down effort to informatisize the economy and to integrate business to business and business to government e-commerce. However, many companies, particularly those with Taiwanese investors, are not interested in providing the central government with transparent access to their transactions. For this reason, along with cost and complexity, very few of the Taiwanese firms have implemented ERP systems.

Business to consumer electronic commerce faces many of the same challenges that it does throughout the rest of China. The lack of a national clearing system and various cultural and legal factors limit the use of credit cards.

Determinants of Internet Diffusion of Fujian

Table 21: Determinants of Internet Diffusion in Fujian	
Gov't investment in ATM	Increases Connectivitiy Infrastructure.
Gov't information office	Increases government diffusion.
The Economy	Increasing sectoral diffusion and pervasiveness.
Migration from Fujian	Increases pervasiveness.
Cultural	Increases pervasiveness.
Relationship with Taiwan	Increases sophistication of use.
Relationship with Guangdong	Increases connectivity.
Relationship with Central Government	Increases sophistication of use also may hinder it.

Role of Government

The provincial government plays a similar role in Fujian as it does in Guangdong. China Telecom acts at the provincial level through the Fujian Post and Telecommunication Administration and at the city level through city bureaus. As noted earlier, the Fujian Post and Telecommunication Administration has chosen to implement a province wide ATM network and is using DWDM over optical fiber.

There is a Fujian Information Office that maintains a CEINet web site on economic indicators. This site has markedly less information than the Guangdong site.

The Economy
The booming export-oriented companies are both investing in the Internet themselves and are paying their employees the type of wages with which they can purchase a computer and Internet connectivity for themselves and/or their family. The economy, also in turn, allows the provincial and city branches of China Telecom to invest in connectivity and information infrastructure.

Migration from Fujian
One out of every 3 overseas Chinese is from Fujian and there are over 8 million overseas Chinese of Fujian origin. Many reside in South East Asia in countries such as Malaysia and have done very well, some extraordinarily so. There are over 800,000 Chinese of Fujian origin in Hong Kong and Maccao. Eighty percent of the residents of Taiwan have ancestors who come from Fujian.

These overseas Chinese, however, have been willing to invest in their homeland. Though there is no evidence that Fujian's state-of-the-art communication network is being financed by overseas Chinese, it can be assumed that it is being built under the "build it and they will come" assumption. If a state of the art network is deployed around the province, the businesses will spring up to use it.

Cultural
People from Fujian, like their neighbors the Cantonese from Guangdong, come from cultures that are fertile soil for commerce.   As electronic commerce becomes possible in Fujian, it should flourish.

Relationship with Taiwan
Since many residents in Taiwan were originally from Fujian, they can speak the same dialect, an indispensable tool in cultivating the personal connections needed to do business with the local bureaucracy. Though at a physical level most traffic between Fujian and Taiwan travels through the United States, there is a virtual bridge being built that is based on e-mail.

Relationship with Guangdong
 Fujian's leaders want to build a strong economic power like Guangdong, so the provincial government and the provincial arm of China Telecom are investing a lot of money to provide state-of-the-art communications infrastructure throughout the province based on DWDM, SDH, and ATM.

Relationship with the Central Government
As with Guangdong, the Central Government sees information technology as an essential tool for keeping track of the Fujian government and its export-oriented businesses. The Fujian provincial government is responsible for tax collection and

managing relationships with the many Taiwanese businesses that have invested in manufacturing facilities in Fujian. As Taiwan integrates more and more information technology into its manufacturing facilities in Taiwan, Taiwanese investors in Fujian will have to choose between the payoff of closer inter-enterprise integration through IT and the risks that enterprise information systems, which enable that integration, could be used by the central government to collect more taxes and limit undocumented trade.

