VERIFYING INTERNET USER ESTIMATION MODEL

by

Mr. Viboon Vijaivorakit

A Final Report of the Three-Credit Course
CE 6998 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
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The Graduate School of Assumption University has approved this final report of the three-credit course. CE 6998 – CE 6999 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

The purpose of this project is to study the verifying Internet user estimation model and how to improve the mathematical model.

We directly interviewed specialist network engineers and administrators for data gathering of questionnaires. Our target groups were large organization and reliable firms, which have leased line from ISPs in Thailand. Every leased line of ISPs will be collected to pass through CAT (Communication Authority of Thailand) that will be monitoring and management, because the number of Internet users in Thailand will increase every year.

The questionnaires is applied in this project has been used to verify Rear Admiral Prasart Sribhadung's mathematical model have been used and verified since 1997.Two of the variables used in the model are the international and domestic link. The verifying International user model will study different form those model including to UF affects both International and domestic link. The verifying Internet user model is applied to verify equation for verifying their factors

After studying this project, we found that this mathematical model should be improved to suitable Internet user in the present otherwise, there are errors to estimate Internet user. However, the writer will try to improve and suggest new Internet user factor and mathematical models.

This project is useful for predicting User Factor and mathematical model moreover it is used to estimate the number of Internet users in the company, leased line providing and Growth in Thailand.

ACKNOWLEDGEMENTS

The writer is indebted to the following people and organizations, without them, this project would not have been possible.

The writer would wish to express sincere gratitude to his advisor, Rear Admiral Prasart Sribhadung. His patient assistance, guidance, and constant encouragement have led the writer from the start of the project to the project completion.

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The writer would like to thank all staffs of KSC and Internet Thailand for their help and which provided the writer vital information while carrying out the data collection required for using this project.

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I. INTRODUCTION

1.1 Significance of the Study

Nowadays Internet is very important for communication. It is easy to use and an inexpensive service that could connect around the world. Whatever you do, Internet is always involved. Many organization including private and government try to study network and implement to extend Internet routing.

Technology in these days is growing rapidly and information technology will change in format such as text mode files, graphic mode and e-commerce transmission channel or media can connect anywhere. Information will be transmitting through leased line of ISPs that will provide leased line and they will pass through CAT.

Since the world of Internet and Networking are changing rapidly. We are surrounded by reminders of the growth in the capabilities of information and communication technologies, especially the Internet. The use of the Internet as an interface between the public administration and citizens as well as businesses comprises abroad and growing range of applications but the most important is the Internet and World Wide Web. By January 2000, about 69 million Internet hosts are connected in about 250 countries and territories. A host may have 1-100 terminals. A terminal may serve 1-20 persons. Assuming that a host serves 10 persons, the number of people on the Internet may be said to be about 690 million in the year 2000 and expected to be over one billion in a few years.

Most of them, in the Internet are sent from sources to destinations through different media. This media may be copper wire, fiber optics, microwave link, satellite link, depending on availability and distance. Information are sent and received in wide varieties of formats including text files and graphics. So far those information are

increasing until they almost saturate the limited transportation channel capacity. Therefore, the users will strive to increase their transportation media capacity with the firms. Information concerning the transportation channel capacity is one of the criteria used for predicting the number of Internet users for Thailand. Rear Admiral Prasart Sribhadung have built a mathematical model to estimate the number of Internet users, which have been used since 1997. Two of the variables used in the model are the International and Domestic links and their utilization factors. It is known that user behavior changes with time for any predicting model of this nature, and periodically verification must be conducted to update the model. However, this has not been done at all since the start. So, this project will conduct surveys required to collect information to verify that mathematical model used to estimate the number of Internet users in Thailand.

1.2 Research Objectives

The main research purposes:

To verify the Internet user estimation model, whether there have been any changes in user behavior from the past to the present. If not should have suitable improving in the present.

1.3 Scope of this study

The verification process will consist of surveys of the followings:

(1) Current Internet link of leased-line users in Thailand.

(2) Internet users of current Internet link of leased-line users in Thailand.

(3) Utilization Factor of current Internet link of leased-line users in Thailand.

(4) Test the information collected to the model and monitoring what difference there are.

1.4 Deliverables

After finishing the project, the deliverables of the project are the following:

(1) Provide conclusion of the project and send e-mail with interested interviewees that have requested since information gathering.

(2) The project report.

II. LITERATURE REVIEW

2.1 Introduction to Internet Growth in Thailand

The first electronic-mail (email) to the world from Thailand through the Internet was sent via a telephone line to Melbourn, Australia, in 1987. First it went to an Internet-Node there with domain-name "munnari.oz.au" then distributed to the rest of the world. That Internet-Node in Thailand was a computer situated at The Asian Institute of Technology (AIT). Each day it would connect to send and receive email three times (14.00, 15.30, and 19.30), during which it would be inaccessible to the users. Monthly-fee of 200 baht (Approximate exchange rate 1987 was US$ = 25 baht) was charged to the users for sending and receiving of up to 15,000 characters. And each 50 excess characters, 1 baht would be charged.

The next Internet-Node was established at Prince of Songkhla University called "sritrang.psu.th", in Songkhla Province in Southern Thailand in 1988. This Node was also connected via a telephone line twice a day (09.00 and 19.00) to the same Internet-Node "munnari.oz.au" in Melbourn, Australia.

In 1991, Chulalongkorn University, Thammasart University, Kasetsart University, and NECTEC established an Academic Electronic Mail Network using scheduled dial-up lines and a mixture of UUCP and MHSnet

2.2 Internet Host and Internet Growth in Thailand

As shown in Figure 2.1, the number of Internet hosts in over 250 countries as of January 2000 is 69.59 millions. If there were 5 - 10 users per host, the number of Internet users would be 347 - 696 millions. As a matter of fact, an Internet host may have only one user, but another may have several hundred users.

The number of Internet users varies widely from one source to another source. While the estimate according to the number of hosts above is 347- 696 millions for the year 2000, the estimate from Jupiter Communication is only about 228 millions for the year 2002. Jupiter Communication said that 62% of all Internet users are in the United State, that there is one new user every 1.67 seconds, and that by the year 2002, the USA market will hit 85 million users. Jupiter Communication indicated that in the year 2000, non-US users are the majority of Internet subscribers, and that by the year 2002, the Internet users for the whole world will reach 228 millions users with 85 million in the United States and 140 million outside the United States.

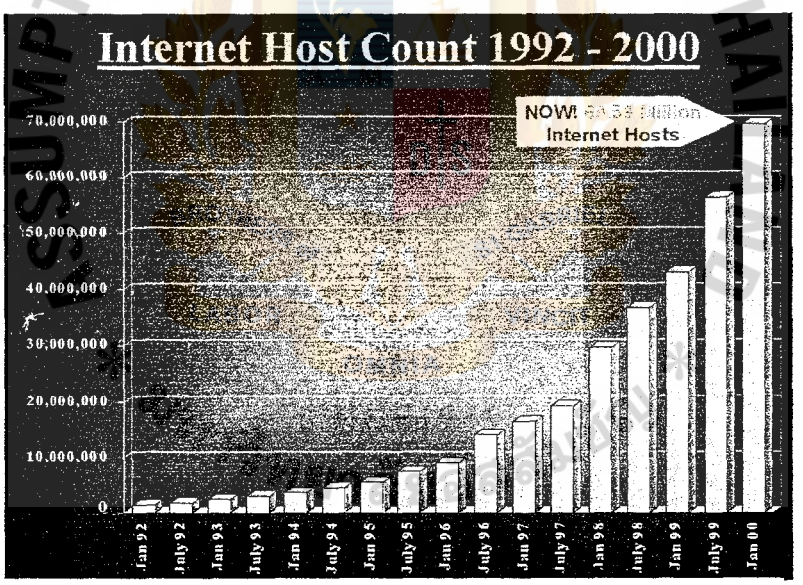


Figure 2.1. Internet Host Count in World 1992-2000.

The term "Business Computer" as a formal education major had not been used in any other countries except Thailand where it has since been adopted at most universities in the country. By the year 2000, the number of computers in Thailand is over 2 million

and the approximate numbers from 1964 to 2000 are shown in Table 2.1.

Table 2.1. Approximate Numbers of Computers in Thailand.

Year	Approximate Numbers of Computers
1964	2
1975	70
1985	23,000
1995	1,000,000
1996	1,300,000
1997	1,600,000
1998	1,800,000
1999	2,000,000
2000	2,300,000

2.3 The Birth of the Internet in the World

In 1969, the US Department of Defense (DOD) Advanced Research Project Agency (ARPA) established ARPANET as an experimental network to support armed force research. In war, it has to be assumed that any part of the network could be destroyed at any moment and the remaining portion must still work. Therefore, to send a message on the network, a computer puts the message in an envelope which is called an Internet Protocol (IP) packet and put the receiving address on the envelop. The responsibilities of sending the packet is not placed on the network (which is assumed to be unreliable) but on the sending and receiving computers.

The Internet Protocol software has been made available on all kinds and brands of computers. Thus, a user can buy whichever computer he likes and connect it to the Internet.

Then came UNIX operating system with Internet Protocol and the popularity of local area network (LAN). So, the whole LAN can have connectivity with ARPANET, i.e. each computer on the LAN can have access to ARPANET.

In the late 1990's, NSF (the US National Science Foundation) established five supercomputer centers. Dr.Srisakdi visited one at the University of Illinois and found that the cost was over 70 million US$. That kind of cost is expensive even in the US standards. As supercomputers should be shared, a researcher closer to any supercomputer should have his terminal connected to that computer. The ideal solution at that time was to use ARPANET for the connection but it did not work because of bureaucracy. So, NSF decided to build its own network based on ARPANET's IP technology. The network was called NSFNET. It connected the five-supercomputer centers by 56 Kbps telephone lines and any user can use telephone to connect to the nearest center to access the network. In 1987, NSFNET became overloaded and the 56 Kbps lines had to be replaced by lines, which were faster by a factor of about twenty.

With the increase of popularity of the Internet, other networks like Bitnet, DECnet, Fidonet, etc. developed methods of connecting to the Internet. At first, the connection was for transferring electronic mail only but later some of them have developed full service translator.

The International Standards Organization (ISO) has designed OSI (Open Systems Interconnect) protocol, which is allowed in many of the Internet's component networks. Consequently, users of OSI also have connectivity to the Internet.

A citizen of Thailand got to use the Internet when it first started in the United State in 1969. At that time, the US Department of Defense (DOD) Advanced Research Project Agency (ARPA) established ARPANET as an experimental network to support research. From 1968 to 1973, Dr.Srisakdi was Director of Graduate Studies in Computer Science at the University of Missouri, Columbia, Missouri, USA and also Directors of a few research projects supported by the US National Science Foundation. Therefore, he became the first Thai to use the Internet.

2.4 First Internet Gateway in Thailand

Chulalongkorn University established Thailand's first Internet Gateway in 1992 with domain-name "chulkn.chula.ac.th", a dedicated international link of 9,600 bit-per-second (9.6 Kbps) connected it to UUNET/ Alternet Technologies in Virginia, USA.That establishment made possible the first 24-hour connection of Thailand to the Internet. Later that year, the link was upgraded to 64 Kbps. That dedicated international link cost Chulalongkorn University 4.2 million baht per year. Originally, only one telephone line was connected via a modem to receive remote users, and the second line was available in 1993. In July 1994, eighteen more modem-connected telephone lines were added, and twenty concurrent Internet users 24-hours a day was possible for the first time.

2.5 Network for Research and Academic Institutions

January 1992, the National Electronics and Computer Technology Center (NECTEC) established the NECTEC Email Working Group (NWG) with the objective to study the needs of email for research and development in academic institutions in Thailand, and advise NECTEC in the acquisition of amenities to facilitate development of networking of academic institutions in Thailand together. After its own establishment, in February 1992, NWG established an academic and research network called Thai Social/Scientific Academic and Research Network (ThaiSARN). Users in this network can via two telephone lines that are connected 24-hours use UUCP (Unix-Unix CoPy) with Thamasart University and Prince of Songkla University. For accessing the Internet the users still had to go via AIT and then "munnari.oz.au". ThaiSARN later acquired six more telephone lines and changed international link to go via Chulalongkorn University domain-name "chulkn.chula.ac.th", and henceforth developed a 24-hours service. In September 1993 the Internet-Node "nwg.nectec.or.th" was established as the second

Internet-Gateway in Thailand connected to Virginia, USA, with a 64 Kbps dedicated international link. ThaiSARN is housed at the Network Technology Research and Development Laboratory (NTL), NECTEC. NTL upgraded this network to a super-network with 2 Mbps international link, the first in Thailand.

NTL created another academic network in 1995 enabled 25 secondary school in Bangkok Metropolis to access the Internet, it is called SchoolNet Thailand. It expanded to 50 schools in 1996, and 135 in 1997. The Project received a free 512 Kbps international link in 1998, and there were more than 300 secondary schools in the project, including even those outside of Bangkok. During the expansion, NTL established a nationwide network called the Golden Jubilee Network, IP-based bulletin board system (BBS) with an electronic library containing information related to His Majesty the King of Thailand. The two networks merged in February 1998, and made accessible via one telephone number throughout Thailand, 1509, henceforth, the project was called School net.

2.6 Non-commercial ISP

Since 1993 to 1996, Thaisarn is established and Internet services have commercial services with general people, any group. After that NECTEC, CAT and TOT have established the first Internet service in Thailand is called "Internet Thailand" who has serviced the first Internet commercial and ISP until in the present. In 2000-2001, amount of ISPS is increased from 15 to 18 ISPs.

Besides in Thailand have non-commercial Internet service increased 4 ISPs, are Thaisarn, UniNet, SchoolNet, and GITS.

Table 2.2. Non-commercial ISPs to Research and Study.

Internet Service	Under Implementation	Service Object
Thaisarn	NECTEC	Study, research and segment object is researcher and instrutor
UniNet	MUA	aims to connect to every University.
SchoolNet	NECTEC+MoTC	aims to connect and service Internet with school, technial college. Traget is expand from 2,000 to 5,000 school
GITS	NECTEC	aims to connect E-Government only, have started since 2000

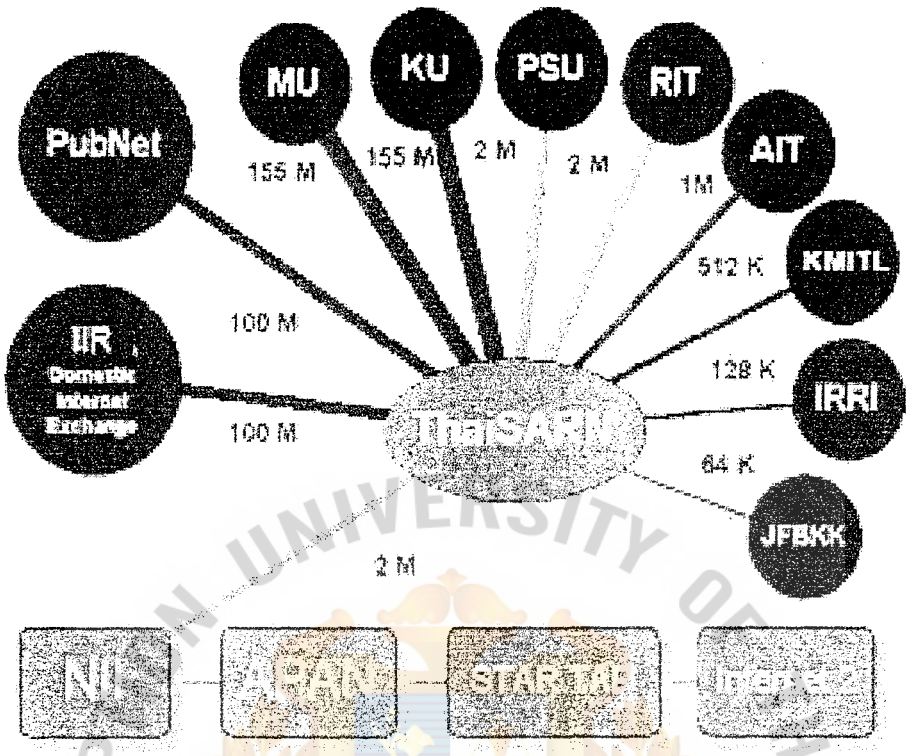


Figure 2.2. Thaisarn Network at NECTEC in Thailand.

This Figure 2.2 will shown that each organization is connected by pass to Thaisarn.

Thaisarn network will help information communication and exchanging involve to research and study so that to expand researching widely.

2.7 Commercial Email Services

The industries in the private sector were also very interested, Digital Electronic Corporation (DEC), Hewlett-Packard (HP), and Asia Credit Limited joined THAISARN in the first quarter of 1992. But Internet usage on THAISARN was restricted to non-commercial only, so using email for business was not possible. At that time, sending business email could only be done through THAIPAK, a Packet Data Link Network operated by the Communication Authority of Thailand (CAT). Later on, other private

companies started giving email service, together with the existing government agency, they are listed below.

THAIPAK run by the **Communication Authority of Thailand (CAT).**

IBM Information Network (IIN) run by IBM.

General Electric Information Service (GEIS) run by Siam GEIS.

MCI Mail run by MCI International Inc.

AT & T Easylink run by Thai Information Network, a subsidiary of AT&T.

British Telecom Global Network Service run by British Telecom.

