A STUDY ON A REGIONAL DEVELOPMENT PLAN
FOR TELECOMMUNICATIONS NETWORKS
IN THE BANGKOK METROPOLITAN AREA
IN THE KINGDOM OF THAILAND

FINAL REPORT

FOR
A LONG-TERM DEVELOPMENT PLAN
ON
THE TELECOMMUNICATIONS NETWORKS

SUMMARY

October 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on a Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Satoshi Akaike, NTT International Corporation, twice between July 1991 and August 1992.

The team held discussions with the officials concerned of the Government of Thailand, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

October 1992

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

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List of Abbreviations for Local Exchange Areas in the BMA

NO.	LOCAL EXCHANGE AREA	ABBR	Telecom Area	NO.	LOCAL EXCHANGE AREA	ABBR	Telecom Area
1	Phloen Chit	PNC	1	30	Dao Khanong	DKN	3
2	Samran Rat	SRR	1	31	Bang Phlat	BGT	3
3	Krung Kasem	KKM	1	32	Phasi Charoen	PSN	3
4	Surawong	SRW	1	33	Charan Sanitwong	CSW	3
5	Samsen	SMS	1	34	Rat Burana	RBN	3
6	Asok Din Daeng	ASD	1	35	Lat Ya	LTY	3
7	Pathum Wan	PTW	1	36	Muban Setthakit	MSK	3
8	Sukhumwit	SKW	1	37	Ekkachai	EKC	3
9	Chaiyaphruk	CYP	2	38	Nong Khaem	NGK	3
10	Bang Na	BNA	2	39	Phra Pradaeng	PPG	3
11	Khlong Chan	KGC	2	40	Bang Bue Thong	BBT	3
12	Thung Mahamek	TMM	2	41	Phahonyothin	PYT	4
13	Sathupradit	STD	2	42	Inthamara	ITM	4
14	Thanon Tok	TNT	2	43	Bang Khen	BGN	4
15	Bang Chan	BGC	2	44	Bang Su	BGS	4
16	Phra Khanong	PKG	2	45	Don Muang	DNM	4
17	Hua Mak	HAM	2	46	Lak Si	LKS	4
18	Trok Chan	TKC	2	47	Ram Inthra	RIT	4
19	Lat Krabang	LKG	2	48	Lat Phrao 1	LTP1	4
20	Khlong Toei	KTI	2	49	Lat Phrao 2	LTP2	4
21	On Nut	ONT	2	50	Chaeng Watthana	CWT	4
22	Ramkamhaeng(	RKN	2	51	Nonthaburi	NTB	4
23	Samut Prakan	SPK	2	52	Ngam Wong Wan	NWW	4
24	Pu Chao Saming Phrai	PSP	2	53	Pak Kret	PKK	4
25	Bang Phli	BPL	2	54	Pathum Thani	PTT	4
26	Bang Pu	BGU	2	55	Rangsit	RST	4
27	Bang Phli Bang Bo	BBB	2	56	Thanyaburi	TYB	4
28	Thon Buri	TNB	3	57	Nawa Nakhon	NWN	4
29	Bang Khae	BKE	3	58	Bang Phun	BAN	4

List of Abbreviations for the Other Offices and Stations (1/2)

NO.	OFFICES AND STATIONS	ABBR	Remarks	NO.	OFFICES AND STATIONS	ABBR	Remarks
1	Bangkok	BKK		30	Lampang	LPG	
2	Chon Buri	CBI		31	Phayao	PYO	
3	Chachoengsao	CCO		32	Nan	NAN	
4	Rayong	RYG		33	Phitsanulok	PLK	
5	Chanthaburi	CTI		34	Sukhothai	STI	
6	Trat	TRT		35	Uttaradit	UTT	
7	Prachin Buri	PRI		36	Kamphaeng Phet	KPT	
8	Nakhon Nayok	NYK		37	Tak	TAK	
9	Nakhon Ratchasima	NMA		38	Nakhon Sawan	NSN	
10	Chaiyaphun	CPM		39	Phichit	PCT	
11	Buri Ram	BRM		40	Phechabun	PBN	
12	Ubon Rachathani	UBN		41	Uthai Thani	UTI	
13	Si Sa Ket	SSK		42	Chai Nat	CNT	
14	Surin	SRN		43	Saraburi	SRI	
15	Yasothon	YST		44	Lop Buri	LBI	
16	Khon Kaen	KKN		45	Sing Buri	SBR	
17	Maha Sarakham	MKM		46	Ayutthaya	AYA	
18	Roi Et	RET		47	Ang Thong	ATG	
19	Kalasin	KSN		48	Suphan Buri	SPB	
20	Udon Thani	UDN		49	Nakhon Pathom	NPT	
21	Nong Khai	NKI		50	Sumut Sakhon	SKN	
22	Loei	LEI		51	Samut Songkhram	SKM	
23	Sakon Nakhon	SNK		52	Kanchanaburi	KRI	
24	Nakhon Phanom	NPN		53	Phechaburi	PBI	
25	Mukdahan	MDH		54	Ratchaburi	RBR	
26	Chiang Mai	CMI		55	Prachuap Khiri Khan	PKN	
27	Lamphun	LPN		56	Surat Thani	SNI	
28	Mae Hong Son	MSN		57	Chunmphon	CPN	
29	Chiang Rai	CRI		58	Ranong	RNG	