VI.   Conclusion

Table 22: Comparison of Guangdong, Fujian, Hong Kong, and Taiwan									
				Level of…					
	Population (in millions)	**GDP per capita**	**Internet users per capita**	**P E R V A S I V E N E S S**	**G E O G R A P H I C A L**	**S E C T O R A L**	**C O N N E C T I V I T Y**	**O R G A N I Z A T I O N A L**	**S O P H I S T I C A T I O N**
Guangdong	71.43	$US 01,342	01.12%	3	4	2	3	2	2
Fujian	32.39	$US 01,254	00.46% est.	2	2	2	2	2	2
Hong Kong	06.71	$US 26,800	22.36%	4	4	4	3	3	3
Taiwan	21.90	$US 14,200	13.67%	4	4	3	3	3	3

Figure 21: Comparison of Kivaeat Diagrams for Guangdong, Fujian, Hong Kong, and Taiwan
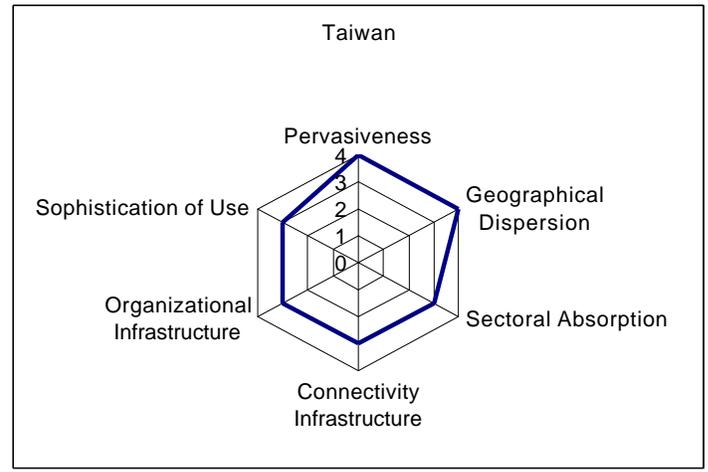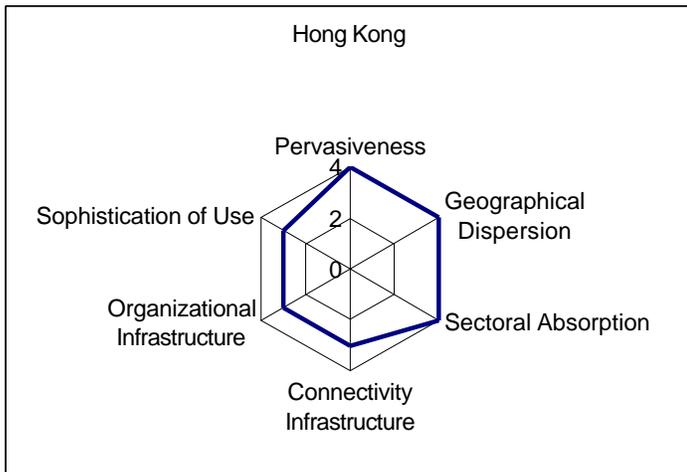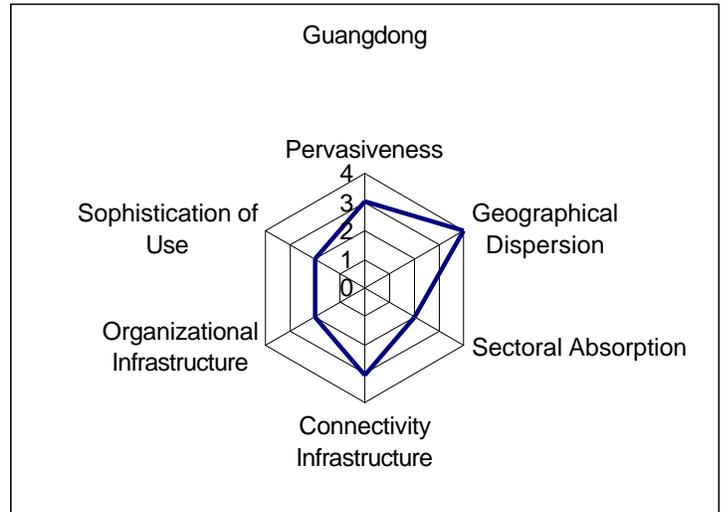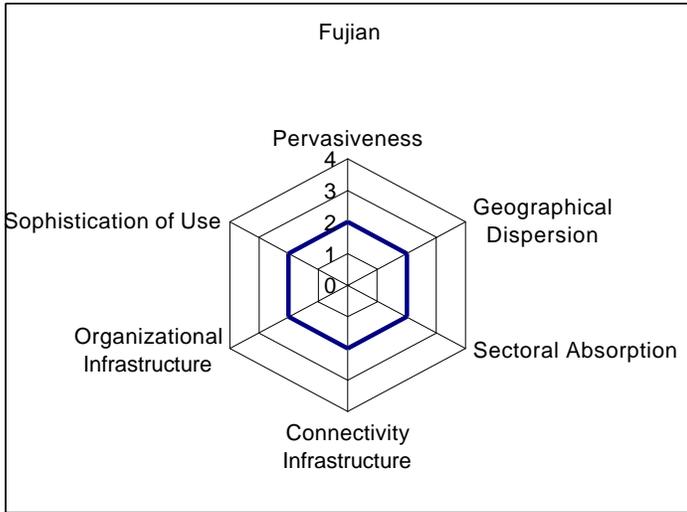
Hong Kong and Taiwan have significantly higher diffusion ratings than Guangdong and Fujian for all six dimensions. This is to be expected given the higher per capita GDP of Hong Kong and Taiwan and their higher degree of integration with the West (see Table 22).

