The History *of* the Internet in Thailand

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Cover Design: Boonsak Tangkamcharoen

Published by University of Oregon Books.
International Standard Book Number: 0-87114-288-0
Printed in the United States of America.

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This material is based upon work supported by the National Science Foundation under Grant No. NCR-961657. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

This book is printed on recycled paper.

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Acknowledgments

We would like to thank Thailand's Internet pioneers — Dr. Kanchana Kanchanasut, Dr. Thaweesak Koanatakool, Khun Trin Tantsetthi, Khun Robert Elz, and Dr. Yunyong Teng-amnuay — who provided enthusiastic and cooperative support for this case study. Sincere appreciation goes to Khun Pramote Jutaporn and Khun Nittida Nuansri of Prince of Songkla University (PSU) who provided a copy of the first email message sent from PSU to Australia on June 2, 1988. We are also indebted to Dr. Deunden Nikomborirak of the Thailand Development Research Institute (TDRI) and Khun Manoo Ordeedolchest, the president of the Association of Thai Computer Industry, who supplied data about the current state of the national network, Thai Internet. Special thanks are also due to Khun Boonsak Tangkamcharoen of the Multimedia Services Department at the National Electronics and Computer Technology Center (NECTEC) in Thailand for his cooperation in publishing this case study.

We would also like to express gratitude to Randy Bush, Principal Investigator of the Network Startup Resource Center (NSRC), and Dr. John Klensin, co-founder of the NSRC, for their guidance in writing this case study. The NSRC is based at the University of Oregon Computing Center, which provided valuable research support. Dr John Russial of the University of Oregon's School of Journalism and Communication provided some helpful writing suggestions. And finally, special thanks are due to Dr. Steven Goldstein of the United States National Science Foundation for his inspiration in writing this paper.

Summary

Thailand was an early participant in bringing the Internet to Asia, and it has a fascinating, but little-known, networking history. The grassroots efforts by a few dedicated and visionary university professors have resulted in a fully functional national network, despite the limited infrastructure and numerous technical obstacles of the early days.

In fact, networking in Thailand began when virtually nothing existed in the country to establish a viable computer network. Telephone density was low, technical knowledge was scarce, and computers were expensive. However, some Thai engineers managed to create the academic network with a small budget and some technical assistance from Australia. Beginning with a UUCP connection and X.25 in 1987, the Thai academic network gradually transitioned to full TCP/IP in 1992. Boosted by the strong economic growth of the early '90s, collaboration occurred with the private sector and was augmented by international financial support. The use of the Internet in Thailand is now highly valued, especially by the younger generation. Currently, the Internet is not only a significant tool for information sharing among academics and students, but also an alternative media and a new business opportunity for Thais.

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 of this writing, Thailand has 16 Internet Service Providers (ISPs) operating nationwide with a combined leased line capacity above 30Mbps. (see Diagram 3, page 16).

Introduction

The development of the Internet in Thailand began in mid-1987 when two faculty members at the Asian Institute of Technology's (AIT) computer science department made some test UUCP connections to the University of Melbourne, University of Tokyo, and UUNET via X.25. A year later, the Australian International Development Plan (IDP) assisted Prince of Songkhla University (PSU) in the south of Thailand in setting up dial-up email connectivity to the University of Melbourne. In 1991, a UUCP network was established to five universities in Thailand. In 1992, when Chulalongkorn University acquired the first 9.6Kbps leased line to UUNET, the network was transformed to TCP/IP. By 1995, the usage had grown extensively, the Internet commercialized and expanded outside the academic realm to the general population. Currently, the Internet is available in almost every big city in Thailand, especially where universities are located. Anyone who can afford it can utilize the commercial Internet Services that are available and growing throughout the country.

This case study portrays the work of local engineers who created the building blocks for Thailand's national network with minimal funds and limited resources of technology and people. However, with the collaboration of the private sector and pro bono support from a few key volunteers, those engineers created the academic network, and now have made the Internet another form of media available for the general population in Thailand.

This case study covers five major topics of the development of the Internet in Thailand: technology, human factors, the economic model, regulations and telecommunications infrastructure, and the current state of the network.

Technology

In the early 1980s, Thailand was a barren landscape for computer networking. Copper telephone lines were mapped thinly: for one hundred Thais, only two telephones were available (Weiss, 1994). A monopoly, managed by two state enterprises — the Telephone Organization of Thailand (TOT) and the Communications Authority of Thailand (CAT) - has governed the telecommunications industry since 1954. Computers were visible but not widely used. They were expensive and incomprehensible for most Thais, due to the lack of Thai language software and the lack of computer standardization.

"Networking in Thailand was just impossible during those days," said Kanchana Kanchanasut, a professor at the Asian Institute of Technology (AIT). Kanchana was Thailand's first electronic mail (email) user in 1986. A graduate from Australia's University of Melbourne, she felt trapped in her own country. She was desperate for email, and one question stayed in her mind, "How can I live here if I can't keep contact with friends in other countries? "

"I remember trying to explain about computer networking and email to AIT people. They just had no clue. They had never been exposed to email and did not listen to what I was talking about," said Kanchana.

Fortunately, in 1986, Kanchan's colleague, Tomonori Kimura, decided to help her develop a basic computer network. Kimura also wanted to keep contact with his friends and colleagues in Tokyo. They began with a normal phone line, a NEC 2400-baud modem, and a simple NEC personal computer (PC). The connection through copper lines running at 1200-2400 bps was noisy and unstable, especially during rainstorms. Consequently, with funding from Kimura's research project, they turned to Thaipak, an X.25 service from CAT, by dialing up to CAT's X.25 service hub through a normal phone line. Through Thaipak, Kanchana and Kimura could use UUCP to connect to the University of Tokyo and the University of Melbourne's server. Shortly thereafter, they established a UUCP connection to UUNET in Virginia on the East Coast of the United States (Kanchana, personal electronic communication, August 27, 1997)

"We were so excited when the first connection was successful," recalled soft-spoken Kanchana. "Since everything was new, we improvised all the time. After teaching, we spent long hours reading and dialing the phone. It was kind of fun, I still remember the noisy line and the excitement each time we could get a good line."

AIT staff did not understand what they were doing, but they cooperated. During that time, there was only one direct phone line at AIT and it belonged to the president of the university. Convinced by Kanchana and Kimura's "research," the president lent them his phone with a condition that they switch it back to his room in the morning.

After the UUCP connection was successful, email was demonstrated to AIT's data communications students and used to organize many computing courses, conferences, and seminars in Southeast Asia.

"Without email, how could we contact many internationally-known CS researchers? AIT could not have done what it did," wrote Kanchana in email correspondence.

Australian Assistance: In early 1988, the Australian IDP helped PSU, AIT, and Chulalongkorn University (CU) set up the first email network in Thailand, called the Thai Computer Science Network (TCSNet). With PSU and AIT as the main local gateways, Thai academics were able to dial-up to either PSU (sritrang.psu.th) or AIT (ait.ait.th) servers which were connected to the University of Melbourne (munnari.oz.au). TCSNet used SUNIII software, UNIX-based software widely used in the Australian Computer Science Net (ACSNet). The University of Melbourne polled PSU and AIT twice a day via a normal phone line. The cost of the long distance calls from Australia to Thailand was about $1,600 (Bt40,000) per year (NECTEC, 1994). Below is a copy of the first message, sent by Robert Elz, an Australian engineer, from PSU's first server (sritrang.psu.th) to the server in Australia (munnari.oz.au).

```
Return-path: kre@sritrang.psu.th
Received: from mulga.OZ by munnari.oz (5.5)
id AA06244; Thu, 2 Jun 88 21:22:14 EST
(from kre@sritrang.psu.th for kre)
Received: by mulga.oz (5.51)
id AA01438; Thu, 2 Jun 88 21:21:50 EST
Apparently-to: kre
Date: Thu, 2 Jun 88 21:21:50 EST
From: kre@sritrang.psu.th
Message-id: <8806021121.1438@mulga.OZ>

Hi.

Bye
```

(Courtesy of the Computing Center, Prince of Songkla University, Thailand)

As full-duplex UNIX-based software, SUNIII was composed of message passing networks with the ability to transmit and route the data through multiple hops. Unlike UUCP, SUNIII did not require users to indicate the destination and command through the remote system. Instead, the network itself worked out how to route the data to the destination. The software worked well on both dedicated and dial-up lines and over other links like X.25 (R. Elz, personal electronic communication, August 10, 1997). During that time, the University of Melbourne was an email gateway in Australia with links to the United States and many other Southeast Asian countries, including Indonesia, Malaysia, Hong Kong, and Singapore. All that was needed to establish email connectivity to Australia in those days was someone running a UNIX server on a simple connection to the University of Melbourne (R. Elz, personal electronic communication, September 2, 1997).

While PSU was directly connected to the University of Melbourne under the arrangement of IDP, AIT was Thailand's gateway via UUNET. When the old ARPANET was decommissioned in the late 1980s, UUNET became the gateway between the Internet and BITNET. UUNET granted AIT a free connection for academic use. To save the transmission costs, all mail to Thailand was routed through the University of Melbourne which would forward it to two local points: PSU and AIT. PSU sorted out its own mail, and AIT, as the administrator of Thailand's top-level domain, took care of traffic using the .TH domain (Kanchana & Pensri, 1992).

The presence of UNIX in the early 1990s spread email usage among Thai academics who, if outside TCSNet, used it through the AIT host (ait.ait.th). The account was available 24 hours a day, but only through one telephone line. This service was free for all users except for users at AIT and an affiliate at Ramkhamheang University who paid per volume of their email messages. The rates were Bt50 for the first 500 characters, Bt45 for each of the following 1,000 characters, and Bt10 for each 1,000 characters transferred to and from PSU.

By August 1992, the network consisted of about 50 email users who also joined various mailing lists in their own research areas on the Internet. The limited connection capacity in those days meant that these users were not allowed to do remote login to other machines on the Internet (Kanchana & Pensri, 1992). Later, Kanchana urged each institution to set up its own UUCP host as a mean to spread out the UUCP network in Thailand (Kanchana, personal communication, 28 August 1998).

"If AIT was the only host in Thailand, we wouldn't be able to expand the local network. It was difficult though to convince the computing manager of each institution. UNIX was not widely used in Thailand, and most people did not know email," Kanchana explained.