List of Abbreviations for the Other Offices and Stations (2/2)

NO.	OFFICES AND STATIONS	ABBR	Remarks	NO.	OFFICES AND STATIONS	ABBR	Remarks
59	Phuket	PKT		67	Yala	YLA	
60	Phangnga	PNA		68	Pattani	PTN	
61	Nakhon Si Thamarat	NRT		69	Narathiwat	NWT	
62	Trang	TRG		70	Hat Yai	HYI	
63	Krabi	KBI		71	Phra Intharacha	PIR	Repeater
64	Songkhla	SKA		72	Nakhon Chaisi	NKC	Repeater
65	Satun	STN		73	Chon Buri Repeater	CBIR	
66	Phatthalung	PTN		74	Chon Buri Terminal	CBIT	

CHAPTER 1 INTRODUCTION

The Study Team on "A Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area in the Kingdom of Thailand" (hereinafter referred to as "the Study Team"), dispatched by Japan International Cooperation Agency (hereinafter referred to as "JICA") has carried out the Study Work in Thailand-I, Work in Japan-I, and Work in Thailand-II during the period from July 1991 to January 1992 as for the first phase of the Study and then Work in Thailand-III, Work in Japan-II, Work in Thailand-IV, and Work in Japan-III during the period from March to September 1992 as for the second phase with counterparts of Telephone Organization of Thailand (hereinafter referred to as "TOT").

This Final Report presents the summary for the long-term plan study performed by the Study Team.

1.1 Composition of the Study Report

The Final Report consists of two parts. Each Part also consists of three volumes:

1) Part 1: The Long-term Plan Study
   a) Summary
   b) Main Report
   c) ANNEX

2) Part 2: The Feasibility Study on the Priority Project
   a) Summary
   b) Main Report
   c) ANNEX

This report presents the summary of the Long-term Plan Study.

1.2 Background of the Study

From the middle of 1980s, Thailand economy has been rapidly growing by enormous increase of foreign direct investments. Result of rapid economic growth, capacity of infrastructure has become short to meet the socioeconomic needs in many fields such as ports, roads, electric power plant, telecommunications, etc.

The Government of the Kingdom of Thailand has made considerable effort to grade up telecommunications services as an essential part of infrastructure for socioeconomic development in line with successive National Economic and Social Development Plans. TOT has been taking 5th EDP (1988~1992), in which approximately one million subscriber lines has been installed, to meet the Government's policy.

The guideline for the sixth ESDP also emphasize to develop and improve the infrastructure facilities. In conformity with the Government's policy, TOT has been proceeding with the "Urgently Expanded Telephone Project" under the sixth EDP of TOT (1989-1992).

The shortage of telephone lines, however, has not yet been resolved throughout the country. The demand and supply gap situation is most serious in Bangkok where the economic and social activities are most concentrated and dynamic. Moreover, numbers of industrial estates and firms have been created in the outskirts of Bangkok more conspicuously than in the other provinces. With developing socioeconomic activities, the requirements of telecommunication service from large scale customers has become more and more enhanced and diversified.

It takes more than several years on average to get a subscriber telephone installation in the Bangkok Metropolitan area. Those subscribers who have much telephone call needs have to wait for years to install additional lines to ease their high line-busy situation. It is still hard to make telephone calls in some downtown areas because of high telephone usage on a limited network capacity and limited number of lines. Sometime it takes more than a week to repair telephone line faults.

JICA conducted "a Master Plan Study on Telecommunications Development in the Kingdom of Thailand" (hereinafter referred to as "the Master Plan Study") in response to the request of the Government of the Kingdom of Thailand from September 1988 to December 1989. The Master Plan Study has revealed several issues on telecommunications in the Bangkok Metropolitan Area and urged the necessity for a further development study in the area.

In response to a request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on A Regional Development Plan for Telecommunications Networks in the Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study"). JICA and TOT agreed upon the scope of work for the Study in October 1990.

The Study Team headed by Mr. Satoshi Akaike, a senior manager of Planning Administration Department of Telecommunications Consulting Division in NTT International Corporation, began the Study from July 1991.

1.3 Scope of the Study

The Study Area is the Bangkok Metropolitan Area (BMA, Bangkok, Pathom Thani, Samut Prakan, Nonthaburi) and the Surrounding Area (Nakhon Pathom, Sumut Sakhon, Ayutthaya). Figure 1.3 shows the Study Area.

The term of the plan is fifteen (15) years from the fiscal year of 1993 to 2007. After the selection of high priority projects, a feasibility study is carried out on the top priority project. The Study divides the long-term plan period into three five-year periods:

1) phase-1: from FY 1993 to FY 1997,
2) phase-2: from FY 1998 to FY 2002, and
3) phase-3: from FY 2003 to FY 2007.