Guangdong is ahead of Fujian because it was the first province in China to build a province-wide IP network. Fujian relied on its X.25 network longer. Now both are moving to provincial ATM backbones which will quickly move them into Level 3 for Connectivity Infrastructure and for Fujian into a possible Level 4 for Geographic Dispersion. Fujian and Guangdong continue to use the Internet as a substitute for conventional communications and have yet to begin to substantially re-engineer business processes to leverage it.

Hong Kong has a significantly higher number of users per capita than Taiwan, in keeping with its status as one of the most wired nations in the world. There has been more real competition in Hong Kong's ISP market than there has been in Taiwan. Hong Kong is further ahead of Taiwan in terms of opening up international links to competitition. Also the different sectors of Hong Kong are slightly ahead of Taiwan in terms of hooking up organizations, but not by much. Tawian does have more (424,209) hosts under its top level domain than does Hong Kong (98,183). Though this difference may at first be dismissed based on the popularity of registering under the ".com" domain, it may point to significantly greater interest in Taiwan on the part of SME's of having a web presence.

Both Hong Kong and Taiwan are behind Singapore in the rollout of broadband services. Regulatory and political problems have delayed the introduction of cable modems in Hong Kong. The choice to deploy one-directional modems in Taiwan, though a short-term technical solution may not be so popular in the long run. Hong Kong will have a real challenge making the broadband market as competitive as its dial Internet market. Even then, the evidence is still not in that broadband deployment will drive the informatization of a country.

The slow speed at which the SMEs in Hong Kong have embraced both EDI and ERP suggests that Hong Kong will also be slow to integrate into the next generation of inter-enterprise information systems. The power of Hong Kong businesses as packagers depends on their incredibly flexible business networks that extends throughout Asia and the world. But with a focus on short-term profits and very little manufacturing capability in Hong Kong, Hong Kong businesses have been slow to invest in advanced IT.

Taiwan, unlike Hong Kong, still has a manufacturing base. It has, in the case of the electronics industry, been much quicker to adopt both electronic interchange and the enterprise systems to support that interchange. The managers of companies in this industry have often worked in Silicon Valley and have the willingness and the ability to re-engineer their companies to leverage the power of the Internet and business to business e-commerce. Taiwan is not only a node in the Global Silicon Network, it has the

potential of being one of the best and fastest nodes on the planet for producing complex electronic products. The use of inter-enterprise information technology combined with the power of their business networks will be the key to their success.

Both Guangdong and Fujian have been slow to enter enterprise and inter-enterprise resource planning technology. There are two different drivers of B2B e-commerce in China. One is the drive for the central government to informatisize the economy. The second is the bottom up desire to use e-commerce to open up new markets and improve the efficiency of doing businesses with old ones. These two drivers are not necessarily supporting one another. Given the present large "gray area" associated with operations of many sectors of the economy, businesses, especially those financed by Taiwan, are likely to resist efforts to make all their transactions transparent to the central government in Beijing. These business are under pressure from both the world economy and the Beijing government to move toward more advanced levels of information technology, but are choosing not to.

This leaves two potential scenarios. The first is that as Taiwan's electronic industry becomes more and more sophisticated in its use of information technology, Fujian will fall further and further behind for fear of what the central government could control if it had access to every business transaction.