In late 1991, another new host was established in Thailand when Dr. Thaweesak Koanantakool, then an engineering lecturer at Thammasat University, installed MHSNet software, a successor of SUNIII, at the university with a 14.4Kbps modem — Thailand's fastest at the time. Thaweesak was another researcher who was frustrated with Thailand's lack of networking infrastructure. Since 1980, he had worked at the Thai Industrial Standards Institute (TISI), developing standardization of Thai codes and Thai input/output methods, handling Thai language strings on computers. With financial and technical aid from the Australian Academic and Research Network (AARNet), the host at Thammasat became another point of contact in Thailand, interacting with the Munnari machine running MHSNet and with Thai universities running UUCP applications. This new network included universities in TCSNet, Kasetsart University, and the National Electronics and Computer Technology Center (NECTEC). It was planned to link the Thaisarn network to the international community by MHSNet for a period of about one year while a TCP/IP link was being set up (Thaweesak, Kanchana, Trin, & Morragot, 1992).

MHSNet was an alternative network application package developed by Message Handling Systems Pty Ltd. of Australia. As a successor to SUNIII, the software had many desirable features missing in UUCP, including smart host, by which the lengthy bang path addressing of UUCP had been eliminated. Data transfer efficiency was also improved over UUCP. In fact, many of AARnet's mail affiliates and Thailand's email gateways (AIT and PSU) were also running MHSNet software. The MHSNet software consisted of more than 40 related programs that made an email node very powerful. It allowed users to send email, documents, data files, and programs to users around the world. MHSNet was licensed for free to universities and for a nominal fee to private companies (Thaweesak et al., 1992).

After the network was set up, Thaweesak urged everyone he knew to use email. "I made people deal with me by email; I have a lot of meetings and carry lots of documents every day. So I told them I would stop bringing documents to the meetings and we had to use email discussion instead of paper and Xerox machines," said Thaweesak.

At the end of 1991, Robert Elz came to Bangkok again for a two-day workshop, and he taught Thai academics and engineers how to use MHSnet software, BIND, and sendmail. Elz's seminar exposed local engineers and academics to an affordable network using dial-up UUCP and MHSNet protocols (Trin, personal electronic communication, October 7, 1997). Besides Elz, the other technical advisor for Thai universities during those days was Juris Reinfelds from the University of Wollongong, in eastern Australia. Reinfelds was the one who persuaded the International Development Plan (IDP) that setting up computer networking in Thailand was a worthy project, and he worked side by side with Thai engineers at PSU during the startup period and installation of the SUNIII system in 1988.

The spread of MHSNet and UUCP in the early 1990s made email more available for Thai academics. Everyone was excited by this new technology. Email became a daily, or even hourly, routine for more than 100 Thai academics. Besides MHSNet, NECTEC was running another "Inter-University Network" on X.25. After some discussion, NECTEC's director, Professor Pairash Thajchayapong, decided that it was time to move to full Internet Protocol (IP). As a result, the two networks agreed to merge on a middle ground — both needed to make the transition to TCP/IP (Thaweesak, personal electronic communication, September 5, 1997).

"We knew if we wanted to create a building block for the Internet, TCP/IP was the way to go. UUCP mail was just a fraction of the possibility of networking; it was cheap, but not suitable for international interactivity," said Thaweesak.

From UUCP to TCP/IP: The merger of MHSNet and the Inter-University X.25 network in 1992 resulted in the establishment of Thaisarn, an acronym for the Thai Social/Scientific Academic and Research Network. Thaweesak explained that Thaisarn was a generic name without any implication about the power center of the network, which is a collection of interconnected academic and research sites. In addition, sarn means information in Thai.

Funded by the national budget, Thaisarn was technically supported by NECTEC's in-house lab, the Network Technology Laboratory (NTL), and collaboratively by participating sites. The network expanded rapidly in the first year, thanks to strong support from Bangkok-based international computer vendors, such as IBM (Thailand), Digital Equipment Corporation (Thailand), and Hewlett Packard (Thailand) which donated servers for testing. Shinawatra Datacom, a local Datakit operator, donated some of its leased line circuits to Thaisarn. During that time, Thailand had neither a

local exchange nor international leased circuits. Consequently, HP (Thailand) and DEC (Thailand) set up two independent nodes locally, hp2hpth.co.th and decth.co.th, to transfer messages between the governmental and academic users and private corporations (see Diagram 1). The data between these two nodes had to travel around the globe through the corporate hubs in the United States before reaching the destinations down the street in Bangkok (see configuration details in Appendix A). These nodes were removed once Thailand leased the first international line to the US in 1992 (Trin, Thaweesak, & Morragot, 1994).

At the end of 1992, Chulalongkorn University in Bangkok acquired a 9.6Kbps link from the Communications Authority of Thailand (CAT) to connect to UUNET. Chulalongkorn paid CAT for both halves of the circuit at 25% discount. It cost around 3 million baht a year for the line. UUNET contributed by not charging the connection fee (access fee). With this leased line, Chulalongkorn became Thailand's new gateway for the so-called "ThaiNet" consortium, which included AIT, Chiangmai, and Assumption University. Chulalongkorn also allowed Thaisarn members to use the Internet via a 9.6Kbps local leased line as a courtesy through NECTEC. Both ThaiNet and Thaisarn members adopted the US National Science Foundation's Appropriate Use Policy (AUP) (Yunyong, personal electronic communication, 28 August 1998). This leased line enabled Thaisarn members to gradually upgrade their dial-up connections to TCP/IP. From a four site UNIX network in mid-1992, Thaisarn became a full TCP/IP network comprising 23 sites in mid-1994, the same year that NECTEC bought a 64Kbps leased line to UUNET. Users increased dramatically from 200 in 1992 to more than 5,000 in May 1994 and above 23,000 in June of the same year. The topology of the early development looked like a star with NECTEC and Chula in the middle. Since there were two separate lines from Thailand to UUNET, AIT acted as the local gateway between Thaisarn and ThaiNet via a 64Kbps leased line. The topology did not change much until commercialization in 1995 (see Diagram 2 and Table 1).

"We envisioned that email access would facilitate our connections with international scholars, so we were looking for the best way to make it happen for the academics in the university," said Dr. Yunyong Teng-amnuay of Chulalongkorn University's Engineering Department. "By that time, I got a promotional brochure from UUNET, then a budding Internet Access Provider, and after considering their experiences and expertise, I decided that we would be better off by connecting to the world's then hottest Internet base."

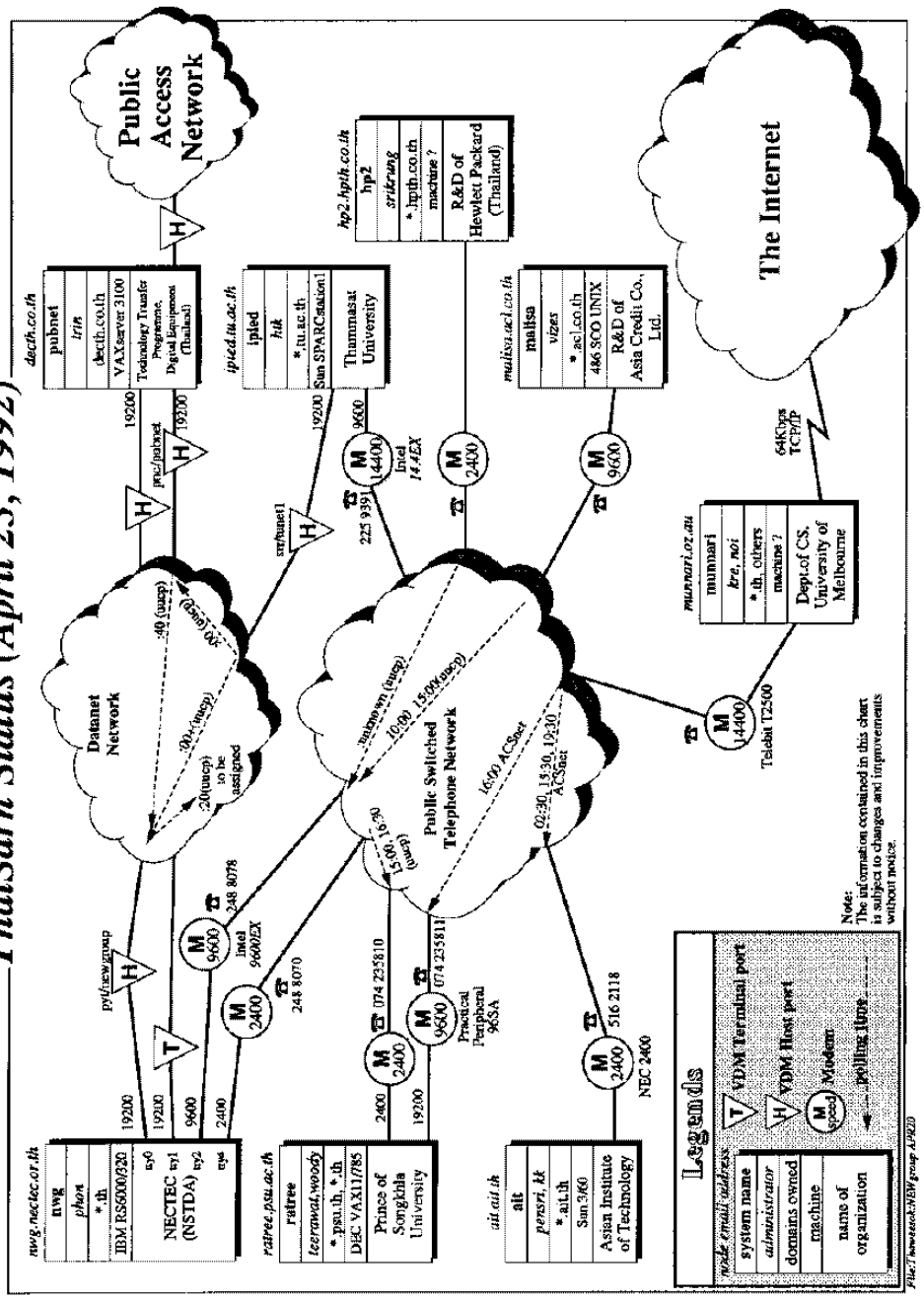

Diagram 1 : Earliest Topology of Thaisarn Network
Source : http://www.nsrc.org/ASIA/TH/thaisarn.gif