2.8 Commercial Internet Service in Thailand

The largest cost for all ISPs in Thailand is for the bandwidth to the USA, accounting for 35-50% of the operating costs. When Chula started the first international gateway in July 1992, the bandwidth was only 9,600 bits per second and later upgraded to 64 Kbps. In September 1993, the second international Internet gateway was established at NECTEC and it was also 64 Kbps. In January 1995, the third international Internet gateway in Thailand or the first private-sector gateway was established at Assumption University and KSC and it was also 64 Kbps. Each international link for ISPs has to be leased in two parts, i.e. half circuit from Bangkok to the US leased from CAT, and half circuit from the US to Thailand leased from an international carrier such as AT&T, Global One, KDD, MCI, TeleGlobe, etc.

2.9 Current Status of Internet in Thailand

The state of academic networking in Thailand has grown significantly, reaching almost every university and research institution in the country. Many Thai schools and universities are using the Internet and Its applications in their curricula. The government is planning to invest more in Information Technology (IT) and human resources by improving the telecommunications infrastructure and providing more education. As, in the past have serviced 2-3 Internet Service Providers (ISPs) and expansion to 16 ISPs operating nationwide with a combined leased line capacity above 30 Mbps.

Nowadays, Thailand currently has sixteen ISPs operating nationwide with a total bandwidth of more than 30 Mbps. The three largest are the Internet Thailand Company, Ksc Comnet, and the Loxinfo Company (see Figure 2.3.)

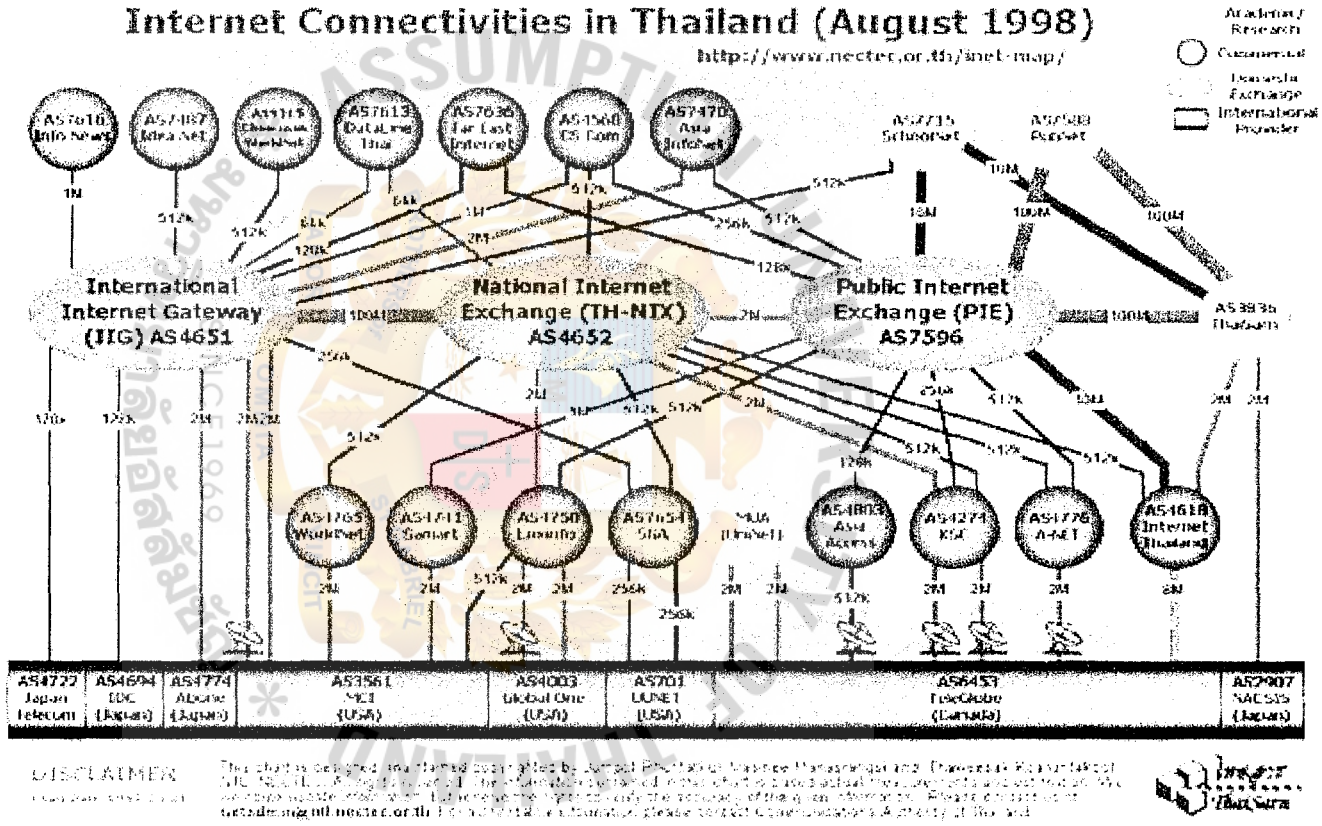


Figure 2.3. Current (as of August 1998) Topology of Thailand's Nation Network.

In 1995, CAT, TOT, and NSTDA established the Internet Thailand Company, a state enterprise Internet Service Provider. While CAT and TOT hold 33 percent, NSTDA, the legal entity of NECTEC, holds 34 percent of the total shares. It was the first time that three state enterprises formed a commercial company on their own, which required Cabinet approval,. Internet Thailand Internet Thailand's first 512 Kbps leased line to UUNET was Thailand's biggest compared to Thaisarn's 64 Kbps at the time, Adopting TIS's system design and service model, Internet Thailand used PPP and SLIP protocol to serve its customers, The monthly charges of the services for individuals ranged from USD$16 for email and Usenet news to $48 for a full IP account. Corporate users were charged from Bht15,000 (then USD$600) for a 9.6 Kbps link to Bht700,000 Then ($28,000) for a 512Kbps link (commercial Internet, January 18, 1995) see the Tables 2.3. and 2.4.).

Table 2.3 Internet Thailand's Initial Pricing for Individual Users.

Service Types	Price(US$)/month	Service description
1. HomeNet	16	mnthly session, 400 in-out messages.
2. WorldNet	24	HomeNet + Telnet, FTP service, 20 hours session, 1MB disk space + 600 in-out messages.
3. BizNet	48	Full Internet, 40 hours session, 2 MB storage, 1200 in-out messages.
4. WorldNet Plus	40	WorldNet + SLIP or PPP enabled.
5. BizNet Plus	60	BizNet + SLIP or PPP enabled.

Table 2.4. Internet Thailand's Initial Pricing for Corporate Users.

Line Speed(Kbps)	Price/month(US$)
9.6	600.0
14.4	800.0
19.2	1000.0
28.8	2400.0
64.0	4000.0
128.0	7000.0
256.0	10000.0
512.0	28000.0

KSC Comment, was also established in 1995, Thailand's IT Year, KSC is a joint venture of CAT, ABAC (privately-owned Assumption University), Ban Chang Group, and the Thai Sugar Group, later replaced by Jasmine International, a Thai fiber optic construction company. At the end of 1995, CAT approved tree additional ISPs, including Loxinfo, Which is led by a giant telecommunications firm, Loxley International Company.

After commercialization, the Internet became more socially significant in Thailand. This was coupled with the national promotion of computer usage. Since the beginning of the 1990s, the government has promoted computer usage by slashing import taxes from 35-40% to 5% for finished products and from 20% to 4% for hardware. Computers have become widely used in Thailand, especially in Bangkok. People's perception of computers versus typewriters change as they realized the power of a machine on which they can store megabytes of data at both work and home. As of 1996, the growth of PCs was 30% and software 11% annually

The Bangkok Post, an English-language newspaper, published 1995 election news live on the web. In July 1995, Thailand's total solar eclipse was also published on a special homepage. Thai expatriates depended on these newspapers to keep up with current events in Thailand. Domestically, NECTEC demonstrated an Internet Café using the first local 2Mbps circuit at the IT-Week conference in 1995. And at the end of the year, Thaisarn received funding from the Japanese National Center for Scientific Information Systems (NSCSIS) for the first E1 leased line from Thailand to the Scientific Information Network (SINET) in Japan Figure 2.4.

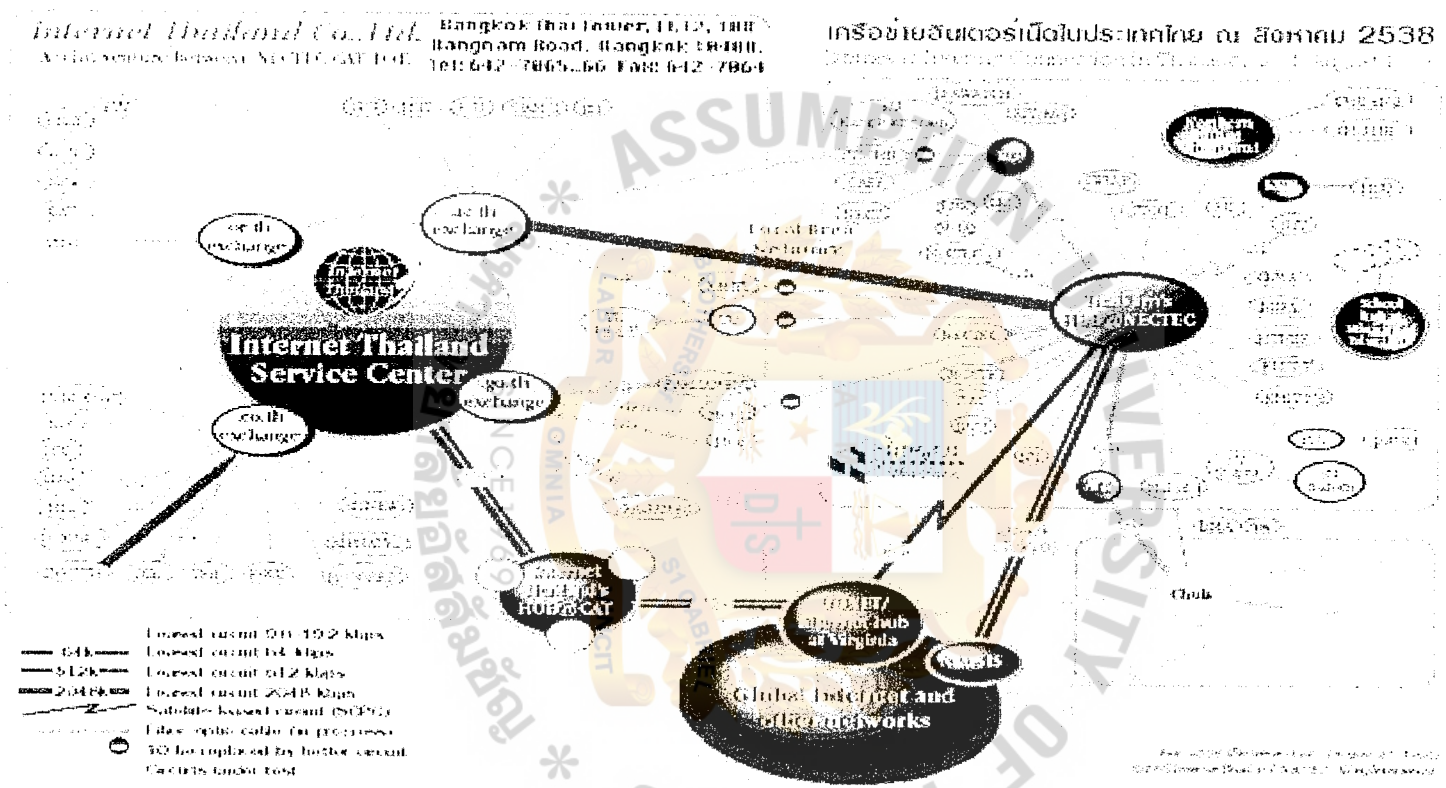


Figure 2.4. Thaisarn's Topology after Acquiring the First E1.

In early 1996, Internet Thailand acquired another E1 to MCI (see Figure 2.4). When Thailand hosted the Asia Europe Meeting in 1996, Internet Thailand and NECTEC combined their international leased lines with a localE1 circuit to provide an Internet service to participants from Europe and Asia. This significantly boosted Thailand's role as and information provider on the World Wide Web.

Despite the national promotion, commercial Internet service did not aggressively gain a foothold in Thailand. By the end of 1995, there were only 60 corporate nodes connected to the commercial ISPs. The total number of users in Thailand was about 100,000, most of whom used the Internet trough their organizations, including thaisarn's sites. Only 10%(10,000) were individual customers of commercial ISPs. According to the sluggish growth of individual users was because commercial Internet service was still a fledging idea and the prices were too high by Thai standards

In Thailand, the Internet service is quite expensive because we are far form the center of the Internet, or the US, and we have to pay for the leased line in US currency, we have an unproductive pricing structure. Instead of setting a lower price for domestic Internet to encourage usage, we make everyone pay for international Internet, which is very expensive. Also, instead of promoting email which is very useful communication tool, we are so excited about the WWW, video, and sound clips which take up more of those expensive bandwidth.

The intervention from the Ministry of Transport and Communications (MoTC) and the competition among Thai ISPs recently drove down the price of services for individual users. In early 1997, after CAT reduced its pricing guideline (for both minimum and maximum), Internet Thailand slashed the startup fee from Bth2,000 to Bht200-300 and monthly service from Bht 1,200 to Bht 900. It also offered a 5 to 10 percent discount of subscriptions longer than 6 months. Some smaller ISPs were less

expensive. Other new ISPs sought a market niche. The Loxinfo Company, for example, encouraged local radio and television production companies to provide materials to website to expand the customer and advertising base. Meanwhile, corporate users paid expensive prices for leased line acquired from local ISPs, at least nine times more than 25 other developing countries. As of 1996, Internet Thailand had 5,000 individual and 80 corporate customers; KSC meanwhile claimed 60,000 individual uses.

CAT's interference in the market also distorted the dynamics. By setting up the guideline pricing, CAT spanned a tacit collusion among big ISPs (as shown in Tables 2.5., 2.6., and 2.7.) when they agreed to set their service charges at the maximum.

Table 2.5. CAT Median Pricing for Individual Users.

Service	Connectivity	Start-up($)	Monthy($)	Session/month	Disk Storage(MB)	Extra time(USD)
Text	Dial-up	8	14.4	15	2	1.2
Graphic	Dial-up	12	36	20	2	1.6

Table 2.6. CAT Median Pricing for Corporate Users.

Service	Connectivity	Start-up($)	Monthy($)	Traffic(MB)	Extra traffic ($/MB)	Maximum Charges($)
UUCP	Dial-up	144	144	40hrs	$3/hr	NA
IP 9.6Kbps	LL	540	540	1300	0.4	720
IP 14.4Kbps	LL	720	720	1900	0.4	900
IP 19.2Kbps	LL	900	900	2500	0.4	1800
IP 28.8-63.9Kbps	LL	1800	1800	3700	0.4	3600
IP 64Kbps	LL	3600	3600	8400	0.4	6300
IP 128Kbps	LL	6300	6300	16600	0.4	9000
IP 256Kbps	LL	9000	9000	33200	0.4	25200
IP 512Kbps	LL	25200	25200	66400	0.4	75600
IP 513Kbps-2Mbps	LL	75600	75600	265400	0.4	151200

Table 2.7. Pricing Model of ISPs in Thailand.

Names	Individual account	Leased line(64Kbps) for Corporate users	
	20hrs/month	Star-up	Monthy
A Net	$29.96	$3600	$3600
Asia Access	31.96	NA	NA
Asia Infonet	24($12 for students)	2160	2160
Idea Net	32	3200	3200
Line Thai	36	3600	3600
Info News	24(10hrs)	3600	3600
Internet Thailand	36	3600	3600
Loxinfo	36	2800	2800
KSC Comnet	32	3600	3600
Siam Global Access	32	3060	3060
Samart Cybernet	32	NA	NA

However, CAT's policy eventually backfield. Since the beginning of commercialization in 1995, CAT had been enjoying a large profit from this new technology. It set a traffic limit for Thai hosts. Additional traffic of 2,000 megabytes per month cost Bht 150 per megabyte. This was 60 times more expensive than the prices of Bht 2.5-Bht 18.75 per megabyte set by foreign ISPs, some of whom offered unlimited traffic for their corporate users. CAT's traffic limits not only discouraged data transfer, technical improvement, and content development of thiasites but also forced them to seek cheaper sites "offshore".

The Bangkok Post, with traffic in excess of 7,000 megabytes per month, moved its internet edition to a US site late last year to avoid the cost. The high CAT charges will impact Thai-based ISPs who hope to establish information sites, provide site hosting services or cyber malls. The Thai ISPs have to be internationally competitive.

Thaweesak, who is now NECTEC's director, also suggested that CAT can promote the Internet penetration simple by changing its role and CAT should take only one role: as an operator (i.e., leasing the line). Regulatory responsibility is to supervise the quality of Internet services to Thia people, and so for CAT has not done that.

As a regulator and middle man, CAT controls the access to the international lines and results the lines it acquires from intonation access providers to small, local ISPs who can not afford their own links. This service, called the International Internet Gateway (IIG), was linked with CAT's local exchange point (TH-NIX) by a 10Mbps Ethernet wire (see Figure 2.5). It was mandatory that every big ISP with an international link while, had to buy at least a 512Kbps link to TH-NIX themselves. Another operated by NECTEC on a cooperative, non-profit basis, connection Thaisarn and four other ISPs.