The second scenario is that the Chinese government, in the interest of driving B2B e-commerce, will implement a transparent taxing, duty, and legal infrastructure that does not put at risk companies with ERP systems or those using EDI. In this case, government policy and world trade forces would work together to drive the integration of advanced information technology in Guangdong and Fujian. Both of the provinces would be better integrated into Hong Kong and Taiwan, and at the same time, better integrated with Beijing. Guangdong and Fujian would lead the rest of China into the information age and resulting prosperity.

Under the second scenario, Guangdong and Fujian would begin to compete with Hong Kong and Taiwan even as they are more integrated with them. Overseas Chinese money would flow into the two provinces, particularly into Fujian as expatriates saw the potential of their former home given a "clean" economic system. It is assumed that Fujian and Guangdong businesses would integrate information technology, if they saw it being used successfully in manufacturing facilities in Taiwan.

Given the strides that Taiwan is taking, and the potential that Guangdong and Fujian represent, Hong Kong policymakers should be concerned that Taiwan, Guangdong, and Fujian will no longer need an intermediary like Hong Kong. Hong Kong needs to leverage its strengths as a financial center and a business packager as it uses the Internet to create a whole new series of markets and business intermediaries. Unfortunately, Hong Kong's financial community has inherited some of the conservatism of British banks. While at the same time, the SME community is too pressed seeking short-term profits to invest in the next generation of inter-enterprise information systems. Efforts such as Cyberport are clearly critical for Hong Kong in terms of creating a

"space" where vision and risk taking can flourish, where Western and Chinese cultures can creatively interact, and where a new generation of inter-organizational information systems and markets can evolve.

The challenge that the whole region faces is how to combine the speed and flexibility of Chinese business networks with the power of computer network technology. Taiwan businesses in their use of ERP, EDI, and Web-based ordering are taking the lead. Guangdong and Fujian will follow. It is up to Hong Kong to determine whether it is the best gateway for creating the new intermediaries and markets needed as East and West co-create cyberspace.

Appendix I: Acronyms used

Acronym	Definition
ADSL	Asynchronous Digital Subscriber Loop is used to provide high speed connections over last mile copper circuits.
ATM	Asynchronous Transfer Mode is a protocol for supporting the transfer of data in cells in a manner that can guarantee quality of service.
CUHK	Chinese University of Hong Kong is the home of the HKIX.
EDI	Electronic Data Interchange involves the electronic exchange of data according to set formats.
ERP	Enterprise Resource Planning are a class of applications that support enterprise wide decision making on resources.
HKISPA	Hong Kong Internet Service Provider Association
HKIX	Hong Kong Internet Exchange provides a way for most of the ISPs in Hong Kong to exchange traffic.
iERP	Inter-Enterprise Resource Planning as a class of applications that facilitate inter-organizatizational data sharing and decision making.
ISDN	Integrated Services Digital Network is a relatively old standard for providing digital service.
ITBB	Information Technology and Broadcasting Bureau is the part of the Hong Kong government responsible for implementing Digital 21.
NII	National Information Infrastructure
OFTA	Office of the Telecommunications Authority is the Hong Kong agency responsible for overseing the telecommunications industry.
POP	Point of Presence is a node on a telecommunication provider network where the network can be accessed.
PRC	People's Republic of China
PTT	Post Telephone and Telegraph is the old abbreviation for the monopoly communication provider in most countries.
PSTN	Public Switched Telephone Network
SAR	Special Administered Region refers to Hong Kong
SME	Small and Medium sized Enterprises
VOD	Video on Demand
X.25	A packet switched protocol that was used extensively in the eighties by the Chinese to support data networks.

Appendix II: Global Diffusion of the Internet Framework

This appendix briefly reviews the framework for analyzing the development and status of the Internet within a country that was established in the first Global Diffusion report,[46] from which the following discussion is drawn. The principal components of the framework are six "dimensions" and an open-ended list of "determinants."