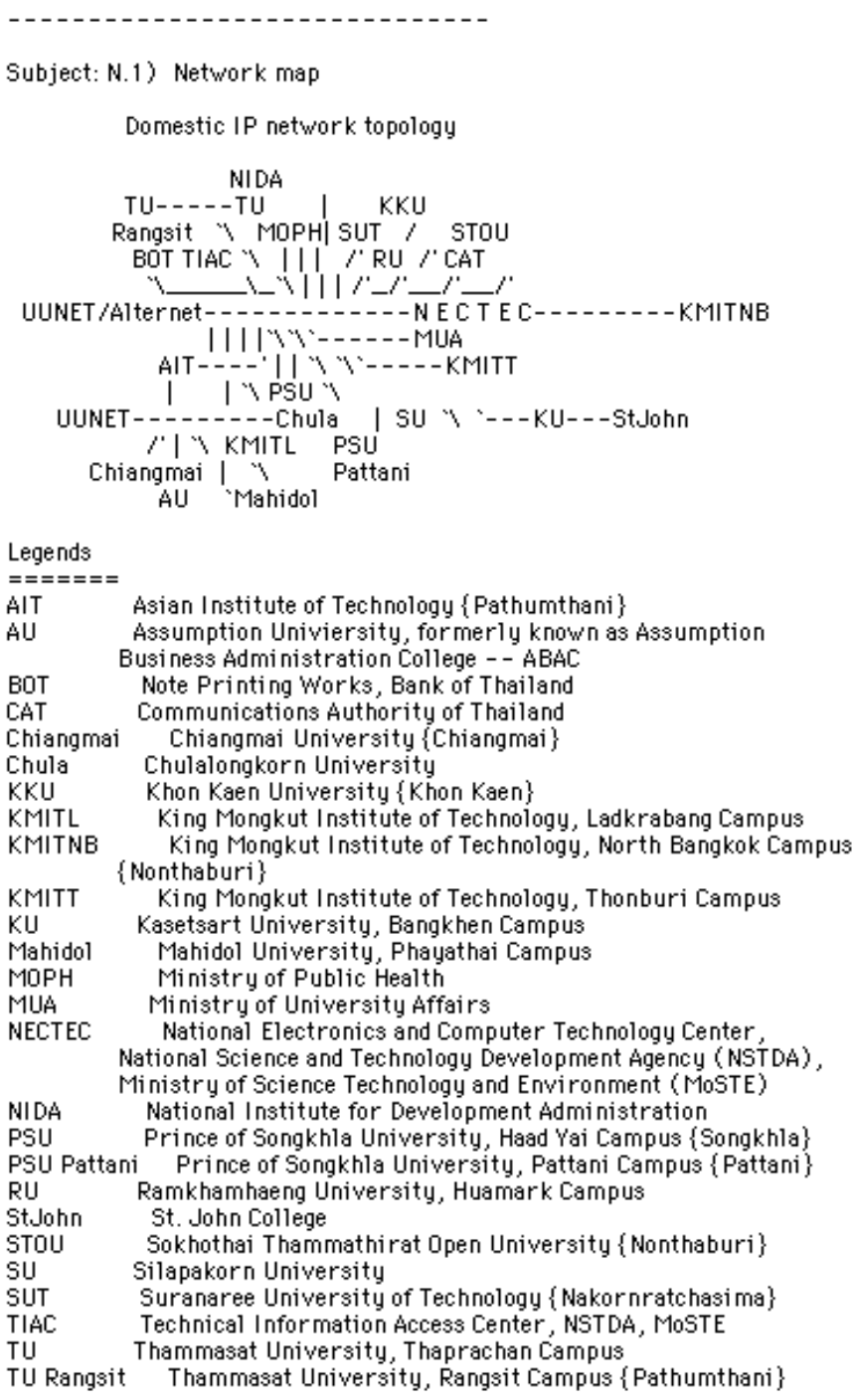

Diagram 2 : Thaisarn Network with Two Leased Circuitsto the US (Mid-1994)
Source : http://www.nectec.or.th/soc.culture.thai/technical.html#N.1

Dr. Yunyong is a veteran UNIX operator in Thailand. In the 1980s, he attended Iowa State University and received a Ph.D in computer science. In setting up the system for the first leased line, Dr. Yunyong received assistance from Rick Adams and the Telebits Co, which donated a 9.6Kbps modem and a router for the hub. Shortly thereafter, the Digital Equipment Co. loaned Chulalongkorn a DEC station 2100 for the server.

Table 1. The In-Out Traffic from Thaisarn to NSFNet during 1993-1994.

Date	Net No.	Bytes into NSFNet	Bytes from NSFNet	Traffic in % In	Out
Jan 93	3	110,086,100	291,218,500	0.00	0.01
Feb	11	153,774,900	450,993,850	0.00	0.01
Mar	12	232,535,800	637,034,800	0.00	0.01
Apr	11	157,441,200	596,281,150	0.00	0.01
May	13	173,862,850	724,595,250	0.00	0.01
Jun	13	25,8465,250	883,010,950	0.00	0.01
Jul	15	275,098,400	1,433,567,400	0.01	0.02
Aug	16	378,205,950	2,042,966,200	0.01	0.03
Sep	16	441,728,700	2,253,084,200	0.01	0.03
Oct	17	473,182,400	2,694,364,850	0.01	0.03
Nov	17	596,610,450	4,087,475,000	0.01	0.04
Dec	18	610,994,800	4,037,458,900	0.01	0.04
Jan 94	21	972,252,150	4,711,328,550	0.02	0.05
Feb	25	2,244,173,700	4,127,016,300	0.02	0.04
Mar	25	2,232,012,250	5,773,924,800	0.02	0.04
Apr	24	2,154,485,000	5,551,750,050	0.02	0.04
May	26	2,373,120,400	7,000,089,650	0.01	0.04
Jun	27	2,123,487,700	7,154,443,600	0.01	0.05
Jul	35	1,974,774,300	9,330,818,650	0.01	0.06
Aug	38	1,776,647,350	9,168,787,100	0.01	0.06
Sep	38	1,853,146,900	8,993,819,400	0.01	0.05
Oct	41	2,165,777,250	8,961,772,250	0.01	0.05
Nov	45	2,666,443,400	12,063,593,000	0.01	0.06
Dec	44	2,405,253,950	12,819,571,550	0.01	0.07

Source: http://www.nectec.or.th/soc.culture.thai/technical.html#N.2

The transition from UUCP to TCP/IP was smooth, due to the effective decisions made by the responsible Thai network engineers. When they decided to move from UUCP to TCP/IP in 1992, Thailand had only about 100 UUCP email users. These users had to learn about the greater abilities of the Internet Protocol (IP) suite, while new users simply absorbed what was presented to them. The popular email software when the network became TCP/IP was *pine*, originally developed in the USA at the University of Washington (Thaweesak, personal electronic communication, September 5, 1997).

Thaisarn's hub consisted of UNIX-based servers. Even though it depended on many vendors, NECTEC standardized its main routers and switches to Cisco and WellFleet. Access modems/routers were radius-driven. As Thailand expanded its nationwide fiber optic network, NECTEC switched the lines running from its hub in Bangkok from copper to the new technology using a special digital phone interface based on E1/R2 standards (Thaweesak, personal electronic communication, July 7, 1997).

> "The significant growth of *Thaisarn* reflected a strong commitment by everyone - not only NECTEC. Even though it was for academia, the private sector strongly supported us. IBM gave us a 3-million baht (USD$120,000) RS/6000-320 AIX server, the Alpha 3000-800 server that DEC gave us cost 3.6 million baht (USD$144,000), and Hewlett-Packard gave us an HP9000-720. NTL had only 5 staff during that time, but we had a lot of support from individual volunteers who worked for free to make the Internet happen in Thailand," said Thaweesak.

Key People and the Volunteer Ethic

Several volunteers enthusiastically supported For example, Trin Tantsetthi, a good friend of Thaweesak at TISI and Thammasat, who offered his labor for free to the network from the beginning.

> "I think it's a duty to reciprocate the taxpayer. You see, the 4-year tuition fees for my bachelor degree from Chula [Chulalongkorn] cost me about 5,000Bt (23Bt = 1USD then). With the 145 credits I earned, it was about $1.5 per credit...too good to be true, wasn't it? This could not have been possible without tax money that subsidized my education. So, when I had a chance, I took that chance to pay back my debt," wrote Trin in an email message (Trin, personal electronic communication, October 6, 1997).

In 1992-93, Trin brought up Thailand's first gopher, ftp, news, and web servers as communication tools of Internet users in Thailand. As an electrical engineering graduate from Chulalongkorn University, Trin was a software architect for DEC (Thailand) and a self-taught network engineer. He explained that an article on the Altair microcomputer, which was published in *Popular Electronics* magazine in 1975, inspired him to work in the computing industry. Later, he studied FORTRAN on his own by using Chulalongkorn's textbooks. It was about 16 years prior to the creation of Thaisarn (Trin, personal electronic communication, October 7, 1997).

Besides Trin, other volunteers worked together under the name "NECTEC Email Working Group (NEW Group)." The group contributed technical knowledge to the nascent network and answered questions from both interested engineers and the growing community of users. The only reward these volunteers received from Thaisarn during those days was a free email account on NECTEC's server (nwg.nectec.or.th). Participation in Thaisarn was appealing to the volunteers, particularly because NECTEC was fast-paced and non-bureaucratic, unlike most other state institutions. Volunteers worked interactively with Thaisarn's staff. Trin explained that the volunteer-based Thaisarn relationship had no strings attached. Without any request, volunteers offered their opinion and labor to Thaisarn to build whatever they thought the network required or the users wanted.

Chulalongkorn University also played a major role training young network engineers, some of whom, after graduation, became NECTEC's

key personnel. Yunyong explained that engineering students at the university were always allowed to participate in the setting up of the Internet gateway project and various services, including setting up mail, FTP servers, and technically supporting Thailand's top-level domain name (Yunyong, personal electronic communication, 28 August 1998).

"We were always excited by the abundance of the new networking technologies and knowledge we received through the Internet. One of the major technology transfers was the introduction of "*Pine*," an email software developed by the University of Washington," explained Yunyong by email.

Public Access Networking: Back in 1991, before Thaisarn acquired the first leased line, there was an attempt to bring up a "public access network" (Pubnet) to bridge the academic and private networks. In the early 1990s, Thailand had more than 50 Bulletin Board Systems (BBS), some of which were connected to FidoNet. Trin proposed the Pubnet idea to his then-employer, Digital Equipment Corporation (DEC Thailand), and received a VAX machine to start up Pubnet. In his proposal, Trin wrote that without a public network, "IT researchers (in Thailand) could not share tools and research works in a convenient manner. As a result, there were many duplicated efforts in solving similar problems. Incompatible Thai system implementations in the personal computer industry, different character sets, proprietary extensions and variants of TIS standards were a few negative examples of what happens when we do not work together." (Trin, 1991)

Trin defined a public network as, "a collection of public access systems which talk to each other by a set of common protocols." Consequently, he designed Pubnet by using the DEC's VAX machine running Ultrix OS as a gateway machine in the middle of Thaisarn's UNIX-based network and the PC-based BBS network (Trin, 1991). What Pubnet needed was a volunteer BBS running a gateway application that would link it up with Thaisarn's UNIX gateway. It was not until the end of 1992, when Alan Dawson, a "veteran modemer" living in Thailand, stepped forward and offered his PC to run *Wildcat* software, that Pubnet became successful. Dawson's gateway machine exchanged email between the UNIX gateway and other BBSes using a BBS packet transfer mode. At that time, Pubnet distributed a free Usenet feed from Thaisarn to BBSes and some BBS operators offered email services with some cost-recovery charges since that required international calls to either the US or FidoNet's Zone master in Singapore (Trin, personal electronic communication, August 5, 1997).