1.4 Objectives of the Study

This study has two phases. One is to formulate a long-term telecommunications development plan which contributes to overall development in the Study Area. The other is to carry out a feasibility study for the top priority project which is selected from the priority projects in the long-term plan.

1) The Long-term Plan Study

The first phase of the Study aims to formulate a long-term telecommunications development plan to fulfill telephone subscription demand, to upgrade the telecommunications services quality, to provide new telecommunications services in the Bangkok Metropolitan area and its Surrounding Area during the 15 years plan period Objectives of the long-term plan are the same as the Master Plan: fulfillment of the telephone demand, upgrade of telecommunications services quality, and provision of various telecommunications services.

The first phase of the Study selects the highest priority project among the projects to be implemented during the phase-1 plan period for the second phase of the Study.

2) The Feasibility Study

The second phase of the Study aims to conduct a feasibility study on the top priority project which should be selected from the high priority projects in the long-term plan. A study on "An Implementation Plan to Upgrade the Telecommunications Services Quality" has been selected as the second phase of the Study.

The Study team conducted the first phase of the Study mainly from July 1991 to January 1992 and the second phase of the Study from March to September 1992.

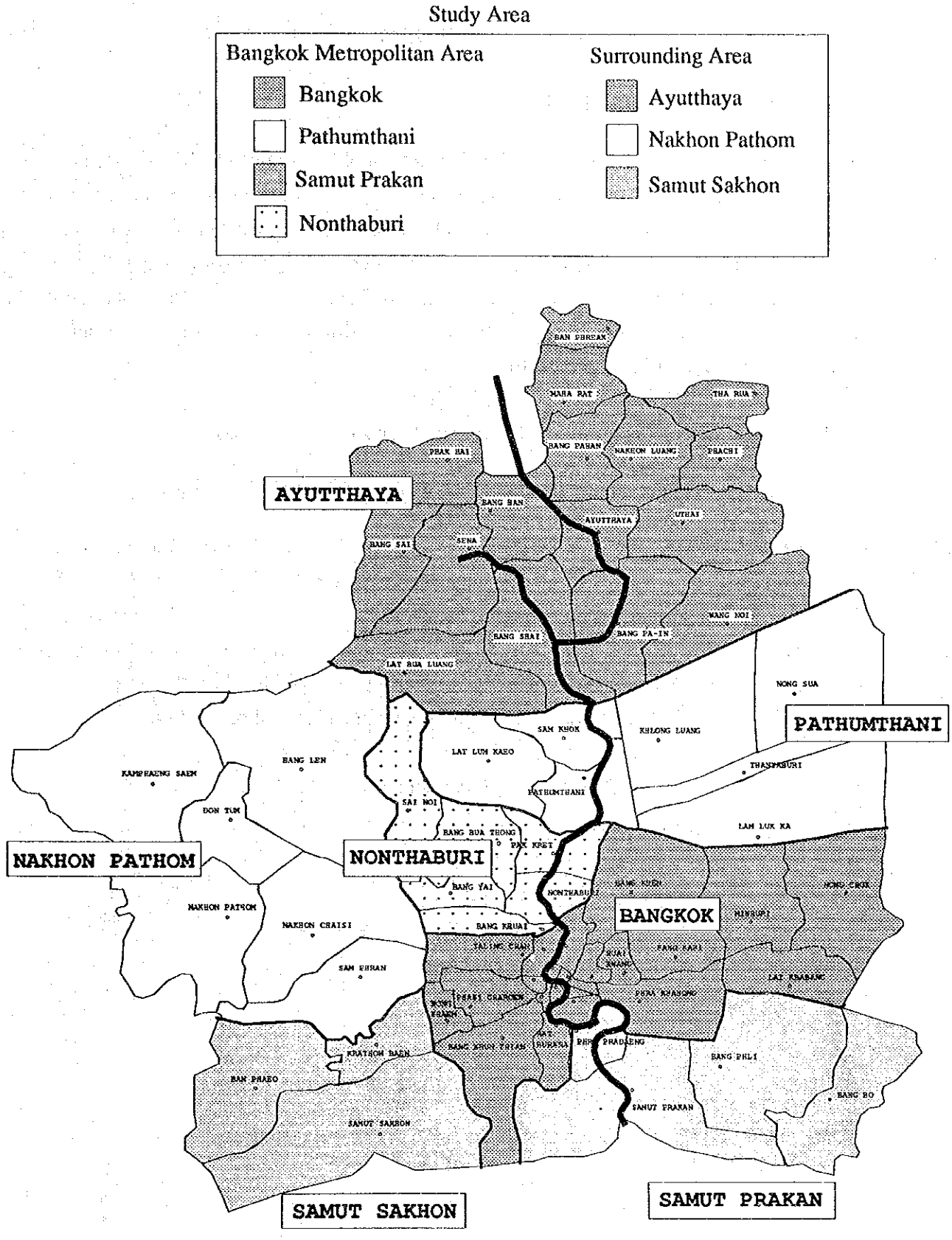

Figure 1.3 The Study Area

CHAPTER 2 REGIONAL DEVELOPMENT FRAMEWORK

2.1 Structure of the BMR

Major socioeconomic activities in the Bangkok Metropolitan Region (BMR: 36 districts of the Bangkok Metropolitan Area and the five surrounding provinces: Pathm Thani, Nonthaburi, Samut Prakan, Sumut Sakhon and Nakhon Pathom) have been predominantly taking place in a belt form along with main roads which are relatively well equipped with basic infrastructure. Since the shortage problem of basic infrastructure will not be solved in the near future, the development will be remained as the belt form along with main roads connecting outer commercial, residential centers and industrial estates.