Dimensions represent a number of interrelated factors that comprise the "Internet capability" of a nation. Each of the six dimensions (Table 1) is given a numeric score supported by a narrative discussion. Displayed graphically on Kiveat diagrams, a dimensional analysis represents a time-slice view that facilitates both assessment of the Internet within a country and comparisons between countries and regions. Compilation and analysis of the determinants and relevant government policies not only establishes how the current situation came to be, but can inform decision-makers of the likely consequences of future regulatory or investment decisions on the further development of Internet capabilities.

Table 1. Dimensions of Internet Diffusion	
Dimension	Function
Pervasiveness	Number of users per capita
Geographic Dispersion	Physical dispersion of infrastructure and access
Sectoral Acceptance	Connectivity in various social sectors
Connectivity Infrastructure	Capacity and robustness of the infrastructure
Organizational Infrastructure	Degree of competition
Sophistication of Use	Integration and innovation

Of the six dimensions, three answer the question: "How much?" The final three dimensions reflect structural variables: Connectivity Infrastructure represents the degree to which users can effectively communicate via the Internet and the number and speed of a country's international connections. Organizational Infrastructure describes the richness and robustness of the Internet service provision market, and hence the potential for further proliferation. It also is the dimension that best reflects one of the most important variables in Internet diffusion, government policy. The final dimension, Sophistication of Use, represents the degree to which the technology has really caught hold within a country and become an integral part of that country's social, economic, and management fabric.

Pervasiveness is a function principally of the number of subscribers and hosts per capita. This is a change from the original definition of this dimension, which originally also attempted to reflect the growth of Internet use beyond a core group of technical experimenters and "early adopters" to the general public, and ease with which the population can get Internet service.[47] The original definition did not account for situations where there were relatively low levels of use but the user community comprised more than a technical core. Additionally, the ease of access issue is also accounted for in other dimensions, and so was dropped from *pervasiveness* for clarity. The subjective descriptor for Level 1 was also changed, to "embryonic" from "experimental," as we have discovered several examples of countries that were clearly at Level 1 for *pervasiveness* but where Internet use was well beyond the experimental stage. The elements of *pervasiveness* as currently defined are listed in Table 2. The term "users" must also be qualified, since it allowed for a great degree of ambiguity in applying the original definition. The intent is to as accurately as possible the number of people who are regular users of the Internet. Such numbers are not readily available. However, it is often possible to obtain or reasonably estimate the number of subscribers, that is, Internet account holders. The actual number of users is usually larger by factors that varying greatly from country to

---

[46] Chapter 2 in Goodman, et al., *The Global Diffusion of the Internet Project: An Initial Inductive Study, op. cit.*, pp. 4-28.

[47] *ibid.*, p. 5.

country, from Internet service provider (ISP) to ISP, and even within a country. There is no way to measure this number and such published estimates as exist are of questionable validity.

Table 2. Dimensions of Internet Diffusion: Pervasiveness
Level 0   *Non-existent:* The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country. There may be some Internet users in the country; however, they obtain a connection via an international telephone call to a foreign ISP.
Level 1   *Embryonic:* The ratio of users per capita is on the order of magnitude of less than one in a thousand. The ratio of hosts per capita is less than 12 hosts per 10 million people.[48]
Level 2   *Established:* The ratio of Internet users per capita is on the order of magnitude of at least one in a thousand. There are fewer than 1,700 hosts per 10 million people.
Level 3   *Common:* The ratio of Internet users per capita is on the order of magnitude of at least one in a hundred. The ratio of hosts per capita is between 1,700 and 70,000 hosts per 10 million people.
Level 4   *Pervasive:* The Internet is pervasive. The ratio of Internet users per capita is on the order of magnitude of at least one in ten. There are more than 70,000 hosts per 10 million people (7 hosts per 1,000 people).

Geographic Dispersion describes the physical dispersion of the Internet within a country, there being benefits to having multiple points-of-presence, redundant transmission paths, and multiple international access points. Internet development in a country typically starts with a single provider and site in the capital or largest population center, from which the infrastructure spreads out as the user population grows and becomes more diversified. A mature Internet network will feature an infrastructure distribution that is proportional to the population. Table 3 summarizes the characteristics used to evaluate geographic dispersion. The original definitions of *geographic dispersion* levels included an assessment of the number of international IP links. This was duplicative and therefore dropped from this dimension.