Many Thais used Pubnet, which was basically free and easy to use. Anyone with a modem and a PC could connect to BBSes and be on Pubnet. However, due to a lack of formal fundraising, Pubnet soon failed financially. Nevertheless, Pubnet successfully demonstrated the possibility of networking among incompatible platforms and prepared Thais for the Internet.

"You see, when Pubnet was proposed, the chance of getting an Internet connection (in Thailand) was far beyond imagination," wrote Trin Tantsetthi, now the president of the Internet Thailand Co., Thailand's first commercial Internet Service Provider (ISP), via email. "It was impossible to get a leased line connection from Thailand to the Internet due to the distance and big international communication costs. And since Pubnet was a free service and volunteer-based, it depended on how deep the pocket of the volunteer was, but I didn't have many alternatives. Volunteer-based organizations everywhere in the world not only rely on strong will and dedication, but also funding." (Trin, personal electronic communication, July 19, 1997)

Thailand's Economic Model - Financing the National Network

Thaisarn began with 12 million baht (USD$480,000) of seed money from the government and about 15 million baht (USD$600,000) in the form of donations from the private sector during the first three years. As of 1993, the network used about 8 million baht (USD$320,000) per year for maintenance and leased line acquisition. Currently, it uses Bt30 million (USD$1.2 million) per year. The government now pays for Thaisarn's leased lines, which are acquired at a 25 percent discount from CAT (see CAT's full price in Table 2). *Thaisarn*'s downstream sites help pay for salary and machine maintenance by contributing towards Thaisarn's fund according to the bandwidth speed of their leased lines (see Table 3 and 4).

Table 2. Monthly Rates of a Full Time Duplex International Leased Half Circuit

Speed	Countries near	Asian and ASEAN Thai Border	Other countries countries
56/64K	$4,800[a]	$5,520	$6,200
128K	6,440	7,360	8,280
192K	9,000	10,240	11,560
256K	10,520	12,040	13,520
384K	13,600	15,560	17,480
512K	16,040	18,360	20,640
768K	22,200	25,400	28,600
1024K	26,240	30,000	33,760
1536/1544K	33,280	38,000	42,800
1920/2048K	35,920	41,040	46,160
8448 K	90,720	103,680	103,680
34M	181,440	207,360	207,360

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: Communications Authority of Thailand. Available: http://www.cat.or.th/new/leased.htm (August 1997)

Table 3. Thaisarn Fund Contribution Requirements (in USD[a]).

Site's Speed	Price/month[b]
1. First 19.2 Kbps	Exempt
2. Second 19.2Kbps	Exempt if connected through the first site
3. 64Kbps	$800[a]
4. 128Kbps	1,600
5. 256Kbps	3,200
6. 512Kbps	4,800
7. 2Mbps	6,400

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

[b]n = no start-up fee

Source: Rabieb Kan Chium Tor Kab Krua Kai Thaisarn II Pan NECTEC. (1997). How to connect to ThaisarnII's Internet), http://ntl.nectec.or.th/thaisarn/thaisarn-policy.html

Table 4. Thaisarn Discounted Contribution Requirements[a].

1st site's speed	No. of downstream sites to *Thaisarn* hub	Accumulative bandwidt	Price/month
64Kbps	At least 3	At least 32Kbps	Exempt
128 Kbps	At least 3	At least 64Kbps	$320[b]
256 Kbps	At least 3	At least 64Kbps	640
512 Kbps	At least 6	At least 128Kbps	960
2Mbps	At least 8	At least 256Kbps	1,280

[a]n = This pricing is applied when sites have their downstream sites connected directly to Thaisarn's hub in Bangkok.

[b]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: Rabieb Kan Chium Tor Kab Krua Kai Thaisarn II Pan NECTEC. (1997). (How to connect to ThaisarnII's Internet), Available: http://ntl.nectec.or.th/thaisarn/thaisarn-policy.html

Despite rapid expansion, Thaisarn could neither cope with strong demand from users nor afford to establish an independent site to every organization. In early 1994, Thaisarn opened a new server called "morakot.nectec.or.th," for individuals who worked for the government agencies and non-profit organizations that could not afford to set up their own nodes. Users were required to pay a startup fee plus monthly costs ranging from USD$12 to $160 per month (see Table 5). Called the "Thaisarn Internet Service" (TIS), the service was reserved only for governmental agencies, educational and research organizations, and non-governmental

organizations (NGOs). Abiding by CAT's restrictive law not to resell the bandwidth, NECTEC could use the TIS-generated income to pay only for server maintenance, phone lines, and staff salary. This demanding regulation later resulted in some unlawful practices and an outburst of demand for the Internet.

Table 5. Thaisarn Internet Service's Pricing.

Service	Price/month	Service Description
A (Text only)	$12[a]	20 hours/month (email,usenet only)
B (Full Internet)	20	30 hours/month (email, Internet)
U (UUCP links to NGOs)	160	30 hours/month
D (an extra 200Kbdisk storage option)	4	
T (an extra 10 hour session option)	4	

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: Thaweesak Koanantakool, Trin Tantsetthi, and Morragot Kulatumyotin. (1994). *Thaisarn*: The Internet of Thailand. Available: http://www.nectec.or.th/bureaux/nectec/ThaiSarn.book/index.html

National IT projects: In the 1996 fiscal year, the Thai government had approved a Bt4.2bn (USD$120-168million) budget for the national IT infrastructure and human resource development. This is a part of the Telecommunications Master Plan and the 8th National Economic and Social Development Plan. Called IT-2000, the plan aims at developing a national IT infrastructure, human resources, and enhancing government service using the computer networks.

The first project, to build a national information infrastructure (NII), is to use the existing telecommunications resources, including the nationwide fiber optic network and satellites, to expand the Internet service into rural areas. This plan is coupled with the current "Information Superhighway Testbed," also managed by NECTEC, which uses ATM technology to improve the data transmission capability of the country from the current 2Mbps to 155-620Mbps (Thaweesak, 1997). NII would facilitate remote schools connecting to the Internet by reducing the long distance telephone costs. Currently, schools that wish to get on the Internet can either cooperate with local universities or dial to Thaisarn's hub in Bangkok. However, not every province in Thailand has a university.

The second project, to invest in people, intends to concentrate on transferring IT knowledge to Thai children. One free universal access service began late last year to celebrate His Majesty the King's golden jubilee. Called Kanchanapisek Network Project, the network provides limited access to the World Wide Web to students and everyone with Internet access in their area by using a special toll-free number. Also, SchoolNet and IT Campus projects were initiated to make Thai students more comfortable with the Internet. Currently, more than 74 schools in Thailand have joined SchoolNet. Local computer vendors such as Microsoft, Intel, Compaq, and Powell support this project by donating some hardware and software to schools. IT Campus is now composed of 15 universities in 11 provinces. It is expected that it will cover at least 30 provinces by the end of 1999. Meanwhile, long-term training is being prepared. Two projects, the National Multimedia Institute (NAMMI) and Electronic Industry Institute, will be established to provide solid technology training in multimedia as a means to make Thailand an information provider on the Internet. Localization of software is also being promoted by the government in setting up the Software Park project — a plan to boost Thai engineers to produce more software by giving them some attractive rewards such as tax exemption from the Board of Investment for large-scale software production.

The third project, called the Government Information Network (GINET), plans to link all government agencies in 76 provinces together on the national fiber optic backbone as well as encourage government officers to become more computer literate. In the future, every government officer will be required to pass a computer test before being promoted.

Regulations and Telecommunications Infrastructure

Regulations: The telecommunications industry in Thailand is a monopoly, governed by two state enterprises: the Telephone Organization of Thailand (TOT) and the Communications Authority of Thailand (CAT). TOT controls the domestic telephone industry; CAT regulates the international, including half-circuits to the Internet. Until commercialization in 1995, CAT reserved the international leased bandwidth for state academics and government. Despite a recent discount from CAT, international calls made from Thailand are about three times more expensive than ones made from the US. Coupled with the first minute surcharge, the rates vary by zones and times that the calls are made (see Table 6). Many expatriates and travelers bypass telephone on the Thai site by using the callback service which reduces their costs up to 77 percent (see Table 7).

Table 6. CAT's International Calling Rate (per minute[a]).

Zone	Standard Price 7.00am-9.00pm	Economy Rate 9.00 pm-12.00am 5.00am-7.00am	Reduced Rate 12.00am-5.00am
Asia, North America, Australia	$1.60[b]	$1.28	$1.12
ASEAN Hong Kong	1.36	1.08	1.08
Europe, Middle East, Pacific Ocean	1.84	1.48	1.28
Africa, Central America, South America	2.20	1.76	1.56
Singapore, Myanmar, Cambodia	1.20	0.96	0.96

[a]n = Rates effective since March 1, 97.

[b]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: The Communications Authority of Thailand. Available: http://www.cat.or.th (1997, July 18)

Table 7. Callback Savings from Thailand to Foreign Countries.

Savings on calls from Thailand to:	Through domestic Exchange	From hotels
Argentina	28%	73%
Australia	23%	72%
Belgium	23%	72%
France	28%	73%
Germany	28%	73%
Italy	23%	72%
South Africa	28%	73%
Switzerland	28%	73%
UK	38%	77%
US	38%	77%

Source: "Callback Services Help Reverse Asia Charges-Phone Services that Undercut Monopolies," (1994, September 29). Financial Times.

At the end of 1994, CAT caved in to the popular demand for the Internet. With TOT and NECTEC's legal entity the National Science and Technology Development Agency (NSTDA), CAT set up Thailand's first commercial ISP, Internet Thailand Company, and established a legal formula for creating an ISP. First, applicants must be in either the telecommunications or computing industry. Second, the new entity must be a joint venture with CAT, which will get 35 percent of the total equity for free (33% to CAT and 2% to CAT's staff). This agreement does not apply to Internet Thailand because in that case CAT actually paid for its shares. Third, every ISP must buy leased circuits to the Internet through or from CAT. CAT reserves the right to send its personnel to work in the ISP and has the right to veto the decisions made by the board of directors. Fourth, every ISP must agree to transfer to CAT the ownership of all networking equipment, such as routers and modems, at the establishment of the new entity. CAT also sets up guideline pricing for how much an ISP can charge their customers.