2.2 Regional Development Framework from 1992 to 2007

1) Strategic Target areas in the 6th National Development Plan

According to the 6th National Development Plan, the BMR is divided into four strategic target areas to promote overall spatial development as follows.

a) Central business areas (area: 147 Km^2, population: 3.3 million in 1990)
b) Rapidly growing suburban area (area: 1,065 Km^2, population: 3.3 million in 1990)
c) Industrial area (area: 75 Km^2, population: 1.3 million in 1990)
d) Outer BMR area (area: 6,352 Km^2, population: 1.4 million in 1990)

Figure 2.2 shows the future development direction in the BMR.

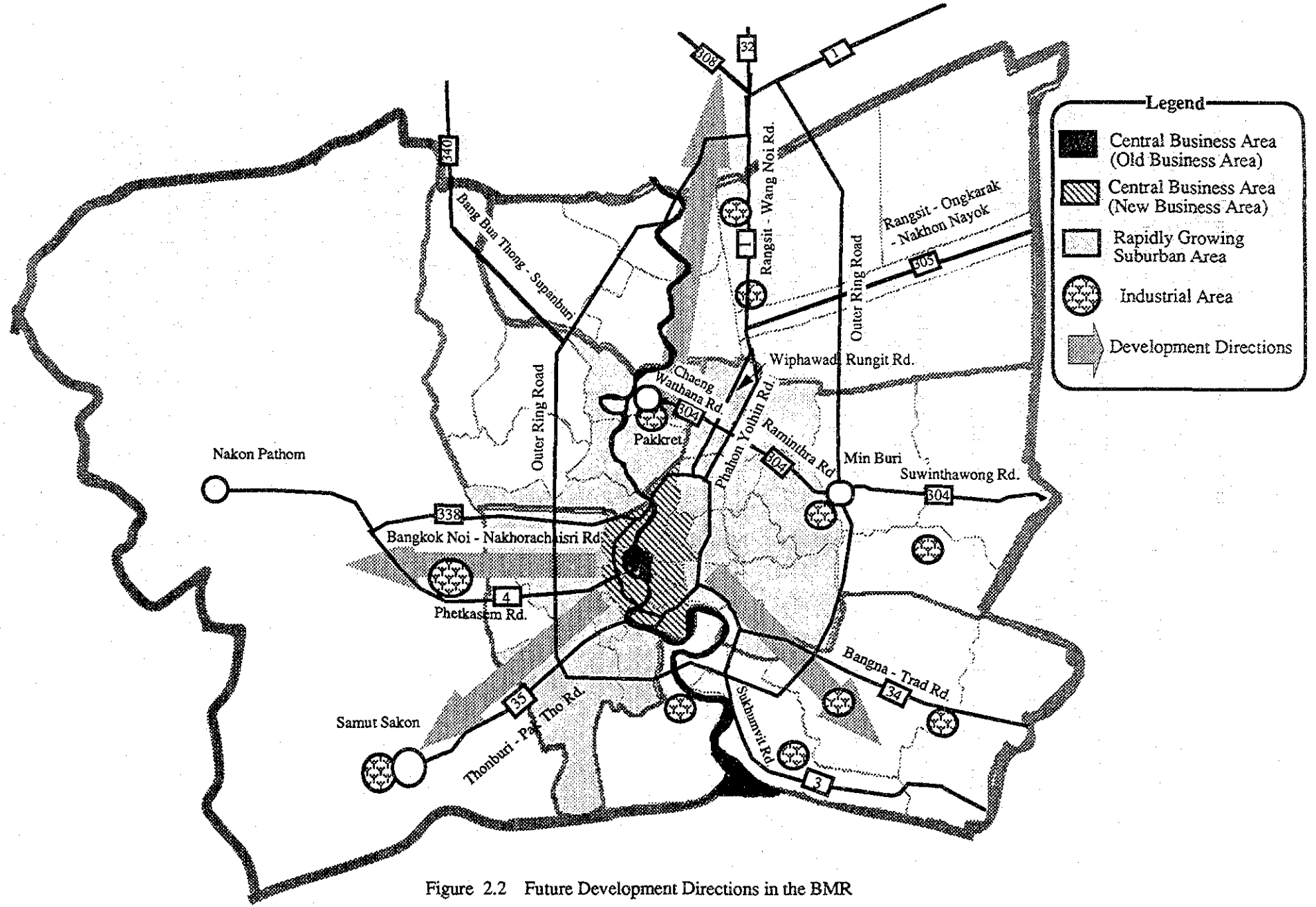

Figure 2.2 Future Development Directions in the BMR

2) Socioeconomic Outlook

Three scenarios on the socioeconomic outlook of Thailand will be examined as follows:

a) Optimistic Scenario (High Case)

The Thai economy can expect the real average annual GDP growth rate of 10% for the next 20 years. The government will increase public sector investment to 8% in 1992 and maintain that level thereafter.

b) The Most Likely Scenario (Base Case)

The Thai economy can expect the real average annual GDP growth rate of 8% for the next 20 years. The government will increase public sector investment to 7% in 1992 and maintain that level thereafter.

c) Pessimistic Scenario (Low Case)

The Thai economy can expect the real average annual GDP growth rate of 5% for the next 20 years. The government will increase public sector investment to 4% in 1992 and maintain that level thereafter.