Table 3. Dimensions of Internet Diffusion: Geographic Dispersion
Level 0   *Non-existent:* The Internet does not exist in a viable form in this country. No computers with international IP connections are located within the country.
Level 1   *Single Location:* Internet points-of-presence are confined to one major population center.
Level 2   *Moderately Dispersed:* Internet points-of-presence are located in at least half of the first-tier political sub-divisions of the country.
Level 3   *Highly Dispersed:* Internet points-of-presence are located in at least three-quarters of the first-tier political sub-divisions of the country.
Level 4   *Nationwide:* Internet points-of-presence are located in all first-tier political sub-divisions of the country. Rural access is publicly and commonly available.

Sectoral Absorption recognizes the differing impacts of the degrees to which four major Internet-using sectors of society have taken up the technology: the academic, commercial, health, and public (government) sectors. While the sectors describe the major social and economic divisions in society, none are homogeneous, as depicted in Table 4. Personal use is not considered in this metric.

Internet use within each sector is rated as rare, moderate, or common, according to the guidelines listed in Table 5. To rate the country as a whole, each sector with a "rare" rating is assigned one point, each "moderate" sector two points, and each "common" rating three points. The overall rating for Sector Absorption is derived from the matrix shown in Table 6.

---

[48] The host/capita quartiles are derived from the host distribution map presented by Larry Press inside the back cover of *OnTheInternet* 3 (January/February 1997).

Table 4. Subsectors of the Social Structure	
Sector	Subsectors
Academic	Primary and Secondary education University education
Commercial	Distribution Retail Finance Service Manufacturing
Health	Hospitals Research Centers Clinics Physicians/Practitioners
Public	Central government Regional and Local governments Public companies Military

Table 5. Assessing Sectoral Absorption			
Sector	Rare	Moderate	Common
Academic-primary and secondary schools, universities	< 10% have leased-line Internet connectivity	10-90% have leased-line Internet connectivity	> 90% have leased-line Internet connectivity
Commercial-businesses with more than 100 employees	< 10% have Internet servers	10-90% have Internet servers	> 90% have Internet servers
Health-hospitals and clinics	< 10% have leased-line Internet connectivity	10-90% have leased-line Internet connectivity	> 90% have leased-line Internet connectivity
Public-top and second tier government entities	< 10% have Internet servers	10-90% have Internet servers	> 90% have Internet servers

Table 6. Sectoral Absorption Rating		
Sectoral point total	Absorption dimension rating	
0	Level 0	Nonexistent
1-4	Level 1	Rare
5-7	Level 2	Moderate
8-9	Level 3	Common
10-12	Level 4	Widely used

Connectivity Infrastructure comprises four components: the aggregate bandwidth of the domestic backbone(s), the aggregate bandwidth of the international IP links, the number and type of interconnection exchanges, and the type and sophistication of local access methods being used. Table 7 depicts how these factors are related to the assessment of the infrastructure's level of development, with Level 0 assigned to a country with no Internet presence (and hence, no infrastructure) and Level 4 assigned to a country with a robust domestic infrastructure, multiple high-speed international links, many bilateral ("peering") and open Internet exchanges—facilities where two or more IP networks exchange traffic, and a variety of access methods in use.

Table 7. Dimensions of Internet Diffusion: Connectivity Infrastructure				
	Domestic Backbone	International Links	Internet Exchanges	Access Methods
Level 0	None	None	None	None
Level 1	< E-1	≤ 128 Mbps	None	Modem
Level 2	T-3 — OC-4	T-1 — T-3	1	Modem 64 Kbps leased lines
Level 3	OC-4 — 100 Gbps	T-3 — 10 Gbps	More than 1; Bilateral or Open	Modem > 64 Kbps leased lines
Level 4	≥ 100 Gbps	≥ 10 Gbps	Many; Both Bilateral and Open	< 90% modem > 64 Kbps leased lines

Organizational Infrastructure Just as the connectivity infrastructure assessed the extent and robustness of the physical structure of the network, organizational infrastructure (Table 8), derived from the number of ISPs and the competitive environment, assesses the robustness of the market and services themselves. Generally, an open, competitive market with low barriers to market entry is more conducive to high rates of take-up by subscribers, wider proliferation of the physical infrastructure, and the provision of a wider variety of services.