Telecommunications Infrastructure: Telecommunications in Thailand has developed dramatically in the past ten years. One year after Kanchana struggled with AIT's single phone line in 1986, TOT allowed Thais to buy phone equipment directly from market sources instead of from TOT agencies for the first time. By the end of 1990, due to an inadequate budget, TOT allowed private companies to build the nationwide fiber optic network,

the submarine fiberoptic network in the Gulf of Thailand, and commercial satellites. The fiber optic network enabled TOT to increase the national long-distance telephone service between Bangkok and Thailand's northern, northeastern, and southern regions. The submarine fiber optic network enhanced voice, data, and television traffic as well as improved long distance calls to the south, which in the past were always affected by winds and monsoons (Rassamee, 1997). Thailand's first commercial satellite was launched in 1993, by the Shinawatra Computer and Communication Group. Currently, Thailand has three satellites, Thaicom 1, 2, and 3 which enhance local, regional, and global transmission capacity of the country.

Meanwhile, the land lines were not improved until the end of 1992. The demand grew dramatically from 305,148 in 1986 to 992,496 in 1990; the future demand is expected to be 800,000 lines annually (TOT, 1996). In 1990, the Thai government authorized Charoen Pokphand Group, a Thai consumer goods manufacturer, to install three million lines in Bangkok and provinces throughout Thailand. This project, however, was interrupted by the 1991 coup d'etat and thus revised by the Anand Panyarachun government. Known as Thailand's most respectable and efficient government, the Anand government considered the initial contract unfair and thus split the three-million-line project into two parts: two million lines in Bangkok for Charoen Pokphand and one million lines in the provinces to Thai Telephone and Telecommunications (TT&T). Both companies used a state-of-the-art transmission network, composed of digital switches and fiber optic lines. The next government also supported the projects. Chuan Leekpai, the country's first elected prime minister with no military or bureaucratic background, encouraged both contractors to finish the projects by the end of 1996, one year earlier than scheduled. The government intends to continue to expand domestic lines. By the end of 2001, telephone density is expected to be 5 to 1 - five people per telephone. However, that does not mean telephones will be equally distributed in Thailand. In fact, they will concentrate in big cities where only a third of total population resides (see Table 8).

Table 8. Telephone Forecast: 1992-2001.

Year	Bangkok and Surround		Provinces		Total of Thailand		
	# of Phones	Phones per 100 people	# of phones	Phones per 100 people	# of phones	Phones per 100 people	BKK: province ratio
1992	2,228,482	26.70	935,843	1.88	3,148,125	5.46	2.38:1
1993	2,617,591	30.77	1,152,251	2.29	3,768,842	6.41	2.27:1
1994	3,007,120	35.00	1,436,128	2.82	4,473,248	7.50	2.11:1
1995	3,457,105	39.06	1,784,895	3.46	5,242,001	8.67	1.94:1
1996	3,882,854	43.10	2,237,042	4.28	6,110,906	9.99	1.74:1
1997	4,282,850	45.68	2,804,178	5.31	7,087,028	11.43	1.53:1
1998	4,651,164	49.88	3,491,939	6.53	8,143,103	12.96	1.33:1
1999	4,877,187	52.46	4,341,157	8.02	9,318,344	14.65	1.15:1
2000	5,252,714	54.52	5,343,206	9.77	10,305,920	18.48	0.88:1
2001	5,507,252	56.06	6,515,319	11.78	12,022,571	18.46	0.85:1

Source: More Freedom on the Line. Bangkok Post Mid-year'96 Economic Review.

The Current State of the Internet in Thailand

Thailand currently has sixteen ISPs operating nationwide with a total bandwidth of more than 30Mbps. The three largest are the Internet Thailand Company, KSC Comnet, and the Loxinfo Company . (see the Diagram 3).

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's first 512Kpbs 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 protocols 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 Bt15,000 (then USD$600) for a 9.6Kbps link to Bt700,000 (then $28,000) for a 512Kbps link (Commercial Internet, January 18, 1995) (see Table 9 and 10).

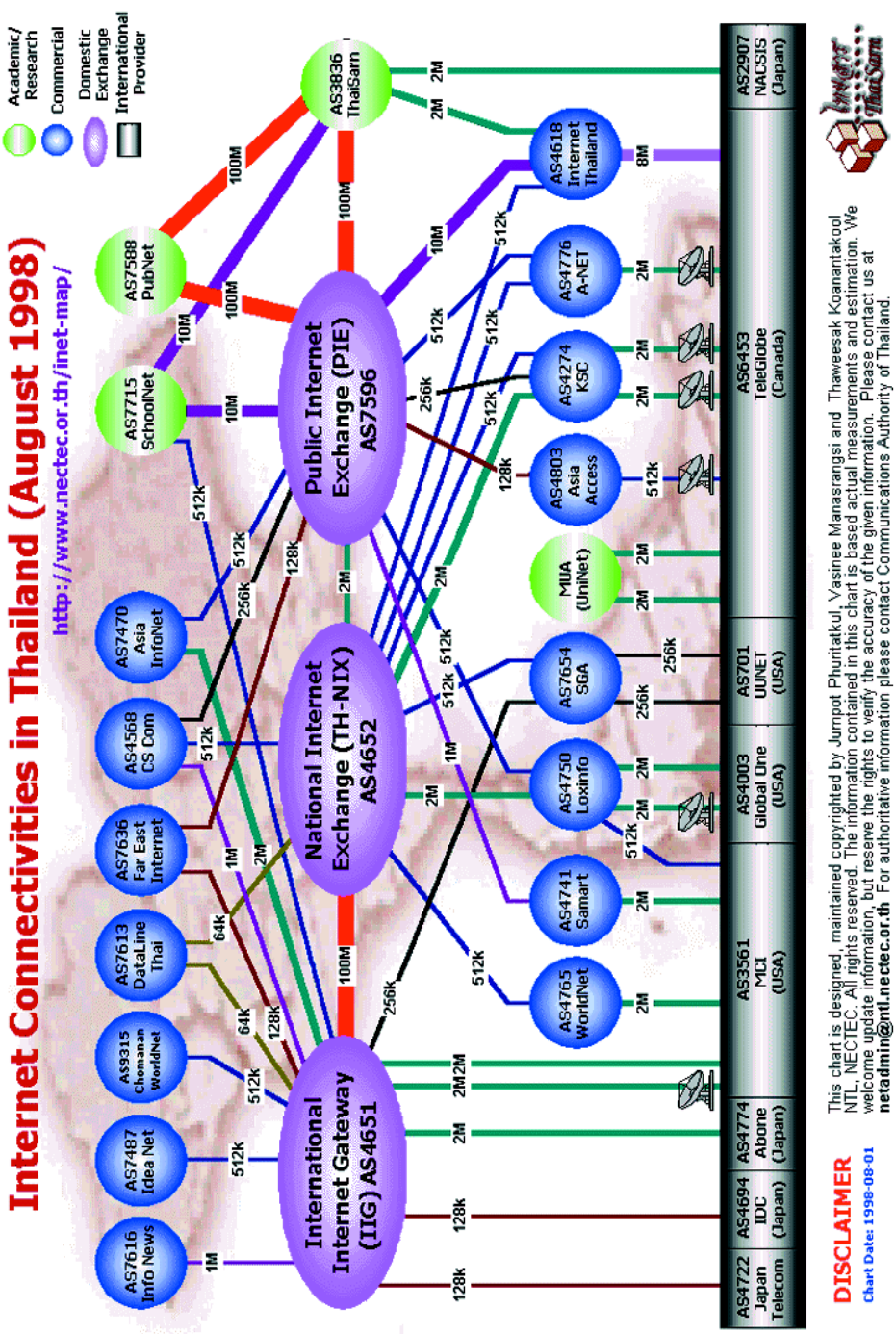

Diagram 3 : Current (as of August 1998) Topology of Thailand's National Network
Source : http://www.nectec.or.th/inet-map/980801 (as of August 1998)

Table 9. Internet Thailand's Initial Pricing for Individual Users.

Service Types	Price/month	Service description
1. HomeNet	$16[a]	Email and USENET, 15 hours monthly 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.

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: "Commercial Internet Service Rates Announced." (1995, January 18). Bangkok Post.

Table 10. Internet Thailand's Initial Pricing for Corporate Users.

Line Speed	Price/month[a]
9.6Kbps	$600[b]
14.4Kbps	800
19.2Kbps	1,000
28.8Kbps	2,400
64 Kbps	4,000
128 Kbps	7,000
256 Kbps	10,000
512 Kbps	28,000

[a]n = All rates are subject to a start-up fee equal to 2-month subscription.

Members pay startup fee plus a 6-month subscription up front.

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: "Commercial Internet Service Rates Announced." (1995, January 18). Bangkok Post.

KSC Comnet, 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 three additional ISPs, including Loxinfo, which is led by a giant telecommunications firm, Loxley International Company, the Wattachak Group, a media company, and the Advanced Research Group.

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 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 changed 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 (Bussakorn, 1996).

Newspapers jumped on the bandwagon of World Wide Web (WWW) publications. 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 Cafe 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 (see Diagram 4).