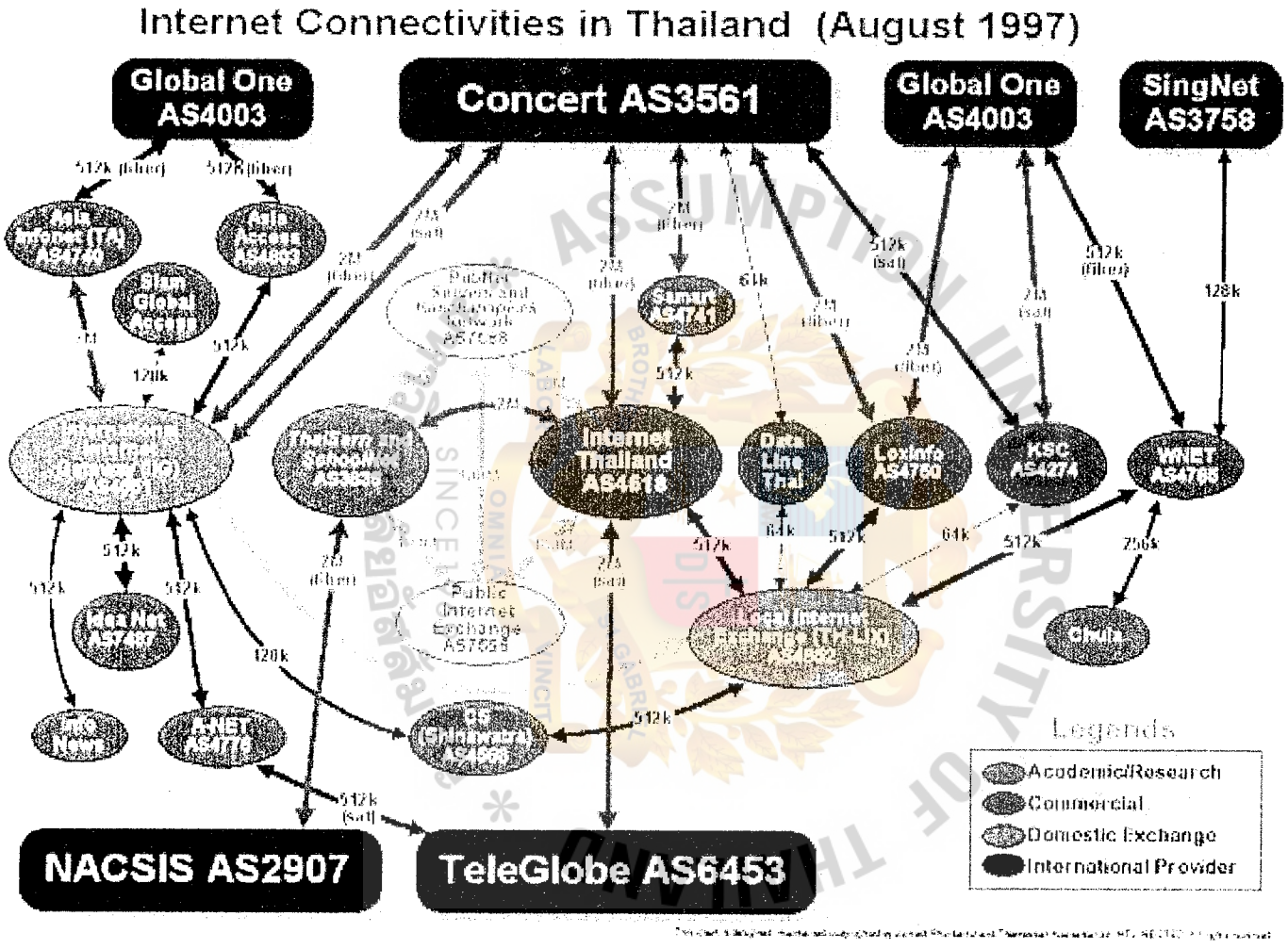


Figure 2.5. Local Internet Exchange in Thailand.

NECTEC set up PIE as an alternative. Unlike TH-NIX, PIE is free and fully manned around the clock. There is even a policy that is not a requirement of TH-NIX. PIE also requires circuits to vendors other than CAT in order to avoid CAT's domestic network being the single point of failure.

After the Thai economy began its downward spiral in early 1996, the business of providing Internet service in Thailand became less viable. Thai ISPs were severely hit by the lower local demand and the baht devaluation. Coupled with the recent policy to expand Internet usage in the country of the Ministry of Transports and Communications, CAT encouraged all ISPs to lower their service charges, with CAT itself slashing 25% off from the half-circuit prices it sells to all ISPs as an incentive. This policy resulted in losses and liquidity problems among most ISPs because CAT ignored the face that these operators must still pay the international Internet access provider in US dollars, which, due to the baht depreciation, doubled in value. Adjusted to the current exchange rate at Bht 40=US$1, an E1 half circuit from Thailand is priced at about Bht 1 million (US$25,000) a month. And for the other half to the international Internet access provider, the price rages at about $22,000 a month.

Parent companies of most Thai ISPs, mostly in the telecommunications industry, could not help either: raising capital Thailand has become much more difficult due to the economic downturn. Since the beginning of 1996, the Stock Exchange of Thailand (SET) has been n the doldrums, with its index dropping more than 50% in last few years. Some ISPs, in order to sell, immediately cut monthly fees for both individual and corporate users. Some offer the services, especially leased lines for local corporate users, far below costs. Some try to lower the operating costs by reducing leased line bandwidth and let the subscribers suffer from the slower services and busy modem banks. Some opted to cancel the startup fee and cut the important training course that it

used to offer to new users. Meanwhile, most ISPs formed the Internet service provider's club in which they cooperate to find ways to minimize costs. For 3example, asking CAT purchase larger international links so that it can redistribute the bandwidth to ISPs at a cheaper rate and recently seeking to increase the monthly service fees. As of April 1998, CAT has neither moved to supervise the deteriorating Internet services nor supported local ISPs seeking to survive the current economic condition of the country.

The combined bandwidth from all ISPs in Thailand to the US from 1992 to 1999 are shown in Table 2.8.

Table 2.8. Combined International Bandwidth to the US in Mbps.

1992	1993	1994	1995	1996	1997	1998	1999/10
0.064	0.13	2.77	4.77	10.25	32.5	37	109.875

The details of the bandwidth to the USA in October 1999 for each of the 15 ISPs plus UNINET (4 Mbps) which is the ISP for education operated by the Ministry of University Affairs are shown in Table 2.9.

Table 2.9. Thai ISP Connectivity to the US Sorted by Bandwidth, October 99.

No.	Company Name	Bandwidth to USA
1	Internet KSC Co., Ltd. (KSC)	46 Mbps
2	Internet Thailand Co., Ltd. (Inet)	16 Mbps
3	Loxley Information Services Co., Ltd. (LoxInfo)	7.5 Mbps
4	A-Net Co., Ltd. (A-Net)	6 Mbps
5	C.S. Communication Co., Ltd. (CS)	6 Mbps
6	Samart Infonet Co., Ltd. (Samart Cybernet)	4.5 Mbps
7	Asia Infonet Co., Ltd. (AsiaNet by CP and TA)	4.5 Mbps
8	World Net & Services Co., Ltd. (Wnet)	4.5 Mpbs
9	Siam Global Access Co., Ltd. (SGA)	2.25 Mbps
10	Info Access Co., Ltd. (Info News)	1 Mbps
11	Asia Access (Thailand) Co., Ltd. (Asia Access)	0.5 Mbps
12	Chomanan WorldNet (Chomanan WorldNet, CMN)	0.5 Mbps
13	Idea Net Co., Ltd. (IDN)	0.25 Mpbs
14	Far East Internet Co., Ltd. (Far East)	0.25 Mpbs
15	Data Line Thai Co., Ltd. (Linethai)	0.125 Mbps
16	UNINET, Thaisarn, SchoolNet, and IIG	10 Mbps
	Total	109.875 Mbps

All Thai ISPs have indicated that they will be increasing their bandwidth to the USA. For example, KSC announced that its bandwidth to the USA would be increased to 87-90 Mbps in the year 2000 and probably 180 Mbps by 2001.

2.10 Asia Pacific Advance Network

Asia-Pacific Advanced Network Consortium (**APAN**) was established on 3 June 1997 for research and development in advanced networking application and services in the Asia-Pacific region.

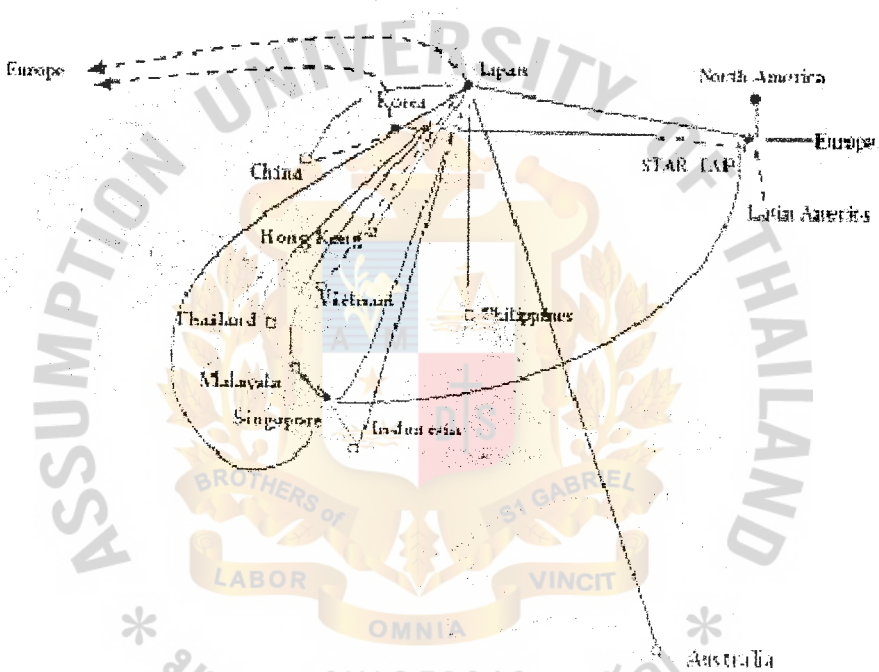


Figure 2.6. Asia Pacific Advance Network.

2.11 Amount of Domain Name in Thailand

Domain Name in Thailand means third-level Domain Name that are every kinds of last dot (th that is Thailand code) such as nectec.or.th. Register of Domain Name is Thailand Network Information Center (thnic) that are classified as follows;

(1) co.th = for commercial organization register

(2) ac.th = for academic register

(3) go.th = for government register

(4) net.th = for internet service segment

(5) or.th = non- commercial

III. NETWORK SYSTEM MODEL

3.1 Internet Users Model

The International Link data is transition from country to outside country. This link will be pass to ISP (Internet Service Provider) that have made to provide with customer. Every ISPs will pass to CAT (Communication Authority of Thailand) and will go through outside hosting at United of America, Asia, Europe zone. The International routing will go to the end of their hosting and reverse to start of node in Thailand.

Figure 3.1. International Link in Thailand.

The domestic link will be used to transmission inside the country. End user can be exchange information each other including to sending and receiving information from one place to another place by ISPs service, which will provide and store information in the hosting. However they have created big hosting as Public Internet Exchange(PIE) at NECTEC and National Internet Exchange(NIX) at CAT that are exchange information inside country so that is reduce cost International leased line and distance.

1997.08.19 NECTEC initiated a monthly Internet Connection in Thailand service. The most up-to-date Internet Map for Thailand is released through this web page every month. All Internet Service Providers and major communication hubs and exchanges in Thailand are presented.

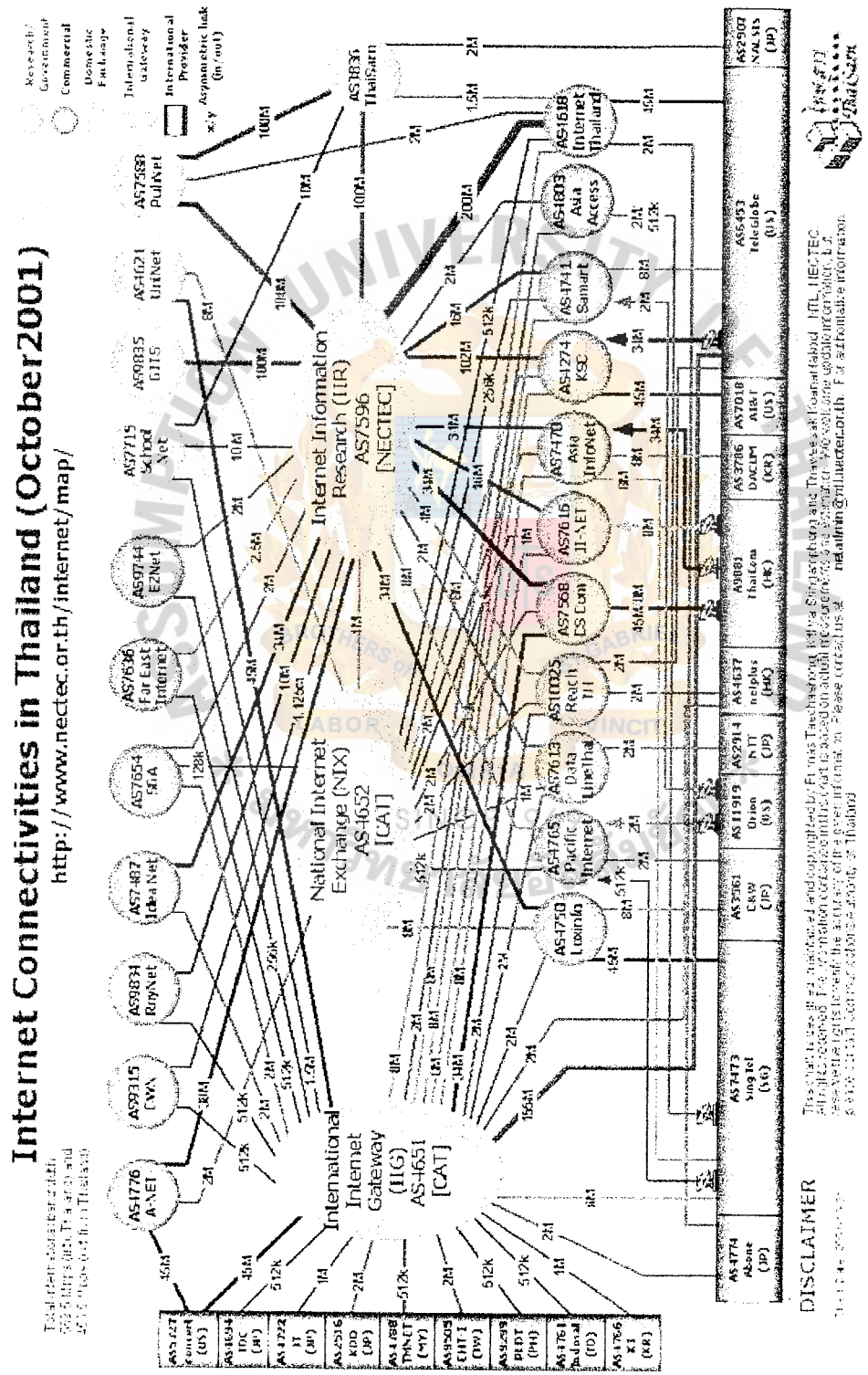


Figure 3.2. Internet Map of Thailand in October 2001.

From Figure 3.1 will show to many small circles a total of 15 circles that is 15 commercial ISPs in Thailand and non-commercial ISPs are 4 firms such as Thaisarn, SchoolNet, PubNet, Uninet. In the part big two circles are large firms that will make to exchange large information in domestic Internet. Both firms of big domestic exchange center are NIX-National Internet Exchange of CAT and PIE-Public Internet Exchange at NECTEC will be done to research and Internet International Gateway of CAT. PIE project has been established by NECTEC that can be count and information gathering to keep to be statistic in present. Form surveying had found data flow about 150 billion bytes per day by information has flowed data around 32% of total of information exchanging. Domestic information exchanging will be help decrease expenditure about 140 million baht per day meanwhile information access and flow rate can be faster in the past.

3.2 Research Methodology

From Rear Admiral Prasart Sridhandung's Internet Users model has built a mathematical model to estimate the number of Internet users, which have been used since 1997. Two of the variables used in the model are the International link and Domestic link.

This model will become to mathematical equations as follows:

The International Link Formula

$$\textbf{User} = \textbf{11(Cx1024)}$$

Where;

User = Amount of User

C = International Link Capacity Channel in leased line by unit Mbps.

1024 = Number of 1 Mega bit per second(1 Mega=1024 bps)

11 = Constant Value of User Factor that is estimated 11 users to 1 Kbps.

The Domestic Link Formula

$$\text{User} = 4(Cx1024)$$

Where;

User = Amount of User

C = International Link Capacity Channel in leased line by unit Mbps.

1024 = Constant Number of 1 Mega bit per second(1 Mega=1024 bps)

4 = Constant Value of User Factor that is estimated 4 users to 1 Kbps

3.3 Internet Users in Thailand

On July 13, 1998, the National Economic and Social Development Committee announced in the Mass Communication and Information Technology Development Plan for Human Resource and Social Development (1999-2008):

"To facilitate computer communication in all tambon, and

Internet usage by 20 percent of the whole population"

By the year 2008, the government plans call for approximately 14 million Thais using the Internet.

Table 3.1. Rough Estimate of Numbers of Internet Users in Thailand and KSC.