CHAPTER 3 TREND OF TELECOMMUNICATIONS TECHNOLOGY AND SERVICES

In the near future, telecommunications network digitization toward services integration so-called ISDN (Integrated Services Digital Network) and telecommunications network intellectualization will be vigorously pursued by network operators to offer new services economically and efficiently. Furthermore, PCN (Personal Communications Network) will be introduced to realize personal communications by radio phones. Figure 3.1 illustrates the evolution of network digitization toward ISDN.

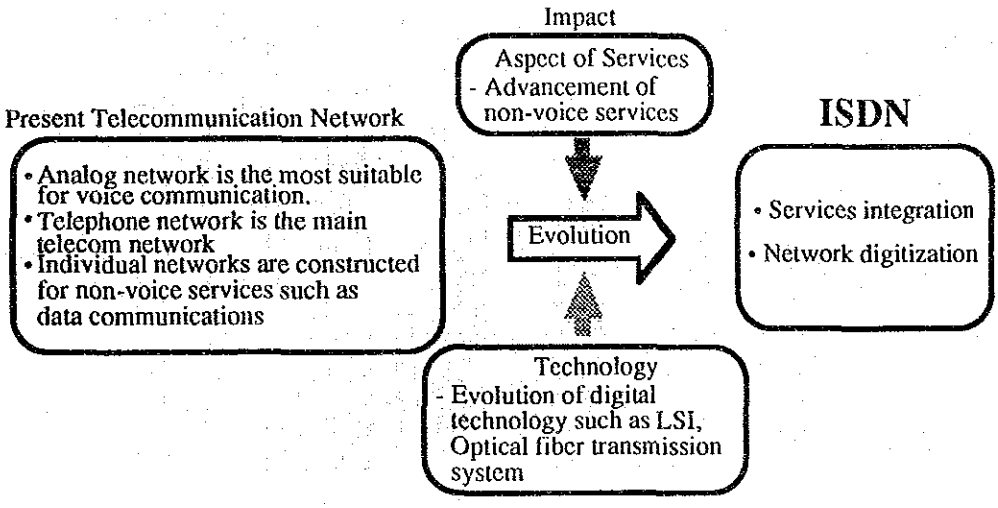

Figure 3.1 Evolution of Network Digitization toward ISDN

Optical fiber communication systems, microwave radio transmission systems, and satellite communication systems make a progress toward high-speed and broad band digital transmission systems to realize B-ISDN (Broad-band ISDN) from N-ISDN (Narrow-band ISDN). Optical fiber lines are to be introduced in entire subscriber loops, i.e. "FTTH (Fiber to the Home)".

One of the most promising approaches for B-ISDN is ATM (Asynchronous Transfer Mode) in the flow of packet switching. The ATM can be characterized by its very high-speed and large capacity transmission links and simple, hard-wired protocols within a network. On the other hand, recent research and development of optical switches is making a progress toward STM (Synchronous Transfer Mode) in the flow of circuit and switching systems which aim at establishment of integrated communications and broadcasting networks.

CHAPTER 4 PRESENT STATE OF TELECOMMUNICATIONS SERVICES

4.1 Ordinary Telecommunications Services

The number of main telephones in the whole Kingdom has reached one million three hundred and twenty five thousands (1,325,000) as of the end of FY 1990 and become 2.5 times larger than that of FY 1984. The telephone density in the whole Kingdom has reached 2.35 main telephone lines per 100 inhabitants and become 2.3 times larger than that of FY 1984. Figure 4.1-1 shows the number of main telephones.