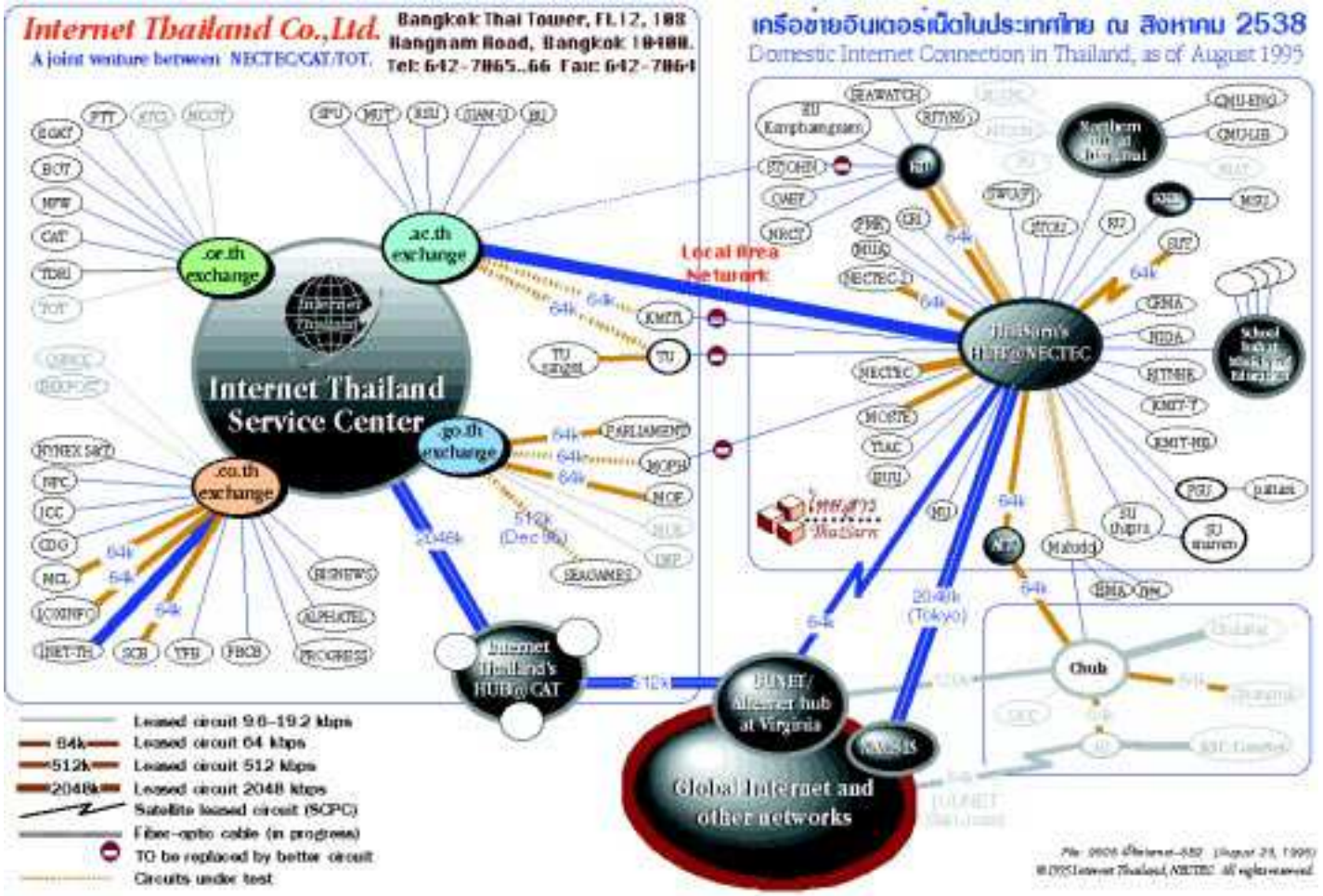

Diagram 4 : Thaisarn's Topology after Acquiring the First E1
Source : http://www.nectec.or.th/inet-map/1995/

In early 1996, Internet Thailand acquired another E1 to MCI (see Diagram 5). When Thailand hosted the Asia-Europe Meeting in 1996, Internet Thailand and NECTEC combined their international leased lines with a local E1 circuit to provide an Internet service to participants from Europe and Asia. This significantly boosted Thailand's role as an 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 through their organizations, including Thaisarn's sites. Only 10% (10,000) were individual customers of commercial ISPs. According to Thaweesak, 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 (Bussakorn, 1996).

"In Thailand, the Internet service is quite expensive because we are far from the center of the Internet, or the US, and we have to pay for the leased line in US currency," said Yunyong. "Also, I think 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 a very useful communicating tool, we are so excited about the WWW, video, and sound clips which take up more of those expensive bandwidths."

The English-dominated Internet also daunted most Thais.

"Thais are not like Singapore Chinese or other countries where people speak English as a second language. That's why the growth here cannot be sustained after it has saturated among English speakers in the country," said Thaweesak (Thaweesak, personal electronic communication, September 5, 1997).

Diagram 5 : The National Network when the Internet Thailand Acquired the First E1
Source : http://www.nectec.or.th/inet-map/1996/

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 (ISPs considering, The Nation, April 28, 1998). In early 1997, after CAT reduced its pricing guideline (for both minimum and maximum), Internet Thailand slashed the startup fee from Bt2,000 to Bt200-300 and monthly service from Bt1,200 to Bt900. It also offered a 5 to 10 percent discount for subscriptions longer than 6 months. Some smaller ISPs were less expensive. ("ISPs expecting," March 25, 1997). Other new ISPs sought a market niche. The Loxinfo Company, for example, encouraged local radio and television production companies to provide materials to its website to expand the customer and advertising base ("Internet provider," June 26, 1997). Meanwhile, corporate users paid expensive prices for leased lines acquired from local ISPs, at least nine times more than 25 other developing countries ("Survey," February 26, 1997). As of 1996, Internet Thailand had 5,000 individual users and 80 corporate customers; KSC meanwhile claimed 60,000 individual users (http://www.nsrc.org/db/lookup/operation=lookup-report ID=890202389184 :497434953/fromPage=TH).

The Thailand Development Research Institution (TDRI), a non-profit organization, found that the PTT model not only increased the cost of Internet service in Thailand but also reduced the country's ability to compete with its neighbors. In its report about Internet pricing in Thailand (Somkiat & Deunden, 1997), TDRI researchers found that when compared with the APEC countries with equivalent GDP, Internet distribution in Thailand was 1-2 years slower. Thailand was ranked side by side with Indonesia and the Philippines, all of which had fewer than 50 hosts per every $1 billion value of GDP (see Table 11). While the Internet in Singapore and Malaysia, both in a free market system, took off since 1995 (as seen in a dramatic increase of host numbers), the Internet in Thailand kept a low profile. Why? It appears that the telecommunications monopoly and the market intervention of CAT discouraged Internet growth. TRDI's equation showed that a country with a monopoly system has 557.2 fewer hosts for every $1billion worth of GDP than a liberalized country (see Appendix B).

Table 11. Hosts per GDP of APEC countries[a].

Country	Abbreviation	Real GDP 1996 (US1Bn)	#Host (Jan 97)	#Host/GDP	Monopoly
Philippines	Ph	81.3	3628	44.6	No
Thailand	Th	187.2	9245	49.4	Yes
Indonesia	Id	229.8	9591	41.7	Yes
Singapore	Sg	94.6	38376	405.5	No
Malaysia	My	88.7	25200	284.2	No
ASEAN		136.3	17208	165.0	
Taiwan	Tw	288.0	34652	120.3	Yes
Hong Kong	Hk	164.7	49162	298.5	No
Korea	Kr	509.4	66262	130.1	No
China	Ch	825.0	129114	156.5	Yes
Mexico	Mx	311.6	29840	95.8	No
Chile	Cl	77.0	15885	206.3	No
Australia	Au	393.8	514760	1307.1	No
New Zealand	Nz	64.8	84532	1305.1	No
Canada	Ca	622.4	603325	969.3	No
Non-ASEAN		361.8	169725	509.9	
All 14 APEC		281.3	115255	386.8	

[a]n = Due to great differences in host density, US, Japan, Brunei, and Papua New Guinea are excluded from this study.

Source: "Rai Ngan Phon Karn Wichai Reung Sapab Karn Kangkan Lae Raka Ka Borikarn Internet Nai Prathet Thai (Competition and Pricing of Thai Internet)," by Somkiat Tangkitvanich and Deunden Nikomborirak, (1997, June 6). Thai Development Research Institute.

CAT's interference in the market also distorted the dynamics. By setting up the guideline pricing, CAT spawned a tacit collusion among big ISPs (as shown in Table 12, 13, and 14) when they agreed to set their service charges at the maximum.

Compared to seven regional countries (Indonesia, Singapore, Malaysia, Hong Kong, Taiwan, South Korea, and Japan), the monthly price of the 20 hour Internet service for individuals in Thailand was 20-63 per cent more expensive than every country except Japan. For the Thai corporations who needed international leased line connections, things were even worse. The monthly cost of a 64Kbps leased line in Thailand was more than USD$3,200 plus a $3,000 non-refundable startup fee. This was 50-80 percent more expensive than other APEC countries (see Table 15).

Table 12. CAT Median Pricing for Individual Users (Effective since March97)

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

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: "Rai Ngan Phon Karn Wichai Reung Sapab Karn Kangkan Lae Raka Ka Borikarn Internet Nai Prathet Thai (Competition and Pricing of Thai Internet)," by Somkiat Tangkitvanich and Deunden Nikomborirak, (1997, June 6). Thai Development Research Institute.

Table 13. CAT Median Pricing for Corporate Users (Effective since March97)

Service	Connec-tivity	Start-up	Monthly	Traffic MB	Extra traffic $/MB	Maximum Charges[b]
UUCP	Dial-up	$144[a]	$144	40hrs	$3/hr	NA
IP 9.6Kbps	LL	540	540	1,300	0.40	$720
IP 14.4Kbps	LL	720	720	1,900	0.40	900
IP 19.2Kbps	LL	900	900	2,500	0.40	1,800
IP 28.8-63.9Kbps	LL	1,800	1,800	3,700	0.40	3,600
IP 64Kbps	LL	3,600	3,600	8,400	0.40	6,300
IP 128Kbps	LL	6,300	6,300	16,600	0.40	9,000
IP 256Kbps	LL	9,000	9,000	33,200	0.40	25,200
IP 512Kbps	LL	25,200	25,200	66,400	0.40	75,600
IP 513Kbps-2Mbps	LL	75,600	75,600	265,400	0.40	151,200

[a]n = Exchange rate 1USD = Bt25

Note: At this publication (August 1998), the exchange rate is Bt40 = 1USD

[b]n = An ISP can seek no more than the maximum charges set by CAT.

The lowest charges can be up to 40 percent lower than the median pricing.

Source: "Rai Ngan Phon Karn Wichai Reung Sapab Karn Kangkan Lae Raka Ka Borikarn Internet Nai Prathet Thai (Competition and Pricing of Thai Internet)," by Somkiat Tangkitvanich and Deunden Nikomborirak, (1997, June 6). Thai Development Research Institute.

Table 14. Pricing models of ISPs in Thailand.

Names	Individual account 20hrs/month	Leased line (64 Kbps) for Corporate users	
		Start-up	Monthly
A Net	$29.96[a]	$3,600	$3,600
Asia Access	31.96	NA	NA
Asia Infonet	24 ($12 for students)	2,160	2,160
Idea Net	32	3,200	3,200
Line Thai	36	3,600	3,600
Info News	24 (10hrs)	3,600	3,600
Internet Thailand	36	3,600	3,600
Loxinfo	36	2,800	2,800
KSC Comnet	32	3,600	3,600
Siam Global Access	32	3,060	3,060
Samart Cybernet	32	NA	NA

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: "Rai Ngan Phon Karn Wichai Reung Sapab Karn Kangkan Lae Raka Ka Borikarn Internet Nai Prathet Thai (Competition and Pricing of Thai Internet)," by Somkiat Tangkitvanich and Deunden Nikomborirak, (1997, June 6). Thai Development Research Institute.

Table 15. Thai Internet Prices Compared with Regional Countries.