		1998		2006	
		Thailand	**KSC**	**Thailand**	**KSC**
1.	Universities	275,000	100,000	1,500,000	450,000
2.	Commercial and Technical Colleges	110,000	53,000	800,000	240,000
3.	Elementary and High Schools	110,000	42,000	800,000	240,000
4.	Individual Users from government, state enterprises, private sectors, etc.	105,000	60,000	8,900,000	2,682,000
	Total	**600,000**	**255,000**	**12,000,000**	**3,612,000**

By the year 2006, when telecommunication is completely liberalized in Thailand, there should be about 12 million Internet users. Customers of all ISPs should be greatly increased by then. For example, KSC plans to increase the number of customers of about 0.25 million in 1998 to about 3.6 million customers in 2006. The rough estimate of the numbers of Internet users in Thailand and of KSC for 1998 and 2006 are given as shown in Table 3.1.

The approximate numbers of Thai national using Internet from 1969-2009 are given in Table 3.2.

Table 3.2. Approximate Numbers of Internet Users from Thailand.

Year	**1969**	**...**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
#users	1	...	100	200	300	400	500	1,000	1,500	3,000*

Year	**1995**	**1996**	**1997**	**1998**	**1999**	**...**	**2006**	**2007**	**2008**
#users	50,000	150,000	350,000	600,000	800,000	...	12,000,000	13,000,000	14,000,000

***Notes:** Assumption University got in with 25,000 users.

Information concerning corporate users with ISPs in Thailand have been guarded as commercial secret because each ISP may be afraid that another ISP may try to take away the corporate customer. As an example, KSC has about 380 corporate customers in 1999. Altogether, the total number of corporate in Thailand connected to all the ISPs may be about 1,000. In the few years, the largest individual Internet link in Thailand is for HRH Princess Maha Chakri Sirindhorn and it is 2 Mbps provided by Assumption University and KSC. The largest link for universities is at Assumption University and it is 3 Mbps to the US.

3.4 Commercial Internet Services

In January 1994, THAISARN Internet Service (TIS), a joint-venture between the National Science and Technology Development Agency (NSTDA) 34%, the Telephone Organization of Thailand (TOT) 33%, and the Communication Authority of Thailand (CAT) 33% was established to give Internet services mainly to governmental, research, academic, and social development institutions, and was administered by NECTEC.TIS receive an ISP license from CAT in September 1994, thus allowing it to fully provide commercial Internet services. Commercial operation officially began on March 1, 1995 as Internet Thailand Service Center (ITSC) but was not yet a company limited, it had 512 Kbps international link connected to UUNET.

All commercial ISPs must have a joint-venture with the Communication Authority of Thailand (CAT) 35% and that amount to be paid by the ISP, and all equipment used in giving Internet services must be transferred to CAT. Furthermore, two representatives from CAT shall be on the board of directors, and chaired by one of them. The ISP license is valid for 10 years. The ISPs are listed below in order of the date they started their operation shown with their present international and domestic bandwidth (March 1, 1999) in megabits-per-second (Mbps).

Table 3.3. Bandwidth of ISP in1995-1998.

Date	ISP	International Link(Mbps)	Domestic Link(Mbps)
1995.3	Internet Thailand	10	10.5
1995.5	KSC Commercial Internet	8	3.5
1996.3	Loxley Information Services	5.5	2.5
1996.3	Info Access	1	0.5
1996.3	Samart Infonet	2.5	1
1996.6	INET(Thailand)	0.5	0.5
1996.7	A-Net	4	2.5
1996.1	Data Line Thai	0.125	0.1875
1996.12	Idea Net	0.25	0.125
1997.3	Asia Infonet	2	0.5
1997.6	Worldnet and Services	2	1
1997.7	Far East Internet	0.125	0.125
1997.1	Siam Global Access	0.5	0.25
1997.1	C.S.Communication	3	0.5
1998.3	Chomanan Worldnet	0.5	0.125

3.5 Internet Fees in Thailand

3.5.1 CAT Controlled Internet Rates 1996

Internet Fees at the beginning were regulated by CAT with ceiling and floor prices for start-up fees and monthly fees, and divided into two categories, Individual Users and Corporate/Organization Users. The most simple and cheapest was 800/480 baht start-up respective monthly fee for Individual User email only subscription. For the Corporate/Organization Users was substantially more costly, starting with 30,000/ 18,000 baht start-up respective monthly fee for 9.6 Kbps. Leased-line.

The rates shown below is the maximum that ISPs can charge, and hence each ISP will be able to offer cheaper prices down to a lower limit which is 40% of the ceiling rate.

Table 3.4. Individual Users.

Service	Link	Star-up Fee(Bht)	Monthly Fee(Bht)	Hours Online	Disk Space (MB)
Email & News Service	Dial-up	800.00	480.00	15.00	0.60
Full Internet Service1	Dial-up	1,200.00	720.00	20.00	1.00
Full Internet Service2	Dial-up	2,400.00	1,440.00	45.00	2.00
Full Internet Service3	Dial-up	3,600.00	2,160.00	70.00	3.00
Virtual IP Service 1	Dial-up	2,000.00	1,200.00	20.00	1.00
Virtual IP Service 2	Dial-up	3,000.00	1,800.00	40.00	2.00

Table 3.5. Corporate/Organization Users.

Service	Connectivity	Start-up Fee(Bht)	Monthy Fee(Bht)
UUCP	Dial-up	8,000.00	4,800.00
IP 9.6Kbps	LL	30,000.00	18,000.00
IP 14.4Kbps	LL	40,000.00	24,000.00
IP 19.2Kbps	LL	50,000.00	30,000.00
IP 28.8-63.9Kbps	LL	100,000.00	60,000.00
IP 64Kbps	LL	200,000.00	120,000.00
IP 128Kbps	LL	350,000.00	210,000.00
IP 256Kbps	LL	500,000.00	300,000.00
IP 512Kbps	LL	1,400,000.00	840,000.00

3.5.2 New CAT Internet Rates 1997

After approximately six months of price control of the Internet usage, the public criticized CAT as being both Internet regulator and major shareholder in all ISPs at the same time, thus, keeping the Internet fees high to make more profit for ISP and in turn for CAT. Therefore, in March 1997, CAT boldly reduced the international half-link and domestic link charges approximately 20% for all ISPs and a 20-80 percent reduction in the maximum Internet access charges for end-users as shown below.

Individual Users

Table 3.6. First Service.

Service	Connectivity	Start-up(Bht)	Monthy(Bth)	Hour Online	Disk Space(MB)	Extra Charge(Baht)
Text	Dial-up	8	14.4	15	2	1.2
Graphic	Dial-up	12	36	20	2	1.6

Second Service

Text Service: First 10 hours will be charged at 400 bahts.

Usage over 10 hours will be charged 40 bahts/hour.

Graphic Service: First 10 hours will be charged at 600 bahts.

Usage over 10 hours will be charged 60 bahts/hour.

Table 3.7. Corporate/Organization Users.

Service	Connectivity	Start-up Fee(Bht)	Monthy Fee(Bht)	Traffic(MB)	Extra Fee(Bht/MB)	Monthly Fee(max)
UUCP	Dial-up	3,600.00	3,600.00	40hrs	75hrs	NA
IP 9.6Kbps	LL	13,500.00	13,500.00	1,300.00	10.00	18,000.00
IP 14.4Kbps	LL	18,000.00	18,000.00	1,900.00	10.00	22,500.00
IP 19.2Kbps	LL	22,500.00	22,500.00	2,500.00	10.00	45,000.00
IP 28.8-63.9Kbps	LL	45,000.00	45,000.00	3,700.00	10.00	90,000.00
IP 64Kbps	LL	90,000.00	90,000.00	8,400.00	10.00	157,000.00
IP 128Kbps	LL	157,500.00	157,000.00	16,600.00	10.00	225,000.00
IP 256Kbps	LL	225,000.00	225,000.00	33,200.00	10.00	630,000.00
IP 512Kbps	LL	630,000.00	630,000.00	66,400.00	10.00	1,890,000.00
IP 513Kbps-2Mbps	LL	1,890,000.00	1,890,000.00	265,400.00	10.00	3,780,000.00

Note:

(1) A customer that upgrades to a higher bandwidth will be charged with the difference between the former and the new start-up fee.

(2) These rates are the maximum that ISPs can change, and hence each ISP will be able to offer cheaper prices down to a lower limit which 40% of the ceiling rate.

3.5.3 Liberalized Internet Rates 1998-9

Since the beginning of Commercial Internet in Thailand, CAT's price control did not result in any substantial effectiveness. The maximum ceiling intended to guard the public from being over-charged was never reached by any ISP, all were fighting with cheaper rates to gain market share and found near or even below the minimum floor in some cases. Furthermore, the Economic Crisis from the floatation of the Baht in mid 1997 resulted in cash shortage for all industries including ISPs, also urged price dumping. So, around 1997 year-end, CAT ceased to regulate Internet rates, and not much change to the market price has taken place. The following are some of the Internet fees offered in 1999.

Table 3.8. Liaberalized Internet Rates 1998-1999.

ISP	Brand Name	Hours online	Storage(MB)	Start-up fee	Monthly Fee	Excess Charge
A-Net	A-Net Direct	25	unlimit	900	None	None
	A-Net Direct	50	unlimit	1,700	None	None
	A-Net Direct	100	unlimit	3,200	None	None
Asia InfoNet	Asianet1	10	2	200	500	40
	Asianet2	20	2	200	900	30
	Asianet3 Web50	50	2	200	2,400	None
	Asianet3 Web100	100	2	200	4,500	None
	Asianet3 Web200	200	2	200	8,400	None
CS Communication	GraphicPro 1	20	2	200	700	25
	GraphicPro 2	30	2	200	900	25
	GraphicPac 1	50/6m	2	200	1,800	25
	GraphicPac 2	100/12m	2	200	3,600	25
	SavePac	10	2	200	400	35
	FlexyPac	-	2	200	450	20
Data Line Thai	Linethai 1	30	2	200	595	20
	Linethai 2	50	2	200	795	20
	Linethai 3	15	2	200	395	20
Idea Net	Graphic 2	50	2	500	None	25
	Unlimited	no limit	2	45,000	None	None
Inet	IntenetPlus	20	2	None	799	None
	InternetExpress	10	1	None	499	None
	AsiaAccess	20	2	None	300	20
InfoNews	Individual	10	2	200	500	None
	Individual	20	2	200	800	None
Internet Thailand	WorldNet	20	2	200	300	20
	WorldNetPlus	20	2	300	900	30
	BizNetPlus	40	2	800	1,400	30
KSC	KSC Instant	15	2	599	None	None
	KSC Premium	20	5	300	900	25
	KSC Economy	15	2	300	500	45
Loxinfo	WebKit 1	10	2	None	500	40
	WebKit 2	20	2	None	900	30
	WebKit 3	50	2	None	2,500	n/a
Samart	Economy	10	1	300	500	50
	Flexible	-	2	300	500	20
	ApricotGS 20	20	2	300	500	20
	ApricotGS 40	40	2	300	900	20
WorldNet	Graphic Service	20	2	None	900	20
	Graphic Service	40	2	None	1,200	20

3.6 IRR (Internet Information Research) at NECTEC

IRR is research group in Network Telecommunication Lab (NTL) at NECTEC that IIR will measurement and estimation both Internet user and include to additional international links form Academic/ research/ government, commercial, Domestic Exchange groups. IRR will be verifying data flow meanwhile verify and update Internet user also.

This Figure 3.2 will be shown IRR that are combining to information form their groups.

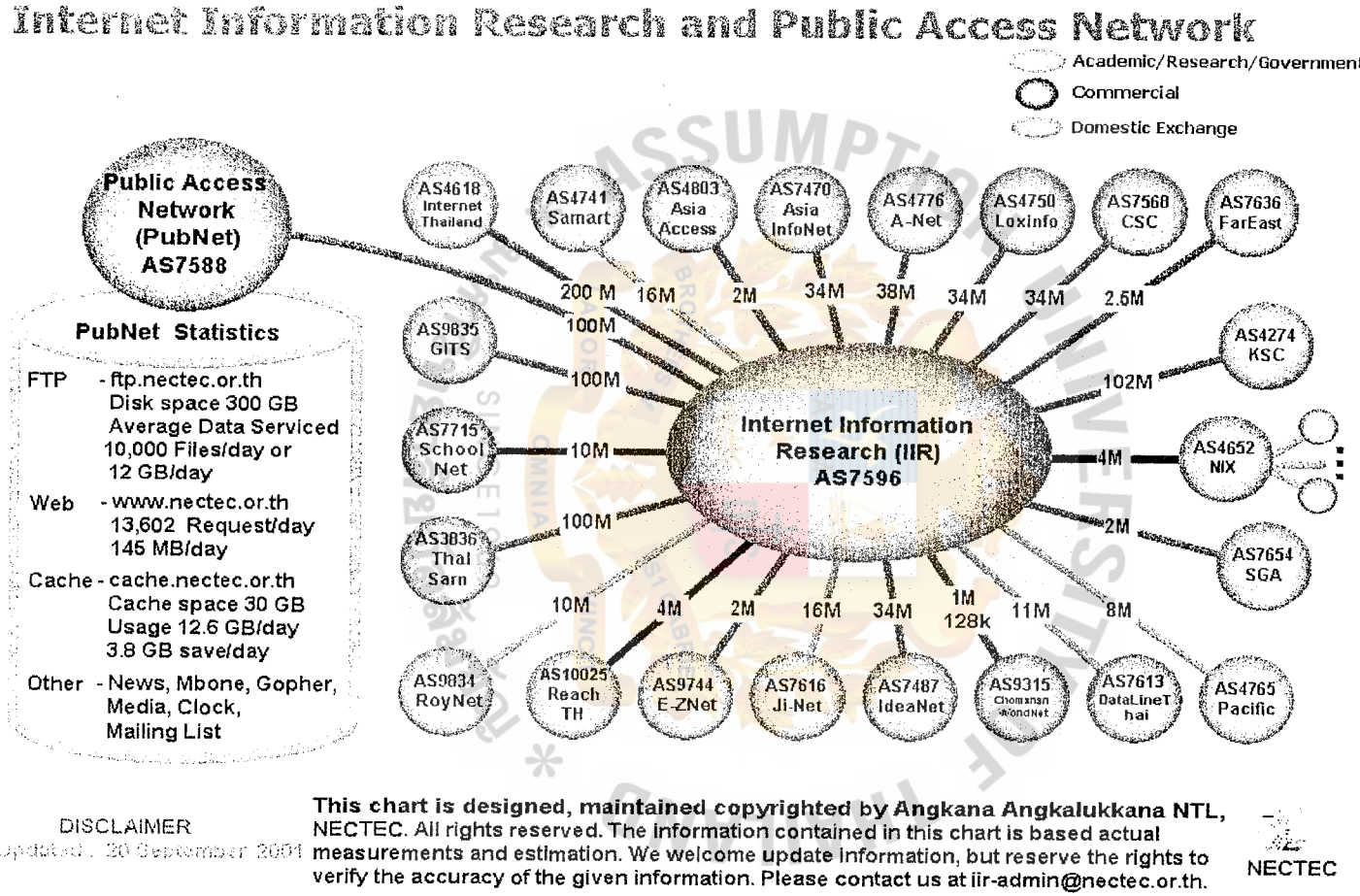


Figure 3.3. Internet Information Research.

The ThaiSarn Public Internet Exchange (PIE) is set up as a peering point for Thai ISPs to access public information on the ThaiSarn Public Access Network (PubNet) operated by the Network Technology Laboratory of the National Electronics and Computer Technology Center (NTL/NECTEC).

Operations of PIE is undertaken by NTL and will be strictly emphasized on fairness of access. Traffic to PUBNET and ThaiSarn is provided for free to all PIE Participants (PIEPs) provided that it strictly abides by ThaiSarn Acceptable Use Policy (ThaiSarn AUP). Inter-ISP traffic may or may not follow ThaiSarn AUP; NTL does not concern or impose any restrictions over commercial traffic as long as it is not destined for or transit via ThaiSarn and/or PUBNET. Violation to ThaiSarn AUP simply means the PIEP is terminated from PIE.

PIE Pilot Project is part of the National Information Infrastructure action plan to support a strong, unified and most economical means for running the Internet in Thailand. It is planned to be a joint mission between Government, Academic/Research Institutions and the private sector.

PIE Project will ensure that all participants will be given equal opportunities to access the third-generation academic/research network "ThaiSarn-III", the Knowledge Distribution Network of Kanchanapisek Network, and public portion of the Government Information Network (GInet). PIE is partially funded by the Royal Thai Government, and is operated as a not-for-profit task of NECTEC.

Definitions of Terms

(1) THAISARN. Thai Social/Scientific Academic and Research Network - the network that links to almost all state universities, NSTDA, Kanchanapisek Network and SchoolNet Thailand projects.

(2) PIE. ThaiSarn Public Internet Exchange - an exchange point in Thailand that

is funded by NECTEC for all ISPs and ThaiSarn NOC. PIE is characterised as a low hop-count, fat pipe conduits to all major commercial ISPs and major academic/research hubs such as ThaiSarn, SchoolNet and NSTDA.

(3) PUBNET. ThaiSarn Public Access Network - A network of *national servers* which are information services which are meant to be given universal access to the Thai citizen.

(4) NATIONAL SERVERS. A pool of information servers which are created for the benefits of data network users in Thailand. These servers typically provide unique information about Thailand; Kanchanapisek Network Servers; NECTEC media servers; NECTEC specialized servers such as the network time server; SchoolNet Thailand Project; government webservers hosted by NECTEC.