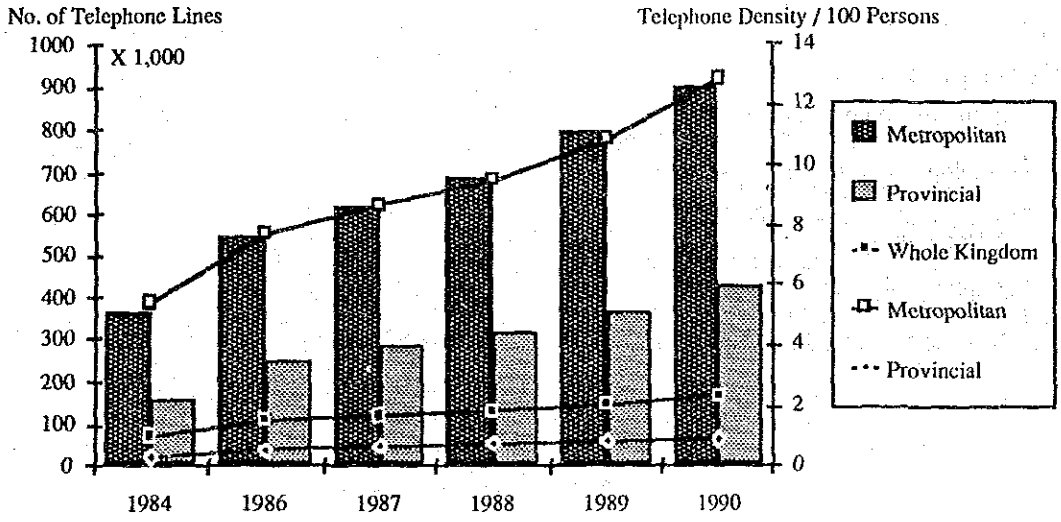

Figure 4.1-1 The Number of Main Telephones

The number of public telephone was approximately 24,000 at the end of FY 1990 in the whole Kingdom. The number of public telephone becomes 1.9 times bigger compared with that in FY 1984. In addition, a card type public telephone was introduced in FY 1991 and is expected to be installed about 11,000 units at the initial concession stage.

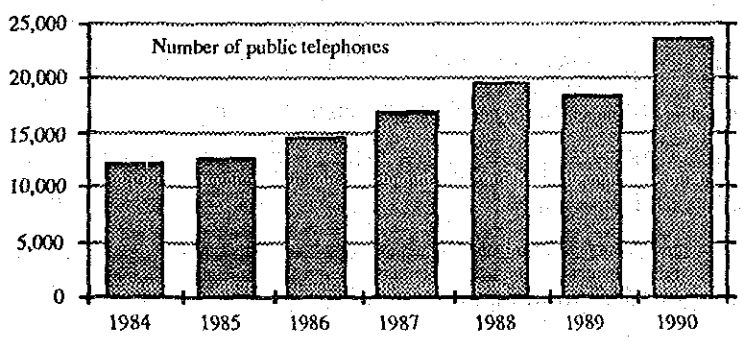

Figure 4.1-2 The Number of Public Telephones

4.2 Other Services

1) Mobile Telecommunications Services

The number of cellular mobile telephones (Nordic Mobile Telephone System adopting 470 MHz and 900 MHz) offered by TOT reached approximately seventy-nine thousand (79,000) at the end of FY 1991. The Advanced Mobile Phone System (AMPS) adopting 800 MHz is also offered by CAT. Table 4.2-1 shows the mobile telephone service development in Thailand.

Table 4.2-1 Mobile Telephone Service Development (whole kingdom)

Year	TOT		CAT	Total	No. of Mobile / 100 persons
	470 MHz	900 MHz	800 MHz		
1986	822			822	0.002
1987	4,413		1,116	5,579	0.01
1988	10,612		6,972	17,584	0.03
1989	20,936		14,171	35,107	0.06
1990	31,981		31,242	63,223	0.11
1991	42,712	36,486	44,243	123,541	0.22

Source: TOT, August 1992

The number of paging service subscribers offered by TOT including the concession basis is approximately ninety-seven thousand (97,000) at the end of 1991 and that offered by CAT is approximately ninety thousand (90,000) at the same time.

The paging phone service in the Kingdom started in 1984. At the beginning of the service, the growth rate of subscribers was rather low; however after the introduction of digital pager service (Paclink, Phonelink and Page phone), it increased rapidly as shown in Table 4.2-2. The number of subscribers per 100 persons is 0.33 at the end of FY 1991.

Table 4.2-2 Transition of Paging Phone Subscribers in the Whole Kingdom

	'84	'85	'86	'87	'88	'89	'90	'91
Phonelink (TOT)							59,607	80,453
Page phone (TOT)								17,258
Paclink (CAT)				17,000	20,000	40,000	60,000	80,000
CAT	6,233	7,992	7,953	6,091	6,791	7,518	9,970	10,000
Total	6,233	7,992	7,953	23,091	26,791	47,518	129,577	187,711
Population (thousand)	50,583	51,796	52,969	53,873	54,961	55,538	56,341	57,196
Penetration (per 100 persons)	0.01	0.02	0.02	0.04	0.05	0.09	0.23	0.33

Note: Phonelink, Pagephone and Paclink are offered with a concession basis.

2) Leased Circuit Service

The number of leased lines offered by TOT in Thailand is approximately eighteen thousand (18,000) at the end of FY 1991 and the sixty percent of the service is used for computer communications. Table 4.2-3 shows the development of the leased circuit service in Thailand.

Table 4.2-3 Development of Leased Circuit Service in Thailand

FY	Computer	Teletype	Telex	Broadcast	Direct Line	Other	Total
1988	4,730	705	4,672	458	1,925	140	12,630
1989	6,472	1,081	4,581	499	2,185	171	14,989
1990	8,751	1,007	4,194	454	2,118	338	16,862
1991	10,438	566	3,847	812	1,692	265	17,620

Source: TOT , July 1991

3) Facsimile Service

In Thailand, it is deregulated for users to purchase and install facsimile terminals. Customers can connect them with ordinary telephone network without any written notice to TOT. The development of facsimile terminals in Thailand is shown in Table 4.2-4.