Countries	Dial-up Service for Individual (20Hrs)		Leased line (64Kbps)	
	Startup	Monthly	Startup	Monthly
Thailand	$11.54[a]	$33.65	$3,076.92	$3,205.13
Hong Kong	12.32	19.78	251.94	659.95
Taiwan	3.60	22.12	107.91	953.24
Singapore	9.26	17.35	300.93	1018.52
S. Korea	11.20	22.40	111.98	667.97
Malaysia	22.82	12.30	595.24	892.86
Indonesia	22.59	25.75	821.36	1232.03
Japan	240.00	160.00	311.47	1541.33

[a]n = Exchange rate 1USD = Bt25

Note: As of August 1998, the exchange rate is Bt40 = 1USD

Source: "Rai Ngan Phon Karn Wichai Reung Sapab Karn Kangkan Lae Raka Ka Borikarn Internet Nai Prathet Thai (Competition and Pricing of Thai Internet)," by Somkiat Tangkitvanich and Deunden Nikomborirak, (1997, June 6). Thai Development Research Institute.

The CAT's self-allocated free shares distorted the competition by increasing the burden to ISPs who, to keep up with the projected profiting, passed those costs on to the user base. TDRI pointed out that CAT's free shares cost each ISP about 8-20 percent in addition to the real costs (see Appendix C).

However, CAT's policy eventually backfired. 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 Bt150 per megabyte. This was 60 times more expensive than the prices of Bt2.5- Bt18.75 per megabyte set by foreign ISPs, some of whom offered unlimited traffic for their corporate users. CAT's traffic limit not only discouraged data transfer, technical improvement, and content development of Thai sites but also forced them to seek cheaper sites "offshore" (Charges push, October 9, 1997. Bangkok Post)

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. In its editorial, the newspaper explained, "Substantial price differences in basic hosting and potential to reduce or eliminate transfer fees makes the decision of placing a Web site offshore easy to make... 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." ("Charges push," October 9, 1996)

Currently, 26 percent of Thai sites have relocated overseas. The number is expected to increase in the future if more Thais realize that relocation is easy to do.

Another study conducted by the Organization for Economic Cooperation and Development (OECD) echoed TDRI's research that the prices ISPs charge corporate nodes directly affect the country's presence on the Internet. In a report entitled, *Information Infrastructure Convergence and Pricing: The Internet* (http://www.oecd.org/dsti/gd_docs/s96_xxe.html), the OECD stressed the relationship between the number of Internet hosts and the cost of telecommunications infrastructure, including computers and Internet access costs. The OECD study indicates that:

- "The penetration of Internet hosts is five times greater in competitive than monopoly markets, and if allowance is made for the date of service commencement, Internet access in countries with

telecommunications infrastructure competition has grown six times faster than monopoly markets.

- The average price for leased line access to the Internet in countries with monopoly telecommunications infrastructure provision in 1995 was 44 per cent more expensive than countries with competitive provision of infrastructure.

- In countries without telecommunication infrastructure competition the need for policy reform is pressing because when Internet Access Providers pay steep charges to PTOs they must pass these costs on to business and residential users.

- On average, Internet Access Provider's prices for dial-up services were nearly three times less expensive in countries with telecommunication infrastructure competition than those with monopoly markets in 1995."

Thaweesak, who is now NECTEC's director, also suggested that CAT can promote the Internet penetration simply by changing its role.

"It is unhealthy when CAT is both regulator and operator at the same time. Ideally, CAT should take only one role: as an operator (i.e., leasing the lines). Regulatory responsibility is to supervise the quality of Internet services to Thai people, and so far CAT has not done that," said Thaweesak (Thaweesak, personal electronic communication, September 5, 1997).

As a regulator and middle man, CAT controls the access to the international lines and resells the lines it acquires from international access providers to small, local ISPs who cannot 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 Diagram 6). It was mandatory that every big ISP with an international link peer locally at TH-NIX and pay CAT a monthly fee. IIG customers, meanwhile, had to buy at least a 512Kbps link to TH-NIX themselves. Another local exchange point includes Thaisarn's Public Internet Exchange (PIE), operated by NECTEC on a cooperative, non-profit basis, connecting Thaisarn and four other ISPs (Trin, personal electronic communication, September 5, 1997).

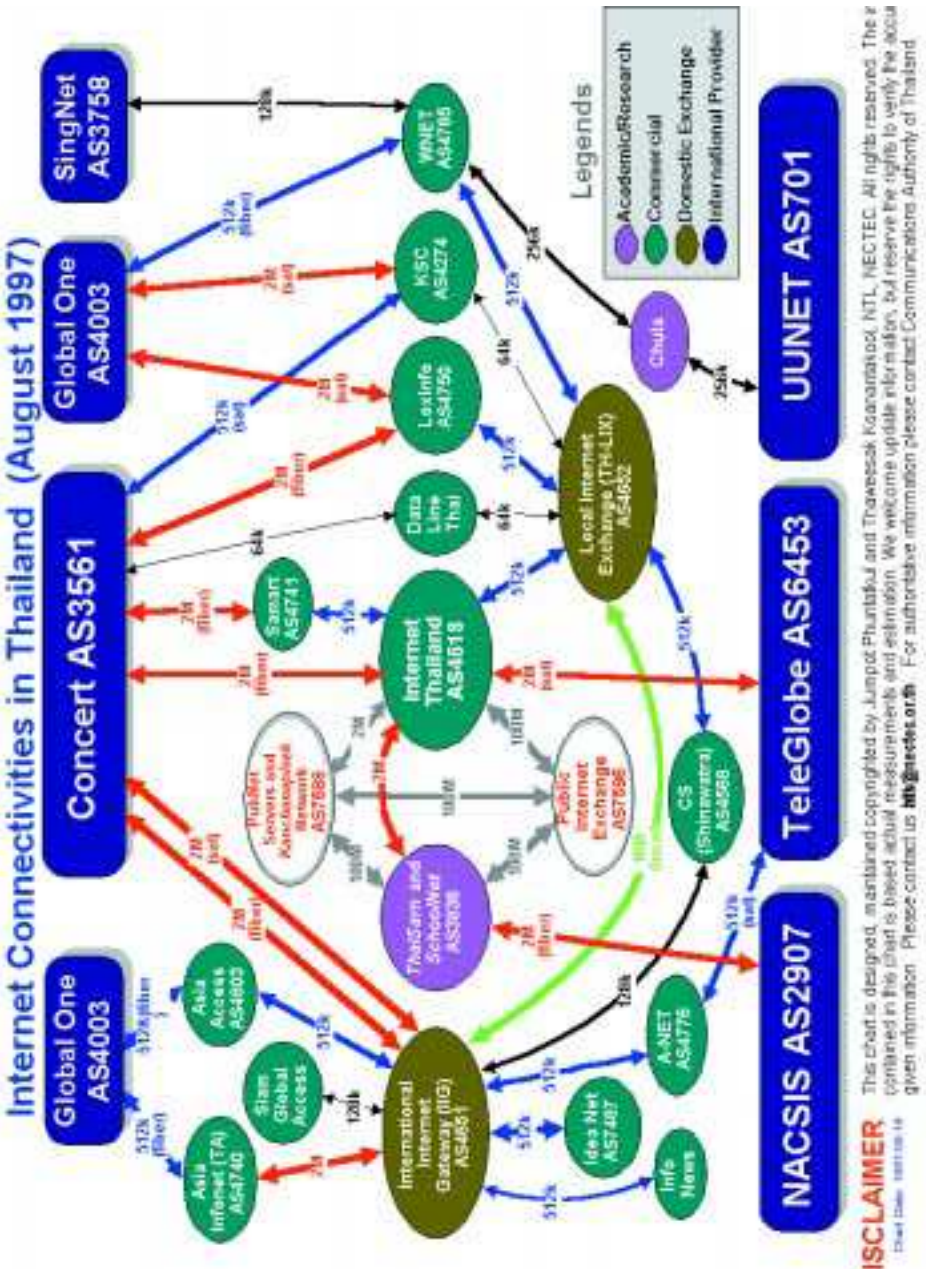

Diagram 6 : Local Internet Exchange in Thailand (as of August 1997)
http://www.nectec.or.th/inet-map/1997/

> "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 each connecting ISP must announce every route it controls, this is not a requirement for TH-NIX. PIE also requires circuits from vendors other than CAT in order to avoid CAT"s domestic network being the single point of failure," wrote Trin in an email (Trin, personal electronic communication, September 5, 1997).

After the Thai economy began its downward spiral in early 1996, the business of providing Internet service in Thailand has become 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 half circuits prices it sells to all ISPs as an incentive. This policy resulted in losses and liquidity problems among most ISPs because CAT ignored the fact that these operators must still fully pay the international Internet access providers in US dollars, which, due to the baht depreciation, doubled in value. Adjusted to the current exchange rate at Bt40=USD$1, an E1 half circuit from Thailand is priced at about Bt1 million (USD$25,000) a month. And for the other half to the international Internet access provider, the price ranges at about $22,000 a month (Trin, personal communication, April 27, 1998). Parent companies of most Thai ISPs, mostly in the telecommunications industry, could not help either: raising capital in Thailand has become much more difficult due to the economic downturn. Since the beginning of 1996, the Stock Exchange of Thailand (SET) has been in 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 ("ISPs considering," The Nation, April 28, 1998). Some try to lower the operating costs by reducing the leased line bandwidths 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 example, asking CAT to 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.

Conclusions and Analysis

As of February 1998, more than 350,000 individuals in Thailand use the Internet (Trin & Thaweesak, personal electronic communication, 14 February, 1998). The growth is impressive, compared to the early 1990s when email was used only in a small coterie of 100 Thai researchers. The early efforts of Thai engineers and collaboration with their international colleagues, that spawned an Internet community in Thailand, have paid off. Many Thai people now benefit from using linked computers as both a personal and professional communications tool.

Thailand provides a case study of a non-English speaking country striving to build its national network to connect to the global Internet, with limited resources of technology and people. Factors contributing to its success include the dedication of some visionary Thais, a strong volunteer ethic, collaborative support from the private sector, funding from the Ministry of Science, Technology, and Environment, and a period of strong economic growth. Meanwhile, several obstacles that hinder further development of the Internet in Thailand are the PTO monopoly, political instability, language barriers, insufficient Thai-language software, a lack of well-trained engineers, and a general human resource shortage of IT professionals.

As we see in this case study, the most significant element underpinning Thailand's national network is a strong collaboration of Thai engineers from both the public and private sectors. These engineers shared a common vision - Thailand must have a national network for the benefit of all Thais. Despite a rough start, and a lack of knowledgeable Thai network engineers and limited telecommunications infrastructure, they labored through the project with minimal financial resources by experimenting, learning from each other, seeking technical assistance from international colleagues, and cultivating the spirit of collaboration engendered by some key volunteers.

Far-sighted vision and cooperation inspired the establishment of Pubnet in 1991. Pubnet became a critical steppingstone for boosting awareness about computer networking among Thais, and, by the end of 1994, served as a vocal force for commercialization.