(5) PIEP. PIE Participant - a Commercial Internet Service Provider who receives a valid operating license from the Communications Authority of Thailand.

IV. NETWORK SYSTEM MODEL IN 1997

4.1 International Link Growth

One of the most important part of the Internet which could be classified as its vital infrastructure is the international link, it's communication path to the rest of the world. It is also the costliest part of an ISP's operations cost, 40-50%. In Thailand, an international link subscriber pays a certain amount to the international carrier company and another almost equal amount called the half-link to CAT. It is the heaviest burden to an ISP, but to get more income one has to get more users which in turns requires more international-link bandwidth, it is directly proportional to one another. Information with direct relevance to a company's efficiency which would reflect the true growth is very hard to find, especially in Thailand. So total sales volume and sales revenue of Internet sales from ISPs are not possible, they are considered as top secret, other factors from indirect means have to be used. One factor which should be a true indication of Internet growth is the increase of international link which can be monitored freely. Approximately at year-end 1992 there was 0.01 Mbps. to march 1999 with 50.30 Mbps, which is a growth of 5029 fold in 6.25 years. A significant growth in international-link bandwidth in 1997 despite the Economic Crisis must result from the lowering of CAT's international half-link and domestic link charges. The figures for each year is shown below.

Table 4.1. International Link Internet Growth.

Year	1992/12	1993/12	1994/12	1995/12	1996/12	1997/12	1998/12	1999/3
Bandwidth Mbps	0.01	0.13	2.77	4.77	12.13	28.51	37.05	50.3
Increase		0.12	2.64	2	7.36	16.38	8.54	13.25
Growth %		1200	2030	72	154	13.5	30	36

4.2 Domestic Link Growth

Because the cost of international link is so high, and representing the major operating cost for ISPs ranging from 40 - 50% of total cost, all ISPs had to find some other solution to reduce that part of the cost. Connecting to a domestic gateway was a solution, first was at CAT which was setup in 1997 called National Internet Exchange (NIX), and the second was at NECTEC in 1998 called Public Internet Exchange (PIE). Aside from reducing operating cost, users in Thailand communication with each other did not have to transit the USA, thus reducing the time to travel.

Table 4.2. Domestic Link Internet Growth.

Year	1997/12	1998/12	1999/3
Bandwidth Mbps	13	19.8125	24.9375
Increase		6.8125	5.125
Growth %		52	26

4.3 Internet Users Growth

Direct head count of Internet users has not been possible anywhere in the world, and in Thailand that would be much more difficult. ISPs are not releasing the exact number of their clients not because it's a secret, but because they do not have it. That stems from several reasons, one is the corporate users do not report how many users they each have, nor do the provincial hubs report their users. Even the Bangkok users are not fully accounted for, the ready-to-use packs which are sold on racks cannot be traced until used and registered online.

From surveys made on provincial hubs before 1997 when only international link was used, it was found that those that have a 64 Kbps link and running at near 100% utilization have between 600-700 customers or approximately 10 customers to 1 Kbps of bandwidth. Very similar outcome would result from hubs with 128, 192, 256, and 512 Kbps bandwidths. On the other hand, corporate leased-line customers reported slightly higher number of users per Kbps bandwidth used and would result in approximately 11-12 users to 1 Kbps. Therefore, generalizing that, 11 users to 1 Kbps. of international link is used to estimate the number of Internet users. From 1997 onwards, when domestic link was used and all domestic traffic did not have to go to the USA first and then back to Thailand again, the utilization of the international link dropped 30-40%. Rough estimation is that 1 Kbps. of domestic link should support 3-4 more users.

Therefore, using the bandwidths utilization in Tables 4.1 and 4.2 as basis to estimate Internet users in Thailand as follows.

Table 4.3. Internet User Growth Both International and Domestic Link.

Year	1992	1993	1994	1995	1996	1997	1998	1999
International Link(Mbps)	0.01	0.13	2.77	4.77	12.13	28.51	37.05	50.3
#User = Int.link x 11x1024		1464	31201	53729	136632	321136	417331	566579
Domestic Link(Mbps)						13	19.8125	24.9375
#User = Dom.link x 4x1024						53248	81152	102144
Estimate Internet Users		1464	31201	53729	136632	374384	498483	668723
Growth %			2031	338	154	174	33	34

This quite unorthodox method of estimating the number of Internet users in Thailand shows that the rate of growth was quite astronomical at the beginning of its introduction to Thailand, which should not be considered a true statistical trend. Starting 1996, a growth rate of 154% seem quite correct, so was 1997 with 174%. The Economic Crisis in the third quarter of 1997 showed its impact and the growth rate sank to 33% and 34% for 1999. However, these last two staggering growth rates are still far better than most commercial sectors in Thailand.

4.4 Growth of Internet Sales

Another factor of the commercial Internet that information is fully available to the public, its each ISP's financial report that must be annually submitted to the Commercial Registration Department. Therefore, each ISP's total sales is available, and added up would represent each year's Internet sales. However, the deadline for submittal is the end of May, only a few ISPs have closed their 1998 book-keeping and had been audited, most figures for 1998 are not yet final. Because only Internet Thailand and KSC started operation before 1996, therefore 1996 and before will be excluded from the report.

By the end of 1996, nine ISPs out of the present fifteen has started operation, some during the very last few months of the year. Total sales for 1996 was 220,461,177 bahts (US$=25 bahts). In 1997, five more ISP opened up right in the middle of the economic crash, they were probably the ones that suffered less. The bahts devalued from 25 bahts in July 1997 to the US$ to 48 bahts in December. All ISPs operated with limited registered capital (15 million bahts) and therefore are reliance on loans and ODs which suddenly became unavailable or very difficult to get. But 1997 year-end Internet sales recorded 522,608,747 bahts, an increase of 104.5% from last year. In 1998, the bahts tumbled further to a record low of 55.5 bahts to a US$ in January, but recovered to 36 bahts in December 1998. An unofficial estimation sales figure for 1998 is no less than 900 million bahts, an increase of 72%, which is much higher then any other industry in the IT-sector.

4.5 Country-wide Expansion

In 1995, when Commercial Internet started and the first two ISP went into operation, Bangkok Metropolis (Bangkok including satellite provinces; Pathum Thani, Nonthaburi, and Samut Prakarn which all have the same telephone dial code 02) was the only area Internet was accessible via a local phone call which cost 3 bahts, the rest of Thailand had to call long-distance. Twenty-five hubs were set-up by 5 ISPs in 12 provinces in 1996. Two years later by December 1998, 87 hubs were set-up by 9 ISPs in 49 provinces, which when Bangkok Metropolis is counted 53 provinces are covered. Today, 23 provinces are still without Internet hubs and must connect through long distance calls. By the end of 1999, 57 more hubs are anticipated and 56 more in year 2000 covering all 76 provinces in Thailand.

V. RESEARCH METHODOLOGY

5.1 Overview

The aim of the project that is verifying Internet users model for users behavior study and optimum requirement of users. The capacity of information sending is fast or slow depending on media that media have several types. The media may be copper wire, fiber optic, and microwave link and include to satellite link, depending on the availability and distance. On the other hand, the capacity of media is used to send and receive several formats such as text files, graphic mode and application programs.

The users will send information by the leased line, which is media. The leased line is leased to come form ISP (Internet Service Provider) and must send to CAT (Communication Authority of Thailand) that is control and monitor whole lease lines.

Once, Those information are increased until they aren't able to send and receive that means leased line has strived its capacity channel, users must change to increase leased line. Those reasons that were found out what should be the factor for using the criteria to predicting the number of users Internet in Thailand.

According to Rear Admiral Prasart Sribhaduang's mathematical model information that has been used since 1997. It is known that user behavior will changed for the time. This project meant to estimate the verifying Internet user model and periodically verification must be conducted to update the model. However, this project will conduct surveys required to collect information to verify that mathematical model used to estimate the number of Internet users in Thailand.

5.2 The Steps in the Research Process

Designing and conducting the project can be very complicated because of technical terms and number of parties involved. Furthermore, a research project must be well planned to ensure that money is well spent. Organizing the project decisions into a series of steps simplifies the planning process. Figure 5.1 lists the steps in the research process.

(1) Formulate the Problem.

A thorough understanding of the problem is essential when planning a research project. Otherwise, the data collected may not adequately address the problem. Unfortunately, problem is not properly defined; the data collected may be useless.

(2) Specify the Research Design.

The second step in the research process is to specify the general design of the project. This step involves two decisions: the type of research to be conducts and source of the data.

(3) Develop the Data Collection Procedure.

When collecting primary data, whether for an exploratory, experimental, or descriptive study, the procedure to be used to collect the data must be developed. Typical decisions at this stage involve the selection of the method used to collect the data and the design of any necessary data-collection instruments.

A variety of methods exist to collect data. Either people can be questioned or their behavior can be observed. The appropriateness of each method varies across studies, and the research must determine which method is best for the study at hand.

The design of a data collection instrument can influence the accuracy of information collect in a study. Simple changes in wording or in the way the questionnaire looks can drastically influence the received. The researcher must ensure that questions are properly worded and that the instrument is properly designed.

(4) Design the Sampling Procedure.

For most studies, only a sample of all possible people or objects will be questioned or examined. Designing the sampling procedure to use is critical. Who is included as a potential sample member, how sample members are selected, and the size of the sample all affect what can be inferred from the results.

(5) Collect the Data.

Companies often hire field services to collect marketing research data. The data collected are only as good as the procedures used to collect them. Therefore, the researcher must institute procedures for selecting and supervising field services to ensure the designed data collection procedure are followed.

(6) Verify and Analyze the Data.

After the raw data have been collected, they must be prepared for verify and analyze. It is important that the researcher selects appropriate data analysis procedure, given the information needs of the study the type of data collected.

(7) Present the results.

The research findings are little value unless their meaning can be clearly communicated to the manage requesting the study. Established for mats exist for written and oral presentations. The researcher must see to it that these formats are follows.

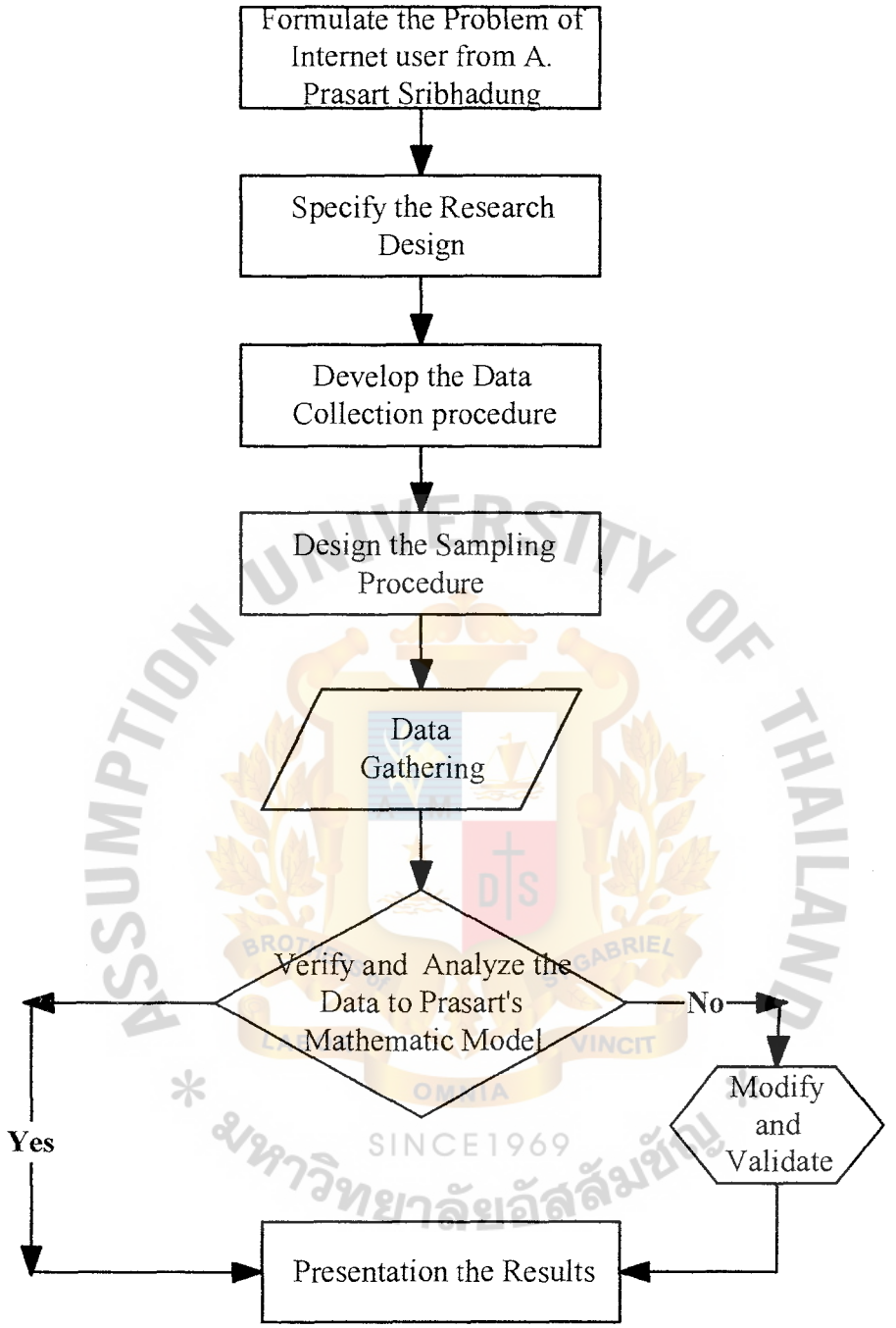


Figure 5.1. Steps in the Research Process.

5.3 Information Gathering

This project is meant the organizations have leased line to pass ISP (Internet Service Provider) directly. The reason, This project must be selected leased line form ISP because they can be classified from other system such as ASDL and ISDN which aren't target group and different methods.

We have surveyed 30 samples that author has directly inquired from network engineers and system administrators of each firms. However the firms are composed both government and private firms therefore those information will be completed and covered about information. Moreover, The data can be accurate and trusted for those.

The questionnaires were able to serve as an interview checklist and the respondents were asked to answer the question shown in Appendix C.

Besides the another information are able to use research in this project that is Traffic Factor (UF) by MRTG or HP Open view program.

The Information Gathering is accumulated and evaluated form government and private companies as the below table.

Table 5.1 Internet Users Data in the Part International Link.

No.	Company list		International link			
		Type of leased line	CAPACITY(Mbps)	Average UF(%)	Peak UF(%)	Amount of users
1	ABAC	Copper wire, Microwave	8	60	80	20,000.00
2	KU	Fiber Optic	2	39	220	30,000.00
3	KMIT'NB	Fiber Optic	1	64	99	23,000.00
4	KMUTT	copper wire	1	24	47	13,000.00
5	SRIPATUM U.	copper wire	2	68	97	15,000.00
6	BANGKOK U.	Fiber Optic	4	69	98	20,000.00
7	KASEMBDUDI U.	copper wire	0.512	70	92	2,800.00
8	ASIA U.	copper wire	0.128	14	85	330.00
9	UTCC	copper wire	2	78	95	21,000.00
10	SUANSUNUNTA'S INSTITUE	copper wire	0.256	85	98	5,000.00
11	The Naval Academy	copper wire	0.256	23	97	2,850.00
12	RTA	copper wire	0.512	39	110	3,486.00
13	MOTC	copper wire	0.512	40	85	1,000.00
14	OOEP	copper wire	0.064	60	80	200.00
15	AEROTHAI	copper wire	0.256	57	103	1,723.00
16	F.E.ZUILLIG	copper wire	0.064	18	100	130.00
17	SVOA	copper wire	0.512	40	85	500.00
18	SUMITRONIC	copper wire	0.128	6	73	50.00
19	TYCO ELECTONIC(Thailand)	copper wire	0.128	80	200	100.00
20	SIT	copper wire	0.128	5	95	40.00
21	UNOCAL(Thailand)	copper wire	0.128	40	99	1,100.00
22	EDS(CALTEX)	copper wire	1	10	95	500.00
23	THE NATION GROUP	copper wire	0.512	65	85	1,700.00
24	AMD	copper wire	0.256	70	95	700.00
25	TOYOTA	copper wire	0.128	40	85	300.00
26	AMARIN PRINTING	copper wire	0.128	35	95	150.00
27	BANGKKOK AIRWAY	copper wire	0.128	70	96	800.00
28	THAI CENAMIC	copper wire	0.256	50	90	250.00
29	IBM(THAILAND)	copper wire	1	70	95	520.00
30	SIAM CEMEN	copper wire	1	45	98	16,000.00

The International Link data is transition from country to outside country. This link will be pass to ISP (Internet Service Provider) that have made to provide with customer. Every ISPs will pass to CAT (Communication Authority of Thailand) and will go through outside hosting at United of America, Asia, Europe zone. The International routing will go to the end of their hosting and reverse to start of node in Thailand.

Table 5.2. Internet Users Data in the Part Domestic Link.