Table 4.2-4 Development of Facsimile Terminal in Thailand

Year	BMA	Provincial	Total
1988	5,274	762	6,036
1989	8,115	1,029	9,144
1990	9,003	1,301	10,304

Source : Bureau of Operation of TOT, September 1992

3) Data Transmission Services

a) DATA NET Service

DATA NET service is a data transmission service using the subscriber lines. The number of subscribers in the whole Kingdom is approximately two hundreds as of August in 1990.

b) Digital Data Network (DDN) Service

DDN service is a data transmission service ranging from 2,400 bit/s to 64 kb/s using the leased circuits. The number of 9,600 b/s circuits is two hundred and thirty-nine (239) and that of 64 Kb/s circuits is sixty-nine (69).

CHAPTER 5 PRESENT STATE OF TELECOMMUNICATIONS NETWORK

5.1 Network Configuration

The telephone network is established with three office levels in the BMA: TC (Tertiary Center), TDM (Tandem Exchange) and LE (Local Exchange); and four office levels in the provincial areas: TC, SC (Secondary Center), PC (Primary Center) and LE. The number of TC, SC and PC areas are 5, 20, and 74 in the whole Kingdom, respectively.

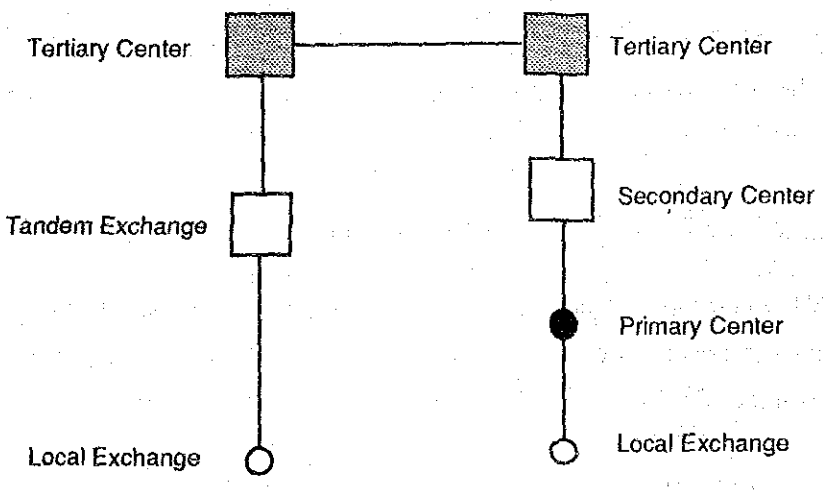

Figure 5.1 Network Hierarchy

5.2 Numbering Plan

An open numbering system is adopted using "0" for the trunk prefix. The configuration of national significant number is as follows:
Trunk Prefix "0" + Trunk Code + Exchange Code + Station Number

1) BMA A-BCD-EFGH A is 2
2) The numbering system for the provincial areas is AB-CD-EFGH. For instance, A is 3 and B is 5 for Ayutthaya

"00" is used for the ISD (International Subscriber Dial) prefix; however "09" is used for Malaysia.

5.3 Signaling System

DC signaling and E&M signaling systems are used for line signaling and MFC-R2 signaling system is used for register signaling.

CHAPTER 6 PRESENT STATE OF TELECOMMUNICATIONS FACILITIES

6.1 Outline of Existing Expansion Projects

TOT carried out the 4th ESDP (Economic and Social Development Plan) from 1977 to 1987 for the five hundred and sixty-nine thousand (569,000) telephone line expansion to cope with the rapidly increasing telephone demand in conformity with the NESDP (National economic and social development Plan). In addition, TOT has been carrying out the 5th ESDP from 1984 to 1992 for the one million one hundred and sixty-one thousand (1,161,000) telephone line expansion. TOT started UTEP (Urgent Telephone Expansion Project) from 1989 to 1992 for the two hundred and seven thousand (207,000) telephone line expansion.

6.2 TOT Seventh ESDP

TOT planned to carry out the 7th ESDP from 1992 to 1996 to expand the three million (3,000,000) telephone line with the BTO (Build Transfer and Operation) scheme. In August of 1991, CP Telecom was awarded a contract to provide two million telephone lines only in the BMA. In July of 1992, TT&T (Thai Telephone & Telecom) was granted a concession for one million telephone line expansion project in the provincial areas.

6.3 Outside Plant

1) Capacity of the Local Cable Network

TOT has about 1.47 million pairs of primary cables in the Study Area as of May, 1991. Approximately 96% of them, about 1.42 million pairs, have been installed in the BMA. The average usage rate of the local cable pairs in the Study Area is 73%. At some exchanges (about 20%) in the Study Area, it exceeded 90% level. Figure 6.3-1 shows the present number of primary cable pairs in the Study Area.