Until recently, Thailand has enjoyed strong economic growth, especially during the first half of the 1990s. The country's growth per GDP was at an average of 7-8 percent annually. Consequently, when the national network was initiated, the country could afford the new technology. Coupled with the reduced computer import taxes, it was also easy to promote computer usage among Thais who had been excited about adopting computers to facilitate their growing businesses.

The economic growth also benefited the telecommunications infrastructure, one of the most critical networking ingredients of a country. For example, when the economic boom reached its peak in 1988-91, the Chatichai government privatized the fiber optic network, submarine cable network, and commercial satellite projects. In 1992, the government launched the project to install 3 million new, local telephone lines. Thanks to these successful schemes, Thailand now has a telecommunication infrastructure ready for the future expansion of the Internet.

While the Thai engineers have successfully created the national network, they could not change some of the country's negative telecommunications and regulatory circumstances that impede the growth of the Internet in the country. Though the increased number of Internet users in the last decade appears dramatic, it is a mere ant trail in the tracks of an elephant herd, considering that the volume of the total population of the country is 60 million. By extrapolation, the Internet user base in Thailand is only about 0.7% of the total population. Most of the users are in the Thaisarn network (about 250,000 users), and corporate and government sectors (about 80,000 users). An estimated 60,000 people pay for an individual account through ISPs. Major barriers to the expansion of Internet usage in Thailand include high prices for the service, monopolistic telecommunications entities, political fluctuation, and a lack of local human resources.

It is generally agreed that cost is the most important determining factor for the sales of a product. The Internet service in Thailand is expensive, as seen in the TDRI study, when compared to both regional countries and the average income of Thai people. This statement about the prices of the Internet services in Asian Pacific countries becomes apparent when gauged by the Power Purchasing Parity index (PPP), which uses the Mac Donald's Big Mac to measure the real purchasing power of different currencies. Adjusted to the PPP index, the price of the Internet services in Thailand is about 50% more expensive than other countries in the region. According to the latest per capita income report (World Almanac 1998), the average Thai earns $6,900 annually. They pay about USD$30-35 per month for an individual dial-up IP account and more than $3,500 per month

for a 64Kbps leased line circuit. Malaysians and Singaporeans, who earn $9,800 and $22,900 respectively, pay only $12-17 for the same dial-up account and $900-1,000 for leased line circuit account. This pricing structure is definitely too high to allow mid-income Thais to afford the Internet service for their businesses, let alone for pleasure. The high operating costs are mostly derived from the expensive international half-circuit and local leased lines, CAT's free 35% equity held in each ISP, and a lack of real market mechanisms.

In addition, the Internet in Thailand is facing regulatory difficulties and political instability. Since the beginning, the government was very slow to acknowledge the importance of the Internet, and react to the country's shortage of human resources. Instead of promoting the technology and Internet usage as a means to educate people, the government's first reaction to the new technology was to reserve the facilities only for state academic institutions and government agencies. Political fluctuations, changes in the government, budget revisions, as well as some corruption not only affected the growth of the national network, but also discouraged many people developing networking projects.

Thais are also daunted by the predominance of English on the Internet and in its software applications. Unless Thailand develops more local software and Thai language web sites to expose more people to the Internet, the Internet will be limited to English-speaking Thais, a small percentage of the total population. This problem is intertwined with the lack of general education, much less the more technology-intensive skills required to effectively use the tools of the Internet.

Some promising efforts are underway to address these problems. The IT-2000 project, which is a part of the telecommunications Master Plan and the 8th National Economic and Social Development Plan, would emphasize the need to solve problems of human resources, local development of technology, and expansion of the Internet by using the existing telecommunications infrastructure. NECTEC plans to increase Internet usage in schools by merging Thaisarn with SchoolNet, using Thaisarn's facilities in universities to provide the Kanchanapisek network to every school in the country for free. TOT is also willing to fund the local leased circuit to the project and thus allow students and researchers to dial-up to a point-of-presence (POP) near their areas at the price of a local call. By the end of 1998, NECTEC plans to open 20 POP sites outside the capital. The bilingual content of the Kanchanapisek network would hopefully encourage more Thai students to use the Internet and learn English at the same time. This is a major step to help younger people feel more comfort-

able with the new technology. Also, the increased presence of the Internet in rural areas would help ISPs promote their services in the long run. If all these plans are successful, it is possible that Thailand could become a major information provider on the most rapidly growing part of the Internet - the World Wide Web.

Since the time of Dr. Kanchana's first test email sent to Australia via UUCP in 1986, Thailand's national network has evolved considerably, with some helpful lessons for other countries at earlier stages of internetworking. This case study, partly compiled from information published on the WWW and personal email correspondence with Thai network engineers living thousands of kilometers away from the authors, is a testament to the success of the past as well as a signal for the future. The collaborative efforts of the Thai networking pioneers and their colleagues abroad illustrate effective use of the technology to join the global Internet and enhance Thailand's role in contributing to future developments of the world's most rapidly growing communications medium.

Appendix A

Thaisarn's Participating Sites (As of April 1992).

Organization	Site names
The National Electronics and Computer Technology Center (NECTEC)	Nwg
Thammasat University (TU)	Ipied
Prince of Songkhla University (PSU)	Sritrang, ratree
The Public Access Network (Pubnet) at Digital Equipment Corporation (Thailand)	Decth
Hewlett Packard (Thailand)	Hp2
Asia Credit Ltd	Malisa
Chulalongkorn University (CU)	Chulkn
Kasetsart University (KU)	Nontri
Thammasat University at Rangsit	tunetr

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.42bis ACER 2424, 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. Thammasat 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.42bis
DataNet address	srr/tunet1
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
Internet address	Decth.co.th
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, 1991

5. 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 receives from	Munnari.oz.au (02.30, 15.30, 19.30)

6. Hewlett-Packard (Thailand) Ltd.

Organization name	R&D Center
System name	Hp2
Internet address	Hp2.hpth.co.th
Modem standard(s)	N/A
DataNet address	N/A
Data format	N/A
Machine	N/A
Mail exchange	
UUCP from	-
UUCP to	Nwg (a few times a day with flexible schedule)
Operational since	March 1992

7. Asia Credit Co., Ltd

Organization name	Asia Credit Co., Ltd
System name	Malisa
Internet address	Malisa.acl.co.th
Modem standard(s)	N/A
DataNet address	N/A
Data format	8-N-1
Machine	486 SCO UNIX
Mail exchange	
UUCP from	
UUCP to	nwg (once a day)
Operational since	March 1992

8. 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

9. 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

Appendix B

In the study, Competition and Pricing of Internet Service in Thailand, researchers at the Thailand Development Research Institute (TDRI) compared Internet hosts in 14 APEC countries* by using the InterNIC's host registration data and real GDP of each country as the benchmarks of comparison. The result is in the Table 9 on page 18 of this case study.

In Table 9, the APEC countries are categorized into three groups. The first group includes Indonesia, the Philippines, and Thailand with fewer than 50 Internet hosts per every US1billion of GDP. The second group consists of Malaysia, Singapore, Taiwan, Hong Kong, South Korea, China, and Chile, which have 120-150 Internet hosts per every US1billion of GDP. Canada, New Zealand, and Australia make up the last group, which has 900 Internet hosts per every US1billion of GDP.

The data were then plotted in a diagram. When using the Ordinary Least Square (OLS) method to locate the correlation between Internet hosts and GDP, the TDRI researchers obtained

$$\text{Hosts} = 439.06\ \text{GDP} - 8254 \qquad (1)$$

This model carries adjusted R2 = 0.25, F statistics = 4.74, T statistics of the two variables (Internet hosts and GDP) = 2.19 and -0.114, respectively. It confirms that - with more than 95 % confidence - the GDP is a significant variable to the expansion of Internet hosts in every country. The equation implies that, on average, an APEC country has 439.06 internet hosts per every US1billion GDP. The negative constant term of 8254 implies that there is a threshold level of income at which Internet hosts will emerge.

In the diagram, Thailand is below the average line. This points out that Thailand's Internet penetration is lower than other countries with equivalent GDP. When compared with its neighboring countries (Malaysia and Singapore), the Internet in Thailand is at least 1-2 years slower. To prove that monopoly is the major obstacle of the Internet growth in Thailand, TDRI researchers again applied the OLS method to the first model by adding two dummy variables to represent CAT's monopoly and a free market system. The result is

Internet hosts = 772.6 GDP -
557.2 monopoly x GDP -41201 (2)

This equation contains adjusted R2 = 0.484, F statistics = 7.11, and T statistics of the three variables (host, GDP, and monopoly) = 3.74, -2.66, and -0.683. It confirms that GDP and monopoly are the major variables to the growth of the Internet in APEC countries. This model then indicates that when GDP is constant, the country with a monopoly has 557.2 Internet hosts fewer than the country with a free market system.

*(*TDRI researchers excluded the United States, Japan, Brunei, and Papua New Guinea from the study because of the significantly different amount of Internet hosts.)*

Appendix C

The Real Price of the Internet in Thailand with and without CAT's free shares.

TDRI researchers calculated the cost of CAT's free shares by denoting:

P = Prices of the internet services without CAT's free shares.
P' = Prices of the internet services with CAT's free shares.
C = Real operational cost an ISP has
X = Expected returns that an ISP projects.

If CAT does not have free shares in an ISP, the operations of the ISP can be expressed as

$$P-C = X \quad (1)$$

But with CAT's free shares at the total of 35% or approximately 1/3 of the total shares, the ISP has to maintain its projected returns. The new pricing can be adjusted to the increased costs as

$$2/3\ (P'-C) = X \quad (2)$$

To maintain the projected profit, the ISP has to make (1) = (2), which can be expressed as

$$3\ P = 2P' + C \quad (3)$$

Without CAT's shares, X = projected profit

$$(P-C)/C + x \quad (4)$$
or $C = P/(1+X)$ (5)

Use (5) in (3) = $3\ P = 2P' + P/(1+X)$ (6)
or $P'/P = (2+3X)/(2+2X)$ (7)

In (7), TDRI researchers used X to represent the ISP's projected profit at 20 and 30 percent (denotative values of X = 0.2 and 0.3) respectively. The result shows that CAT's free shares increase the ISP's operating costs about 8-20 % of the real costs, and this portion is passed to the consumers in the form of higher service charges.

Appendix D

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 Development Plan
IIG	International Internet Gateway
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 Operators
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
Thaisarn	Thai Social/Scientific Academic and Research Network
THLIX	Thailand Local Internet Exchange
TIS	Thai Industrial Standard
TIS	Thaisarn Internet Service
TISI	Thai Industrial Standards Institute
TOT	Telephone Organization of Thailand
TT&T	Thai Telephone and Telecommunication
UUCP	Unix to Unix CoPy

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