Table 8. Dimensions of Internet Diffusion: Organizational Infrastructure
Level 0   *None:* The Internet is not present in this country.
Level 1   *Single:* A single ISP has a monopoly in the Internet service provision market. This ISP is generally owned or significantly controlled by the government.
Level 2   *Controlled:* There are only a few ISPs because the market is closely controlled through the maintenance of high barriers to entry. All ISPs connect to the international Internet through a monopoly telecommunications service provider. The provision of domestic infrastructure is also a monopoly.
Level 3   *Competitive:* The Internet market is competitive and there are many ISPs due to the existence of low barriers to market entry. The provision of international links is a monopoly, but the provision of domestic infrastructure is open to competition.
Level 4   *Robust:* There is a rich service provision infrastructure. There are many ISPs and low barriers to market entry. The provision of international links and domestic infrastructure are open to competition. There are collaborative organizations and arrangements such as public exchanges, industry associations, and emergency response teams.

Sophistication of Use To truly understand the Internet capability of a country, it is necessary to understand not only how many and where people use the services, but how the Internet is employed. Of particular interest is the "elbow" reached when the service is mature enough to attract interest and use outside the narrow community of technicians. A second major milestone is reached when the user community transitions from only using the Internet to creating new applications, sometimes eventually having an impact on Internet use elsewhere. Table 9 depicts the development stages that reflect an increasing sophistication in the use of the Internet.

Table 9. Dimensions of Internet Diffusion: Sophistication of Use

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

Determinants influence the Internet capability of a country and shape its development over time. The current dimensions of a country's Internet capabilities resulted from the interactions of these determinants, which were in turn affected by the diffusion of the Internet. A country's future Internet capabilities will continue to be the result of the actions and interactions of these dimensions, most of which are not themselves static. The determinants are discussed in greater detail in the first Global Diffusion report.[49]

The most important determinant, government policy, belongs in a category by itself, since the policies of government overlay all other determinants, affecting both their nature and their effectiveness, based upon a government's ability to exercise coercive power. The policies created by a government are generally intended to achieve the fulfillment of that government's goals, which may be more or less closely related to the goals of those governed, depending upon the form of government. The government's policies may also appear to be more or less rational, depending upon how well the policy reflects the realities of its milieu, but governments can—and all too often do—create policies that reflect a lack of awareness or understanding of its environment, or an excessive optimism regarding the government's ability to overcome obstacles to its policies.

 Porter postulated four basic determinants of national advantage, which serve here to describe the general nature of the determinants of Internet diffusion.[50] *Factor conditions* refer to the factors of production, the inputs for any industry or enterprise. While most factor conditions are subject to change caused by outside influences, such change, when it occurs, is generally slow and incremental. The *Constituents*, which Porter called "demand conditions" describe the nature of the market with respect to the demands of sophisticated users, the breadth and variety of demands, and the size and patterns of demand growth. Porter notes that the quality of demand is more important than the quantity of demand. The Internet, like other technologies and innovations, usually does not simply appear in a particular country; it is introduced into the country to

---

[49] Goodman, et al., *The Global Diffusion of the Internet Project: An Initial Inductive Study, op. cit.*, pp. 11-16.

[50] Michael E Porter, *The Competitive Advantages of Nations* (New York: The Free Press, 1990), pp. 71-72. Porter's "firm strategy, structure, and rivalry" was shortened to "strategy, structure, and rivalry" for clarity in the context of Internet development.

satisfy the demands of one or more constituent groups, such as the business or academic communities. The strength of these constituencies and their demands relative to conditions either supporting the *status quo* or specifically opposed to the Internet determine whether efforts to develop the Internet in a particular country will be successful, and are major factors in the speed with which Internet service proliferates. *Related and supporting industries* refers to the quality of industries required for the introduction and development of, in this case, the Internet, and the relationships between industries. The presence and condition of supporting industries is generally not as critical to Internet diffusion as it is to industrial activities. Related industries such as software development concerns can, however, act as a spur to Internet diffusion. Most important is the degree of development of the telecommunications infrastructure, the nature of the sector (monopoly or open), and the relationship between telecommunications operators and ISPs. *Strategy, structure, and rivalry* refers to the ease of formation of new companies, barriers to market entry, and the competitive environment.