No.	Company list	Domestic link				
		leased line Type	Capacity(Mbps)	Average UF(%)	Peak UF(%)	Amount of users
1	ABAC	Microwave	1	57	95	20,000.00
2	KU	Fiber Optic	1	90	120	30,000.00
3	KMIT'NB	Fiber Optic	0.8	40	97	23,000.00
4	KMUT'T	copper wire	0.256	50	89	13,000.00
5	SRIPATUM U.	copper wire	1	60	96	15,000.00
6	BANGKOK U.	Fiber Optic	2	69	98	20,000.00
7	KASEMBDUDI U.	copper wire	0.128	56	75	2,800.00
8	ASIA U.	copper wire	2	43	85	330.00
9	UTCC	copper wire	0.256	58	87	21,000.00
10	SUANSUNUNTA'S INSTITUT	copper wire	0.128	80	110	5,000.00
11	The Naval Academy	copper wire	0.128	73	112	2,850.00
12	RTA	copper wire	0.256	69	98	3,486.00
13	MOTC	copper wire	0.128	68	87	1,000.00
14	OOEP	copper wire	0.01	40	50	200.00
15	AEROTHAI	copper wire	0.064	30	73	1,723.00
16	F.E.ZUILLIG	copper wire	0.205	50	83	130.00
17	SVOA	copper wire	0.128	72	95	500.00
18	SUMITRONIC	copper wire	0.128	35	65	50.00
19	TYCO ELECTONIC(Thailand)	copper wire	0.256	42	65	100.00
20	SIT	copper wire	0.064	75	98	40.00
21	UNOCAL(Thailand)	copper wire	0.128	20	90	1,100.00
22	EDS(CALTEX)	copper wire	1	22.2	54	500.00
23	THE NATION GROUP	copper wire	0.128	30	65	1,700.00
24	AMD	copper wire	0.64	25	63	700.00
25	TOYOTA	copper wire	0.064	42	75	300.00
26	AMARIN PRINTING	copper wire	0.064	86	105	150.00
27	BANGKKOK AIRWAY	copper wire	0.064	47	87	800.00
28	THAI CENAMIC	copper wire	0.064	36	89	250.00
29	IBM(Thailand)	copper wire	2	35	98	520.00
30	SIAM CEMEN	copper wire	0.512	80.5	199	16,000.00

The domestic link will be used to transmission inside the country. End user can be exchange information each other including to sending and receiving information from one place to another place by ISPs service, which will provide and store information in the hosting. However they have created big hosting as Public Internet Exchange(PIE) at NECTEC and National Internet Exchange(NIX) at CAT that are exchange information inside country so that is reduce cost International leased line and distance.

This link can be used to select types of Leased line type, how many to capacity Channel, Average Utilization Factor percent, Peak Utilization Factor percent, Users. The data is able to explain as follows:

Leased Line may be Copper wire, Fiber Optic, Microwave link, Satellite link that are used to see different both capacity and application. Capacity channel is speed of Leased line that is necessary to use for those.

Averages and Peak Utilization Factor will be calculated to percentage of total capacity bandwidth, which can be monitored by MRTG program.

Peak Utilization Factor can be monitored by MRTG program.

Users who are person have also got E-mail address both individual e-mail and group.

Table 5.3. Internet Users Data in the Other Factor Part.

No.	Company list	Internet Users Increasing(%)	Remote Access	Computer	Proxy Servers	Memory(Gbps)
1	ABAC	25.00	762.00	1,000.00	2	4
2	KU	5.00	360.00	3,000.00	2	2
3	KMIT'NB	25.00	400.00	1,000.00	2	20
4	KMUTT	10.00	150.00	3,000.00	1	27
5	SRIPATUM U.	15.00	360.00	1,200.00	2	72
6	BANGKOK U.	10.00	415.00	1,500.00	5	20
7	KASEMBDUDI U.	20.00	64.00	300.00	1	20
8	ASIA U.	10.00	8.00	400.00	1	18
9	UTCC	30.00	192.00	1,500.00	3	41
10	SUANSUNUNTA'S INSTITUE	30.00	60.00	600.00	2	40
11	The Naval Academy	20.00	128.00	200.00	3	60
12	RTA	20.00	128.00	250.00	3	27
13	MOTC	10.00	111.00	300.00	2	18
14	OOEP	20.00	-	120.00	1	6
15	AEROTHAI	30.00	30.00	200.00	2	6
16	F.E.ZUILLIG	30.00	10.00	130.00	2	1
17	SVOA	20.00	16.00	400.00	1	36
18	SUMITRONIC	20.00	5.00	60.00	1	6
19	TYCO ELECTONIC(Thailand)	5.00	5.00	57.00	1	6
20	SIT	10.00	4.00	40.00	1	128
21	UNOCAL(Thailand)	10.00	24.00	400.00	2	32
22	EDS(CALTEX)	20.00	4.00	500.00	2	40
23	THE NATION GROUP	10.00	30.00	1,000.00	2	20
24	AMD	20.00	8.00	1,000.00	1	20
25	TOYOTA	15.00	8.00	700.00	2	9
26	AMARIN PRINTING	20.00	3.00	200.00	3	10
27	BANGKKOK AIRWAY	20.00	16.00	1,000.00	1	9
28	THAI CENAMIC	10.00	5.00	200.00	1	9
29	IBM(THAILAND)	20.00	30.00	1,000.00	1	20
30	SIAM CEMEN	10.00	30.00	4,000.00	1	20
		520.00				
	Average of Increase Growth(%)	17.33				

The above table will show in the other factor that will be able to analyze for those. This table is compose to many factors however we will be analyze in later chapter that have effect to this Internet users model and will be signification how to affect in the Internet user growth.

The other factor can be how to accumulate and definite as follows:

(1) Internet Users Increasing is accumulated how to increase when have compared for 12 years. This factor will be observed to demand Internet users by compare to percentage Utilization Factor observing.

(2) Remote Access is number of remote access model that is classified by digital model and analog model. This factor will be study how many persons will use to remote from outside organizations.

(3) Computer will be observing amount of computers that are compared to amount of E-mail address to give for them.

(4) Proxy Server is kind of server that is store information to recall regularly. As some information will always called to use for execute. This factor will be studying relation between traffic factor and Proxy Server.

(5) Memory of Proxy Server will be observing how to relate with storage information. Large memory can be support large application and data to call rapidly.

VI. IMPLEMETATION

6.1 Verify Distinction from Internet Users Information to Prasart's Internet User Model.

Case 1:Utilization Factor = 100%

From Rear Admiral Prasart Sridhadung's Internet Users model have built a mathematical model to estimate the number of Internet users by this model is assumed to running 100% Utilization Factor, which have been used since 1997. Two of the variables used in the model are the International link and Domestic link.

This model will become to mathematical equations as follows:

The Internal Link Formula

$$\text{User} = 11(Cx1024) \qquad (1)$$

Where;

User = Amount of User that have Email address.

C = Capacity Channel of International link in leased line by unit Mbps.

1024 = Number of 1 Mega bit per second (1 Mega=1024 bps)

11 = Constant Value of User Factor that is estimated 11 users to 1 Kbps.

The Domestic Link Formula

$$\text{User} = 4(Cx1024) \qquad (2)$$

Where;

User = Amount of User that have Email address.

C = Capacity Channel of Domestic link in leased line by unit Mbps.

1024 = Constant Number of 1 Mega bit per second (1 Mega=1024 bps)

4 = Constant Value of User Factor that is estimated 4 users to 1 Kbps.

We will be use two equations that are taken data from questionnaire.

The verifying to constant value of User Factor (International and Domestic link are 11 and 4 respectively) are still use to accurate or not that we can compare calculation to data from questionnaires. If the information have error deviation too many things, as a result, we would be update User Factor. So that they would be suitable method and validity from other information such as IIRC (Internet Information Research Center).

To verifying Internet user model were shown in Table 6.1.

Table 6.1. The Verifying Internet User Method.

No.	Company list	International link				Domestic link			
		Capacity(Mbps)	Formula	Questionnaire	Different	Capacity(Mbps)	Formular	Questionnaire	Diferential
1	ABAC	8	90112	20,000.00	70,112.00	1	4096	20,000.00	- 15,904.00
2	KU	2	22528	30,000.00	- 7,472.00	1	4096	30,000.00	- 25,904.00
3	KMITNB	1	11264	23,000.00	- 11,736.00	0.8	3276.8	23,000.00	- 19,723.20
4	KMUTT	1	11264	13,000.00	- 1,736.00	0.256	1048.576	13,000.00	- 11,951.42
5	SRIPATUM U.	2	22528	15,000.00	7,528.00	1	4096	15,000.00	- 10,904.00
6	BANGKOK U.	4	45056	20,000.00	25,056.00	2	8192	20,000.00	- 11,808.00
7	KASEMBDUDI U.	0.512	5767.168	2,800.00	2,967.17	0.128	524.288	2,800.00	- 2,275.71
8	ASIA U.	0.128	1441.792	330.00	1,111.79	2	8192	330.00	7,862.00
9	UTCC	2	22528	21,000.00	1,528.00	0.256	1048.576	21,000.00	- 19,951.42
10	SUANSUNUNTA'S INST	0.256	2883.584	5,000.00	- 2,116.42	0.128	524.288	5,000.00	- 4,475.71
11	The Naval Academy	0.256	2883.584	2,850.00	33.58	0.128	524.288	2,850.00	- 2,325.71
12	RTA	0.512	5767.168	3,486.00	2,281.17	0.256	1048.576	3,486.00	- 2,437.42
13	MOTC	0.512	5767.168	1,000.00	4,767.17	0.128	524.288	1,000.00	- 475.71
14	OOEP	0.064	720.896	200.00	520.90	0.01	40.96	200.00	- 159.04
15	AEROTHAI	0.256	2883.584	1,723.00	1,160.58	0.064	262.144	1,723.00	- 1,460.86
16	F.E.ZUILLIG	0.064	720.896	130.00	590.90	0.205	839.68	130.00	709.68
17	SVOA	0.512	5767.168	500.00	5,267.17	0.128	524.288	500.00	24.29
18	SUMITRONIC	0.128	1441.792	50.00	1,391.79	0.128	524.288	50.00	474.29
19	TYCO ELECTONIC(Thai	0.128	1441.792	100.00	1,341.79	0.256	1048.576	100.00	948.58
20	SIT	0.128	1441.792	40.00	1,401.79	0.064	262.144	40.00	222.14
21	UNOCAL(Thailand)	0.128	1441.792	1,100.00	341.79	0.128	524.288	1,100.00	- 575.71
22	EDS(CALTEX)	1	11264	500.00	10,764.00	1	4096	500.00	3,596.00
23	THE NATION GROUP	0.512	5767.168	1,700.00	4,067.17	0.128	524.288	1,700.00	- 1,175.71
24	AMD	0.256	2883.584	700.00	2,183.58	0.64	2621.44	700.00	1,921.44
25	TOYOTA	0.128	1441.792	300.00	1,141.79	0.064	262.144	300.00	- 37.86
26	AMARIN PRINTING	0.128	1441.792	150.00	1,291.79	0.064	262.144	150.00	112.14
27	BANGKKOK AIRWAY	0.128	1441.792	800.00	641.79	0.064	262.144	800.00	- 537.86
28	THAI CENAMIC	0.256	2883.584	250.00	2,633.58	0.064	262.144	250.00	12.14
29	IBM(THAILAND)	1	11264	520.00	10,744.00	2	8192	520.00	7,672.00
30	SIAM CEMEN	1	11264	16,000.00	- 4,736.00	0.512	2097.152	16,000.00	- 13,902.85
	Verifying result				133,072.89				- 122,431.50

As exhibited in Table 6.1, a respondent is compare to differential calculation between Formula and questionnaire.

Each different result can be found form:

Verifying Different = Internet model formula - Questionnaire of surveying

Each different Result can be find form:

Verifying Result = Σ(Internet model formula - Questionnaire of surveying)

6.2 Result and Discussion of Internet Users Model and Surveying Different

The different Internet user model between formula and Questionnaire both the international link and Domestic link have too many different.

The verifying result will able to explain too many different as follows:

International Link

The verifying result of International link is positive too many different (+133,072.89) that means the Constant Value of User Factor in International Link (11 users to 1 Kbps) is exceed. Therefore it should be improved to suitable the user behavior.

Domestic Link

The verifying result of Domestic link is Negative too many different (-122,431.50) that means the Constant Value of User Factor in Domestic Link (4 users to 1 Kbps) is less . Therefore it should be improved to suitable the user behavior.

If the different of verifying result are as follows:

Verifying result = 0, that these formula is still able to used and suitable forecast in Internet users' behavior.

Verifying result <<< 0 and >>> 0, that these formula isn't able to used and suitable forecast in Internet users' behavior.

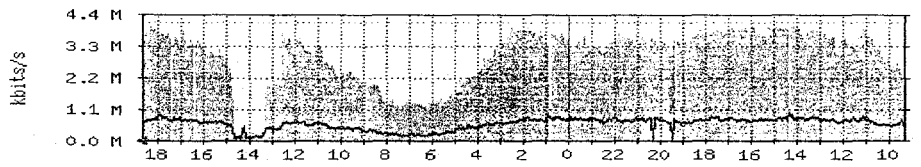
6.3 Verifying Internet User Model by UF Affects (International Link)

As the above topic 6.2 is assumed to data running at near 100% utilization factors, we must able to find multiple factor that let's call "Internet User Factor or User Factor". The User Factor will be mention and calculation in the topic later. However the Table 6.1 will be used to reference in various calculation including to user factor from those information by Prasart's Internet Users Model reference.

Utilization Factor is traffic of data flow in leased line that may be affects to hindrance with data transmission. How utilization Factor (UF) has affected with data flow that will be study later. Utilization Factor can be monitor by MRTG program (Multi Router Traffic Graphic) meanwhile can classified to monitor by daily, weekly, monthly, and yearly. Besides of separate incoming and outgoing traffic. This below Figure is user traffic sampling of Bangkok University.

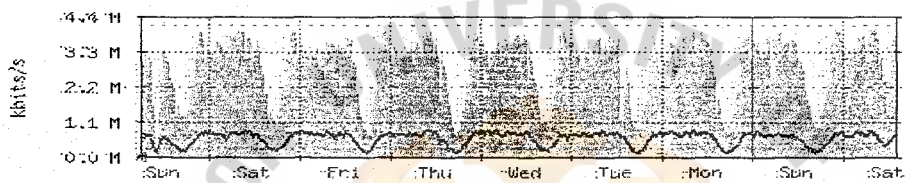
Traffic Analysis for 4 Mbps to A-Net
Max Speed:4096 kBits/s (propPointToPointSerial)
The statistics were last updated Sunday, 14 October 2001 at 18:40

Daily' Graph (5 Minute Average)



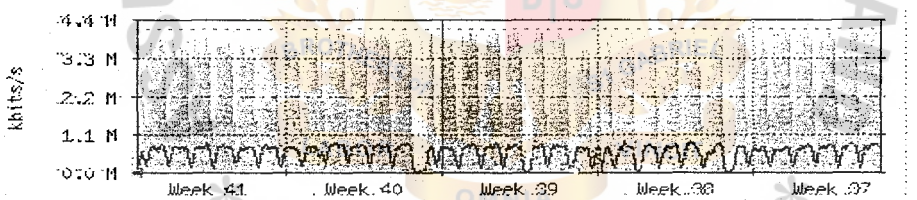
Max In:4025.7 kbits/s (98.3%) Average In:2946.3 kbits/s (71.9%) current In:3767.5 kbits/s (92.0%)
Max Out:982.4 kbits/s (24.0%) Average Out:606.1 kbits/s (14.8%) Current Out:665.9 kbits/s (16.3%)

Weekly' Graph (30 MinuteAverage)



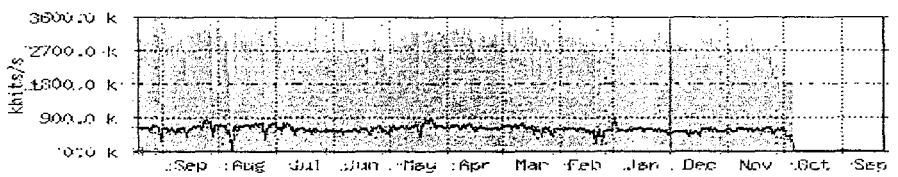
Max In:4026.0 kbits/s (98.3%) Average In:2939.0 kbits/s (71.8%) Current In:3755.2 kbits/s (91.7%)
Max Out:864.5 kbits/s (21.1%) Average Out:605.9 kbits/s (14.8%) Current Out:835.1 kbits/s (20.4%)

Monthly' Graph (2 HourAverage)



Max In:4032.3 kbits/s (98.4%) Average In:2898.6 kbits/s (70.8%) Current In:3128.8 kbits/s (76.4%)
Max Out:905.4 kbits/s (22.1%) Average Out:588.9 kbits/s (14.4%) Current Out:686.9 kbits/s (16.8%)

Yearly' Graph (1 Day Average)



Max In:3494.1 kbits/s (85.3%) Average In:2824.5 kbits/s (69.0%) Current In:3075.6 kbits/s (75.1%)
Max Out:880.4 kbits/s (21.5%) Average Out:592.3 kbits/s (14.5%) Current Out:627.6 kbits/s (15.3%)

Figure 6.1. Utilization Factor of Bangkok University to Daily-Yearly.

To verifying Internet user model by UF Affects (International Link) were shown in Table 6.2.

Table 6.2. To Verifying Internet Users Model by UF Affects (International Link).

No.	Company list	International link							
		Cap(Mbps)	Average UF(%)	Peak UF(%)	Formula+UFav	Formula+UFpk	Questionnaire	Different+UFav	Different+UFpk
1	ABAC	8	60	80	54067.2	72089.6	20,000.00	34,067.20	52,089.60
2	KU	2	39	220	8785.92	49561.6	30,000.00	- 21,214.08	19,561.60
3	KMITNB	1	64	99	7208.96	11151.36	23,000.00	- 15,791.04	- 11,848.64
4	KMUTT	1	24	47	2703.36	5294.08	13,000.00	- 10,296.64	- 7,705.92
5	SRIPATUM U.	2	68	97	15319.04	21852.16	15,000.00	319.04	6,852.16
6	BANGKOK U.	4	69	98	31088.64	44154.88	20,000.00	11,088.64	24,154.88
7	KASEMBDUDI U.	0.512	70	92	4037.0176	5305.79456	2,800.00	1,237.02	2,505.79
8	ASIA U.	0.128	14	85	201.85088	1225.5232	330.00	- 128.15	895.52
9	UTCC	2	78	95	17571.84	21401.6	21,000.00	- 3,428.16	401.60
10	SUANSUNUNTA'S INST	0.256	85	98	2451.0464	2825.91232	5,000.00	- 2,548.95	- 2,174.09
11	The Naval Academy	0.256	23	97	663.22432	2797.07648	2,850.00	- 2,186.78	- 52.92
12	RTA	0.512	39	110	2249.19552	6343.8848	3,486.00	- 1,236.80	2,857.88
13	MOTC	0.512	40	85	2306.8672	4902.0928	1,000.00	1,306.87	3,902.09
14	OOEP	0.064	60	80	432.5376	576.7168	200.00	232.54	376.72
15	AEROTHAI	0.256	57	103	1643.64288	2970.09152	1,723.00	- 79.36	1,247.09
16	F.E.ZUILLIG	0.064	18	100	129.76128	720.896	130.00	- 0.24	590.90
17	SVOA	0.512	40	85	2306.8672	4902.0928	500.00	1,806.87	4,402.09
18	SUMITRONIC	0.128	6	73	86.50752	1052.50816	50.00	36.51	1,002.51
19	TYCO ELECTONIC(Thai	0.128	80	200	1153.4336	2883.584	100.00	1,053.43	2,783.58
20	SIT	0.128	5	95	72.0896	1369.7024	40.00	32.09	1,329.70
21	UNOCAL(Thailand)	0.128	40	99	576.7168	1427.37408	1,100.00	- 523.28	327.37
22	EDS(CALTEX)	1	10	95	1126.4	10700.8	500.00	626.40	10,200.80
23	THE NATION GROUP	0.512	65	85	3748.6592	4902.0928	1,700.00	2,048.66	3,202.09
24	AMD	0.256	70	95	2018.5088	2739.4048	700.00	1,318.51	2,039.40
25	TOYOTA	0.128	40	85	576.7168	1225.5232	300.00	276.72	925.52
26	AMARIN PRINTING	0.128	35	95	504.6272	1369.7024	150.00	354.63	1,219.70
27	BANGKKOK AIRWAY	0.128	70	96	1009.2544	1384.12032	800.00	209.25	584.12
28	THAI CENAMIC	0.256	50	90	1441.792	2595.2256	250.00	1,191.79	2,345.23
29	IBM(THAILAND)	1	70	95	7884.8	10700.8	520.00	7,364.80	10,180.80
30	SIAM CEMEN	1	45	98	5068.8	11038.72	16,000.00	- 10,931.20	- 4,961.28
	Different Result		1434	2972				- 3,793.72	129,235.92
	Average		47.8	99.07					

As exhibited in Table 6.2, a respondent was differential calculation bewteen formula to questionnaire when calculation is increased multiple as Utilization Factor in the International Link as follows:

The International Link Formula by UF affects form MRTG program.

$$\text{User} = 11(UF)(Cx1024) \quad (3)$$

Where,

UF = Percentage Utilization Factor can be monitored by RTG program

Two types that are classified by Average UF and Peak UF.

6.4 Result of Internet Users Model and Surveying Different by UF Affects (International Link)

(1) Case: Average UF

The result will still identify to clear different between formula to questionnaire.

The verifying result of International link is slightly negative different (-3,793.72) that is hardly different information. That means the Constant of User Factor will still use it(11 users to 1 Kbps).

(2) Case: Peak UF

However, the result of different is positive too many different (129,235.92) that means the constant of User Factor (11 users to 1 Kpbs) should be improved to suitable Internet user.

6.5 Verifying Internet User Model by UF Affects (Domestic Link)

The before this topic that had tried to verify different between formula to questionnaire by UF affects (International Link). However this topic will still similar to their different but is changed By UF (Domestic Link) only.

To verifying Internet user model by UF Affects (Domestic Link) were shown in Table 6.3 and Figures 6.1, 6.2.

Table 6.3. To Verifying Internet User Model by UF Affects (Domestic Link).

No.	Company list	Domestic link								
		Cap(Mbps)	Average UR(%)	Peak UR(%)	Formula	Formula+UFav	Formula+UFpk	Questionnaire	Different+UFav	Different+UFpk
1	ABAC	1	57	95	4096	2334.72	3891.2	20,000.00	- 17,665.28	- 16,108.80
2	KU	1	90	120	4096	3686.4	4915.2	30,000.00	- 26,313.60	- 25,084.80
3	KMITNB	0.8	40	97	3276.8	1310.72	3178.496	23,000.00	- 21,689.28	- 19,821.50
4	KMUTT	0.256	50	89	1048.576	524.288	933.23264	13,000.00	- 12,475.71	- 12,066.77
5	SRIPATUMU.	1	60	96	4096	2457.6	3932.16	15,000.00	- 12,542.40	- 11,067.84
6	BANGKOK U.	2	69	98	8192	5652.48	8028.16	20,000.00	- 14,347.52	- 11,971.84
7	KASEMBDUDI U.	0.128	56	75	524.288	293.60128	393.216	2,800.00	- 2,506.40	- 2,406.78
8	ASIA U.	2	43	85	8192	3522.56	6963.2	330.00	3,192.56	6,633.20
9	UTCC	0.256	58	87	1048.576	608.17408	912.26112	21,000.00	- 20,391.83	- 20,087.74
10	SUANSUNUNTA'S INST	0.128	80	110	524.288	419.4304	576.7168	5,000.00	- 4,580.57	- 4,423.28
11	The Naval Academy	0.128	73	112	524.288	382.73024	587.20256	2,850.00	- 2,467.27	- 2,262.80
12	RTA	0.256	69	98	1048.576	723.51744	1027.60448	3,486.00	- 2,762.48	- 2,458.40
13	MOTC	0.128	68	87	524.288	356.51584	456.13056	1,000.00	- 643.48	- 543.87
14	OOEP	0.01	40	50	40.96	16.384	20.48	200.00	- 183.62	- 179.52
15	AEROTHAI	0.064	30	73	262.144	78.6432	191.36512	1,723.00	- 1,644.36	- 1,531.63
16	F.E.ZUILLIG	0.205	50	83	839.68	419.84	696.9344	130.00	289.84	566.93
17	SVOA	0.128	72	95	524.288	377.48736	498.0736	500.00	- 122.51	- 1.93
18	SUMITRONIC	0.128	35	65	524.288	183.5008	340.7872	50.00	133.50	290.79
19	TYCO ELECTONIC(Tha	0.256	42	65	1048.576	440.40192	681.5744	100.00	340.40	581.57
20	SIT	0.064	75	98	262.144	196.608	256.90112	40.00	156.61	216.90
21	UNOCAL(Thailand)	0.128	20	90	524.288	104.8576	471.8592	1,100.00	- 995.14	- 628.14
22	EDS(CALTEX)	1	22.2	54	4096	909.312	2211.84	500.00	409.31	1,711.84
23	THE NATION GROUP	0.128	30	65	524.288	157.2864	340.7872	1,700.00	- 1,542.71	- 1,359.21
24	AMD	0.64	25	63	2621.44	655.36	1651.3072	700.00	- 44.64	951.51
25	TOYOTA	0.064	42	75	262.144	110.10048	196.608	300.00	- 189.90	- 103.39
26	AMARIN PRINTING	0.064	86	105	262.144	225.44384	275.2512	150.00	75.44	125.25
27	BANGKKOK AIRWAY	0.064	47	87	262.144	123.20768	228.06528	800.00	- 676.79	- 571.93
28	THAI CENAMIC	0.064	36	89	262.144	94.37184	233.30816	250.00	- 155.63	- 16.69
29	IBM(THAILAND)	2	35	98	8192	2867.2	8028.16	520.00	2,347.20	7,508.16
30	SIAM CEMEN	0.512	80.5	199	2097.152	1688.20736	4173.33248	16,000.00	- 14,311.79	- 11,826.67
	Different Result		1580.7	2703					- 151,308.05	- 125,937.39
	Average		52.69	90.1						

As exhibited in Table 6.3, a respondent was differential calculation between formula to questionnaire when calculation is increased multiple as Utilization Factor in the Domestic Link as follows:

The Domestic Link Formula by UF affects form MRTG program.

$$\textbf{User} = \quad \textbf{4(UF)(Cx1024)} \qquad \textbf{(4)}$$

Where,

UF = Percentage Utilization Factor can be monitored by MRTG program

Two types that are classified by Average UF and Peak UF.

6.6 Result of Internet Users Model and Surveying Different by UF Affects (Domestic Link)

(1) Case: Average UF

The result will still identify to clear different between formula to questionnaire.

The verifying result of Domestic link is too many negative different(-151,308.05) that means the Constant Value of User Factor in Domestic Link (4 users to 1 Kbps) is less more than them. Therefore it should be improved to suitable the user behaviors

(2) Case: Peak UF

However, the result of different is positive too many different (-125,937.39) that means the constant of User Factor (4 users to 1 Kpbs) should be improved to suitable internet user.

If the different of verifying result are as follow;

Verifying result = 0, that these formula is still able to used and suitable forecast in Internet users' behavior.

Verifying result <<< 0 and >>> 0, that these formula isn't able to used and suitable forecast in Internet users' behavior.

6.7 Model Verification

As Internet User model can not directly count head count of Internet Users that have not been possible to count directly or has not been measured to any active devices. Anyway they would be much more difficult. ISPs (Internet Service Provider) are not releasing the exact number of their clients not because it's a secret.

However, as Rear Admiral Prasart's Internet users model has built and verify a mathematical model form information since 1997 when time is changed to pass along time and the increase Internet users when the formula and Internet user multiple may be changed their factor numbers.

Therefore, as information gathering is directly obtained from specialist network such as system engineer, network engineer and administrator including to verifying many mathematics and statistic method that are too many different value.

These reasons will be use to new multiple User Factor both International and Domestic Link by reverse equations. Besides, writer take to help form my advisor(Rear Admiral Prasart Sribhadung). Therefore writer will suggest to about analyze and mathematics model as follows:

Form equations (1) International Link and (2) Domestic Link are applied to convert formula so that will find new user factor multiple in formula (1), (2):

$$\textbf{User Factor} = \frac{\textbf{User}}{\textbf{1024(C)}} \qquad \textbf{(5)}$$

And User Factor by UF affects:

Form equations (1) International Link and (2) Domestic Link are applied:

$$\textbf{User Factor} = \frac{\textbf{User}}{\textbf{1024(UF)(C)}} \qquad \textbf{(6)}$$

Where;

User = Amount of User that have Email address.

C = Capacity Channel of International link in leased line by unit Mbps.

1024 = Constant Number of 1 Mega bit per second(1 Mega=1024 bps)

UF = Percentage Utilization Factor can be monitored by MRTG program

Two types that are classified by Average UF and Peak UF.

To finding Each Internet User Factor can be find mean of User Factor that mean value will be verifying up-date form IIR (Internet Information Research) at NECTEC again. In equation (5) and (6) that are involve to UF. The both equations can take to find new user factor from surveying information.

Formula mean user factor from each surveying information as follows;

$$\text{New User Factor} = \frac{\sum(\text{User Factor}_1 + \ldots + \text{User Factor}_n)}{N}$$

After they can get new user factor, we are verifying to information by compare amount of users from IIRC (Internet Information Research Center) at NECTEC to questionnaire information.

To improve Internet user factor multiple was shown Table 6.4.

Table 6.4. User Factor Improving in the Part of International Link.

No.	Company list	International link						
		Capacity(Mbps)	Average UF(%)	Peak UF(%)	Questionnaire	User Factor	User Factor=UFav	User Factor=UFpk
1	ABAC	8	60	80	20,000.00	2.44	4.07	3.05
2	KU	2	39	220	30,000.00	14.65	37.56	6.66
3	KMIT'NB	1	64	99	23,000.00	22.46	35.10	22.69
4	KMUTT	1	24	47	13,000.00	12.70	52.90	27.01
5	SRIPATUM U.	2	68	97	15,000.00	7.32	10.77	7.55
6	BANGKOK U.	4	69	98	20,000.00	4.88	7.08	4.98
7	KASEMBDUDI U.	0.512	70	92	2,800.00	5.34	7.63	5.80
8	ASIA U.	0.128	14	85	330.00	2.52	17.98	2.96
9	UTCC	2	78	95	21,000.00	10.25	13.15	10.79
10	SUANSUNUNTA'S INST	0.256	85	98	5,000.00	19.07	22.44	19.46
11	The Naval Academy	0.256	23	97	2,850.00	10.87	47.27	11.21
12	RTA	0.512	39	110	3,486.00	6.65	17.05	6.04
13	MOTC	0.512	40	85	1,000.00	1.91	4.77	2.24
14	OOEP	0.064	60	80	200.00	3.05	5.09	3.81
15	AEROTHAI	0.256	57	103	1,723.00	6.57	11.53	6.38
16	F.E.ZUILLIG	0.064	18	100	130.00	1.98	11.02	1.98
17	SVOA	0.512	40	85	500.00	0.95	2.38	1.12
18	SUMITRONIC	0.128	6	73	50.00	0.38	6.36	0.52
19	TYCO ELECTONIC(Thail	0.128	80	200	100.00	0.76	0.95	0.38
20	SIT	0.128	5	95	40.00	0.31	6.10	0.32
21	UNOCAL(Thailand)	0.128	40	99	1,100.00	8.39	20.98	8.48
22	EDS(CALTEX)	1	10	95	500.00	0.49	4.88	0.51
23	THE NATION GROUP	0.512	65	85	1,700.00	3.24	4.99	3.81
24	AMD	0.256	70	95	700.00	2.67	3.81	2.81
25	TOYOTA	0.128	40	85	300.00	2.29	5.72	2.69
26	AMARIN PRINTING	0.128	35	95	150.00	1.14	3.27	1.20
27	BANGKKOK AIRWAY	0.128	70	96	800.00	6.10	8.72	6.36
28	THAI CENAMIC	0.256	50	90	250.00	0.95	1.91	1.06
29	IBM(THAILAND)	1	70	95	520.00	0.51	0.73	0.53
30	SIAM CEMEN	1	45	98	16,000.00	15.63	34.72	15.94
			1434	2972		176.50	410.92	188.40
	User Factor		47.8	99.07		5.883168538	13.69744055	6.279970697

As exhibited in Table 6.4 (International Link) a respondent was shown as follows:

(1) That mean of average and peak Utilization Factor were 47.8% and 99.07% respectively.

(2) User Factor UF (100%) = 5.9 ≈ 6

User Factor UF av (47.8%) = 13.7

User Factor in case peak UF (99.07) = 6.3

To improve Internet user factor multiple was shown Table 6.5.

Table 6.5. User Factor Improving in the Part of Domestic Link.

No.	Company list	Domestic Link						
		Cap(Mbps)	Average UF(%)	Peak UF(%)	Questionnaire	User Factor	User Factor+UFav	User Factor+UFpk
1	ABAC	1	57	95	20,000.00	19.53	34.27	20.56
2	KU	1	90	120	30,000.00	29.30	32.55	24.41
3	KMITNB	0.8	40	97	23,000.00	28.08	70.19	28.94
4	KMUTT	0.256	50	89	13,000.00	49.59	99.18	55.72
5	SRIPATUM U.	1	60	96	15,000.00	14.65	24.41	15.26
6	BANGKOK U.	2	69	98	20,000.00	9.77	14.15	9.96
7	KASEMBDUDI U.	0.128	56	75	2,800.00	21.36	38.15	28.48
8	ASIA U.	2	43	85	330.00	0.16	0.37	0.19
9	UTCC	0.256	58	87	21,000.00	80.11	138.12	92.08
10	SUANSUNUNTA'S INS	0.128	80	110	5,000.00	38.15	47.68	34.68
11	The Naval Academy	0.128	73	112	2,850.00	21.74	29.79	19.41
12	RTA	0.256	69	98	3,486.00	13.30	19.27	13.57
13	MOTC	0.128	68	87	1,000.00	7.63	11.22	8.77
14	OOEP	0.01	40	50	200.00	19.53	48.83	39.06
15	AEROTHAI	0.064	30	73	1,723.00	26.29	87.64	36.01
16	F.E.ZUILLIG	0.205	50	83	130.00	0.62	1.24	0.75
17	SVOA	0.128	72	95	500.00	3.81	5.30	4.02
18	SUMITRONIC	0.128	35	65	50.00	0.38	1.09	0.59
19	TYCO ELECTONIC(Th)	0.256	42	65	100.00	0.38	0.91	0.59
20	SIT	0.064	75	98	40.00	0.61	0.81	0.62
21	UNOCAL(Thailand)	0.128	20	90	1,100.00	8.39	41.96	9.32
22	EDS(CALTEX)	1	22.2	54	500.00	0.49	2.20	0.90
23	THE NATION GROUP	0.128	30	65	1,700.00	12.97	43.23	19.95
24	AMD	0.64	25	63	700.00	1.07	4.27	1.70
25	TOYOTA	0.064	42	75	300.00	4.58	10.90	6.10
26	AMARIN PRINTING	0.064	86	105	150.00	2.29	2.66	2.18
27	BANGKKOK AIRWAY	0.064	47	87	800.00	12.21	25.97	14.03
28	THAI CENAMIC	0.064	36	89	250.00	3.81	10.60	4.29
29	IBM(THAILAND)	2	35	98	520.00	0.25	0.73	0.26
30	SIAM CEMEN	0.512	80.5	199	16,000.00	30.52	37.91	15.34
	Different Result		1580.7	2703		461.57	885.60	507.75
	Average		52.7	90.1		15.4	29.5	16.9

(1) That mean of average and peak Utilization Factor were 52.7%, 90.01% respectively

(2) User Factor in case UF (100%) = 15.4

User Factor in case average UF (52.7%) = 29.5

User Factor in case peak UF (99.1%) = 16.9 ≈ 17

6.8 Result and Discussion from User Factor Improving

Both Table 6.4 and Table 6.5 that meant to improve User Factor. Whenever utilization factor is almost be 100%, User Factor calculation will be to near number of factor both International and Domestic Link such as:

(1) International Link:

User Factor UF (100%) = 6

User Factor UF pk (99.07%) = 6.3

User Factor UF av (47.8%) = 13.7

Therefore, Calculation comes form surveying that is almost accurate their information. In spite of information is Ufav (47.8%) be able to evaluate amount of users in firms. So the number of User Factor (International Link) is 6 that means 6 users to 1 Kbps or one person can be use information about 1/6 Kbps (0.167 Kbps).

(2) Domestic Link

User Factor UF (100%) = 15.4

User Factor UF pk (90.07%) = 16.9

User Factor UF av (52.7%) = 29.5

Therefore, the calculation would be see User Factor of UF value 90.07% and 100% are near values. The number of User Factor (Domestic Link) is

15.4 that means 15 users to 1 Kbps or one person can be information about 1/15 Kbps (0.067 Kbps).

These number can be use predict Internet user growth in Thailand.

6.9 Model Validation Compare to IIRC (Internet Information Research Center) from NECTEC

The Table will show to research form IIRC research of NECTEC in Thailand.

Table 6.6. Total Amount of User in Thailand by IIRC Research.

Internet Information Reseach Center(IIRC)

Internet Information Research (IIR)

Growth of Internet & Domestic Bandwidth of Internet in Thailand

Year/month	Total Internaional Bandwidth(Mbps		Total Domestic Exchange Bandwidth (Mbps)		
	To Thailand	From Thailand	To IIR	To NIX	To IIR+NIX
2001/10	569.5	450.5	858.125	40.875	899
2001/09	568.5	449.5	866.125	34.875	901
2001/08	546	418.25	846.125	34.875	881
2001/07	539.625	414.375	738.125	34.375	772.5
2001/06	555.625	430.375	736.125	25.188	761.313
2001/05	522.625	397.375	746.125	25.188	771.313
2001/04	515.625	400.375	745.125	25.188	770.313
2001/03	526.625	407.375	657.125	25.188	682.313
2001/02	325.125	225.125	657.125	27.188	684.313
2001/01	316.375	215.437	599.375	25.187	624.562
2000/12	267.5	170.062	587.375	25.187	612.562
2000/11	265	167.562	559.375	25.187	584.562
2000/10	254.5	165.063	558.5	25.187	583.687
2000/09	228.25	161.25	558.5	25.187	583.687
2000/08	228.25	161.25	548.5	25.187	573.687

Remark: http://ntl.netec.or.th/internet/int-bandwidth.html

From above Table will use International Link formula as outside country to Thailand that is used to verify User Factor how to valid and error by User factor from mathematical model and improvement which one is still reliability their users. The above Table 6.6. total current International bandwidth in October 2001 = 569.5 Mbps. Form the formula (3) International Link is # user = (user factor)x(1024)x(Capacity).

User Factor = 11 (11 users to 1 Kbps)

Therefore, Amount of User = 11x1024x569.5 = 6,414,848 users

New User Factor = 6 (6 users to 1 Kbps)

Therefore, Amount of User = 6x1024x569.5 = 3,499,008 users

From IIRC research in NTL at NECTEC have monitored amount of Internet users about ***3,536,001 users*** in October 2001 that will show different error about:

(1) Error of Internet User = $|6,414,848 - 3,536,001| / (3,536,001) = 0.814$

Percentage Error = 81.4%

(2) Error of Internet User = $|3,499,008 - 3,536,001| / (3,536,001) = 0.0104$

Percentage Error = 1.04%

Therefore from the calculation that can be assumed User Factor of International link = 6 and User Factor of Domestic link = 15 were correctly estimate for those. We will change Prasart's formula to new formula as follows:

The International Link Formula by UF affects

$$\textbf{User} = \textbf{6(UF)(Cx1024)} \qquad \textbf{(1)}$$

The Domestic Link Formula by UF affects

$$\textbf{User} = \textbf{15(UF)(Cx1024)} \qquad \textbf{(2)}$$

VII. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This research was aimed to verifying Internet User Estimation Model by verifying it to **Rear Admiral Prasart Sribhadung's Internet User Model** that he has built a mathematical model to estimate the number of Internet users, which have been used since 1997. Two of the variables is used in the model are International and Domestic Links include to their utilization factors. The mathematical model will be changed as time. The studying of verifying will be check to UF = 100% and other UF affects for those.

However We will also verify with Information of IIRC at NECTEC that is research center as information will always be updates in Thailand. In summary of the verifying was concluded with the following discussion:

(1) To verifying mathematical model will exchanged from Rear Admiral Prasart Sribhadung's Internet User Model by assuming UF = 100% to equation as following:

The International Link Formula

$$\textbf{User} = \textbf{11(Cx1024)} \qquad (1)$$

The Domestic Link Formula

$$\textbf{User} = \textbf{4(Cx1024)} \qquad (2)$$

The summary verifying result was much more different from mathematical model to surveying. Therefore the Internet User multiple should be improve their factors both International and Domestic Link. However writer was try to find reverse mathematical model and statistic subjects including to advice

from Rear Admiral Prasart Sribhadung who is specialist and experience the actual working that were suggest to improve Internet User Factor and number is changed as following:

User Factor (International Link) = change from 11 to 6

User Factor (Domestic Link) = change from 4 to 15

International Link

User Factor = 11 that mean 11 users/ 1 Kbps. In the International link one person can be use information as 0.0909 Kbps.

User Factor = 6 that mean 6 users/ 1 Kbps. In the International link one person can be use information as 0.167 Kbps.

Therefore, increase information is increased more than in the past from 0.0909 to 0.167 Kbps/user as result of increase International Link and Internet growth.

Domestic Link

User Factor = 4 that mean 4 users/ 1 Kbps. In the International link one person can be use information as 0.25 Kbps.

User Fator = 15 that mean 15 users/ 1 Kbps. In the Domestic link one person can be use information as 0.067 Kbps.

Therefore, Information transmission is decreased from 0.25 to 0.067 Kbps/user because increase proxy server and data storage of ISPs have high technology.

(2) To verifying mathematical model will changed from Rear Admiral Prasart Sribhadung's Internet User Model by UF using that assuming User Factor (International link) = 6 and User Factor (Domestic link) = 15 were correctly estimate for those.

The International Link Formula by UF affects

$$\textbf{User} = \textbf{6(UF)(Cx1024)} \qquad (7)$$

The Domestic Link Formula by UF affects

$$\textbf{User} = \textbf{15(UF)(Cx1024)} \qquad (8)$$

The summary verifying result was much more different from mathematical model to surveying. Therefore the Internet User Factor should be improve their factors both International and Domestic Link.

The summary of result by UF affects that can be found by User Factor:

International Link

User Factor UF(100%) = 6 that means 6 users/1Kpbs or 1 user/0.167 Kbps

User Factor UFpk (99.07%) = 6.3 that means 6.3 users/1Kpbs or 1 user/0.159 Kbps

User Factor U av (47.8%) = 13.7 that means 13.7 users/1Kpbs or 1 user/0.073 Kbps

So, if UF is increased, one user has be use more information.

Domestic Link

User Factor UF(100%) = 15.4 that mean 15.4 users/1Kpbs or 1 user/0.065 Kbps

User Factor UFpk (90.07%) = 16.9 that means 16.9 users/1Kpbs or 1 user/0.06 Kbps

User Factor UFav (52.7%) = 29.5 that mean 29.5 users/1Kpbs or 1 user/0.034 Kbps

So, if UF is increased, one user has be use more information.

(3) Application in the Internet User Model.

User Estimation.

In User Applied, can be used to predict about amount of Internet user that can know how many to estimate full users in capacity channel.

To apply is use in the new company that has to know about estimate to Internet user in the firms.

Such as the company have leased line 64 Kbps how many persons will provide the Internet user with company. To calculation is as follows.

International link, # user = (6x0.064x1024) = 394 users

Domestic link, # user = (15x0.064x1024) = 984 users

On the other hand, can be used to predict about Capacity channel of lease line.

Capacity Channel Evaluation.

In the reverse, users in company have to connect Internet outside the company and how to know lease line provide capacity channel.

Such as, in case company ABC has to use leased line by the employee of company has 500 persons who want to use Email and Internet user. To calculation is as follows.

From # user = 6(Cx 1024)

Find Capacity Channel of Lease line (C) is ;

$$C = 500 / (1024 \times 6)$$

Capacity Channel = 0.0813 Mbps

$\therefore$ We should select Capacity of Lease Line, $\approx$ 128 Kbps

7.2 Recommendations

According to the study it will recommend the following:

(1) The mathematical model has been used since 1997. It should be updated regularly at least one-year accordance with Internet user growth because of technology growth rapidly.

(2) The surveying might be a segment as each segment organizations and business organization have be different business that sending and receiving information have much more different to their users.

However we can be classified to each large segment

(A) Government and State Enterprise segments are The navel Academy, Airrothai and ministry, MEA.(Metropolitan Electricity Authority, PEA(Province Electricity Authority), EGAT, etc.

(B) Academic segments are university, School, Technical College, and Rachapaj's Institue.

(C) Individual/ Incorporation segment are large companies such as IBM, Siam Cemen, SVOA, Caltex, F.E. Zuellig, etc.

(D) Financing and Banking segments are Ayudhaya Bank, Thai Farmer Bank, Bangkok Bank, etc.

(E) Manufacturing and Industrial Segments are Unocal, Toyota, AMD

(3) As Verifying Internet User Model has implement to data gathering hardly, The next developers have to accumulate data several types as much as possible including oral interview, document and important utilization factor form MRTG program. Moreover the next developer should have technical knowledge about network.

APPENDIX A

ORGANIZATION SITE NAMES

Table A.1 Thaisarn's Participating Site.

Organization	Site names
The National Electronics and Computer Technology Center (NECTEC)	Nwg
Thamasart University (TU)	Ipied
Prince of Songkhla University (PSU)	Sritrang, ratree
The Public Access Network (Pubnet)	Decth
Chulalongkorn University	Chulkn
Kasetsart University	Nontri
The Asian Institute of Technology (AIT)	AIT

Node's Configuration Details

1. NECTEC

Organization name	The National Electronics and Computer Technology Center
System Name	Nwg
Internet address	Nwg.nectec.or.th
Modem standard(s)	Intel 9600EX V.22, V.32 (9600bps) V.42, V.42, V.42bis ACER 24245, V.22, V.22bis (2400bps)
DataNet address	pyt/newgroup
Data format	8-N-1
Machine	IBM RS-6000/320 (16MB/640MB) AIX3.1
Mail Exchange	
UUCP from	Ipied (hourly), decth (hourly)
UUCP to	Sritrang,psu.th (1,200bps, 15:00, 16.30)
Operational since	February 12,1992

2. Thammasart University (Main Campus at Thaprachan)

Organization name	The information Procession Institute for Education and Development
System name	ipeid
Internet address	ipied.tu.ac.th
Modem standard(s)	Intel 14.4EX V.22, V.22bis, V.32, V.32bis (14,400bps), V.42, V.42, V.42bis
DataNet adrress	srr/tunet 1
Data format	8-N-1
Machine	Sun SPARC station 1 (8MB/207MB) SunOS 4.1.1
Mail exchange	
UUCP from	N.A.
UUCP to	Decth (hourly), nwg (hourly)
Operational since	January 20, 1992

3. Prince of Songkhla University

Organization name	The Computer Center
System name	Ratree
Internet address	Ratree.psu.ac.th
Modem standard	Practical modem 96SA V.22, V.22bis, V.32, V.42, V.42bis
Data format	8-N-1
Machine	Digital VAX 11/785 (Ultrix)
Mail exchange	
UUCP from	NWG (15.00, 16.30)
UUCP to	N.A.

ACSNet from Munnari.oz.au

Operational since 1988

4. PUBNET Hub at Digital Equipment (Thailand) Ltd.

Organization name The Technology Transfer Program Digital Equipment (Thailand) Ltd.

System name Decth

Modem standard(s) N.A.

DataNet address Pnc/pubnet

Data format 8-N-1

Machine VAX server 3100/ULTRIX 4.2 (8MB/312MB)

Mail exchange

UUCP from -

UUCP to nwg (a few times a day with flexible schedule)

Operational since September 1, 19991

5. Chulalongkorn University Network

Organization name Chulalongkorn University

System name Chulkn

Internet address Chulkn.chula.ac.th

Modem standard(s) N/A

Data format Srw/chulkn

Machine 80486 SCO Unix 3.2

ACSNet to ait.ait.th

6. Kasetsart University

Organization name	Department of Computer Engineering
System name	Nontri
Internet address	Nontri.ku.ac.th
Modem standard(s)	2400bps Hayes compatible
DataNet address	pyt/nontri
Data format	8-N-1
Machine	386 SCO UNIX
Mail exchange	
UUCP from	N/A
UUCP to	N/A

7. The Asian Institute of Technology (AIT)

Organization name	The Division of Computer Science
System name	Ait
Internet address	Cs5.ait.ac.th
Modem standard(s)	NEC V.22 (1200) V.22bis (2400bps)
Data format	7-E-1
Machine	Sun 3/60
Mail exchange	
ACSNet	Munnari.oz.au (02.30, 15.30, 19.30)
Receives from	-

APPENDIX B

GLOSSARY OF ACRONYMS

Glossary of Acronyms

AARNet	Australian Academic and Research Network
ACSNet	Australian Computer Science Network
AIT	Asian Institute of Technology
ATM	Asynchronous Transfer Mode
AUP	Appropriate Use Policy
BBS	Bulletin Board System
BIND	Berkeley Internet Name Domain
CAT	Communications Authority of Thailand
GINET	Government Information Network
IDP	International Internet Gateway
IIG	International Development Plan
IP	Internet Protocol
ISP	Internet Service Provider
IT	Information Technology
NAMMI	National Multimedia Institute
NECTEC	National Electronics and Computer Technology Center
NII	National Information Infrastructure
NSCSIS	National Center for Scientific Information System
NTL	Network Technology Laboratory
NWG	Network Working Group
OLS	Ordinary Least Square Method
PIE	Public Internet Exchange
PSU	Prince of Songkla University

PTO	Public Telecommunication Operation
SINET	Scientific Information Network
SUNIII	Sydney Unix Network
TCP/IP	Transmission Control Protocol/Internet Protocol
TCSNet	Thai Computer Science Network
TDRI	Thailand Development Research Institute
Thiasarn	Thai Social/Scientific Academic and Research Network
THLIX	Thailand Local Internet Exchange
TIS	Thaissarn Internet Service
TISI	Thai Industrial Standards Institute
TOT	Telephone Organization of Thailand
TT&T	Thai Telephone and Telecommunication
UUCP	Unix to Unix CoPy

APPENDIX C

QUESTIONNAIRE

QUESTIONNAIRE

CE 6998 & CE 6999 PROJECT
Verifying Internet User Estimation Model

Partial Fulfillment of the Requirements for the Degree of

Master of Science in Computer and Engineering Management

Assumption University

Name_____Position_____
Company_____Address_____

1. What kind of leased line does the firm connect to ISP? classified by

- International Link[ ] Copper wire [ ] Fiber Optic [ ] Microwave [ ] Satellite
- Domestic Link [ ] Copper wire [ ] Fiber Optic [ ] Microwave [ ] Satellite

2. What capacity is the International Link, when was it connected or upgraded?_____ Kbps/Mbps _____ Kbps/Mbps _____ Kbps/Mbps

3. What capacity is the Domestic Link, when was it connected or

upgraded?_____ Kbps/Mbps _____ Kbps/Mbps _____ Kbps/Mbps

4. What is the present Utilization Factor (UF) of
   - International Link Avg.___% Peak ____%
   - Domestic Link Avg._____ % Peak ____%
5. How many Internet users do you think you have (inclusive individual dial-up users and users of leased-line accounts)? _____(estimate)

6. How many Internet accounts have been generated totally _____ and active accounts (that still logging in) _____

7. How many percent have your Internet users increase /decrease in the last 12 months?

[ ] decrease [ ] increase _____ %

8. How many modems do you have for remote access dial-up? _____

9. How many computers do you have in the LAN that can access the Internet?
_____

10. How many cache engine and proxy servers are you using _____ with how much total of memory _____ Gbps

11. Do you experience any problem with your ISP ? what kind ?

_____
_____

Any comments or suggestions?

_____
_____
_____
_____
_____

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