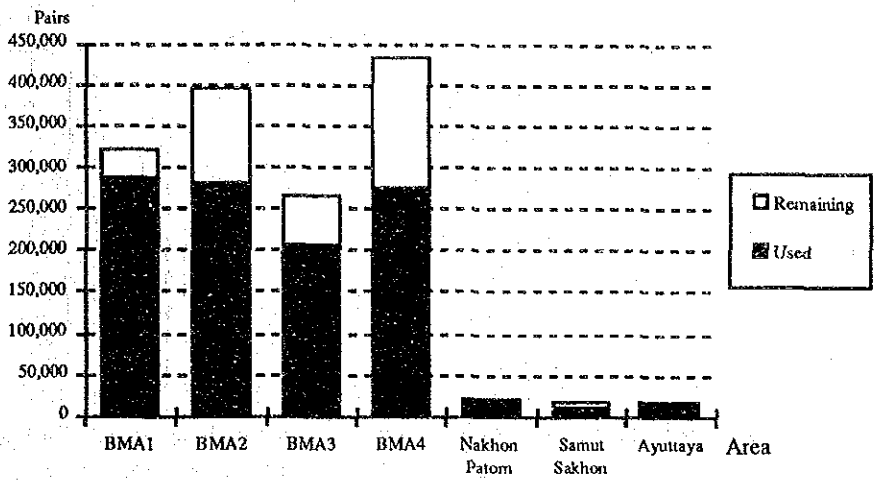

Figure 6.3-1 Number of Primary Cable Pairs in May 1991

2) Quality of the Local Cable Network

Figures 6.3-2 and 6.3-3 show the service breakdowns in the BMA and the provincial areas. The number of faults per 1,000 connected lines in the BMA is approximately 48 in 1990 and has steadily decreased since 1985. However, the number of faults per 1,000 connected lines in the provincial areas is approximately 58 in 1990 and has not decreased since 1984.

The number of faults caused by telephone sets, drop wires and cables accounts for approximately 81% of all faults in the BMA and 64% in the provincial areas in 1990.

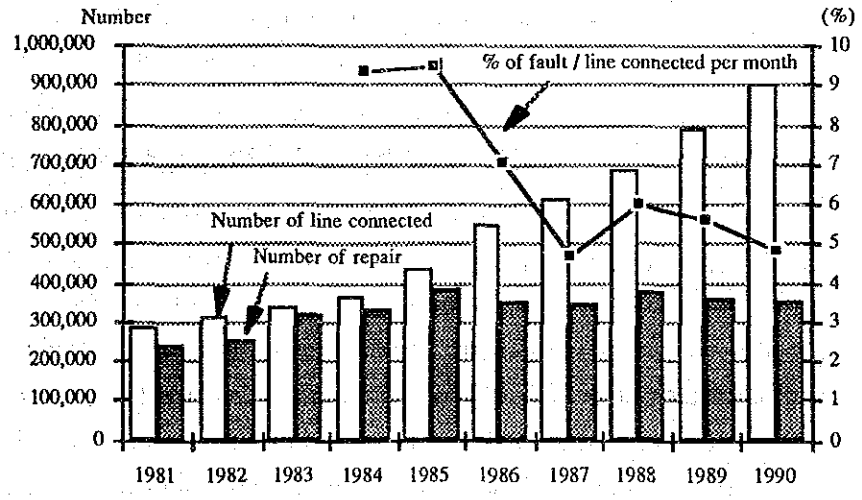

Figure 6.3-2 Number of Repairs and Percentage of Faults per Line Connected per Month in the BMA

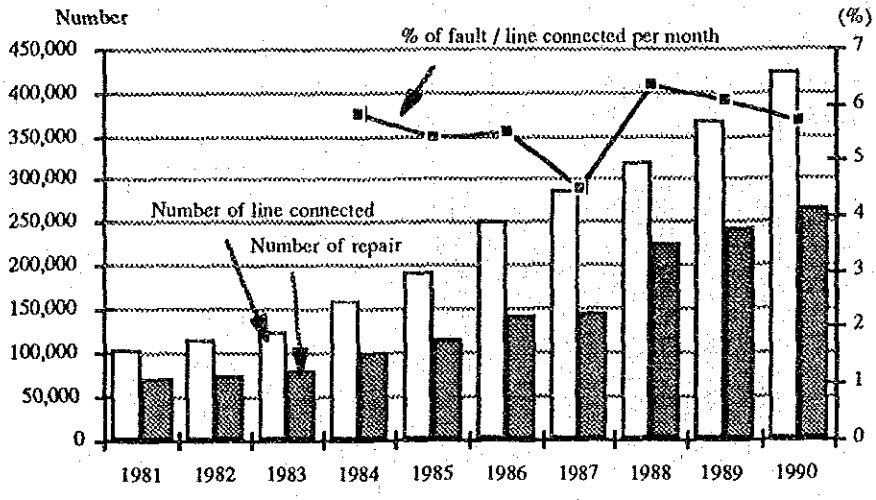

Figure 6.3-3 Number of Repairs and Percentage of Faults per Line Connected per Month in the Provincial Area

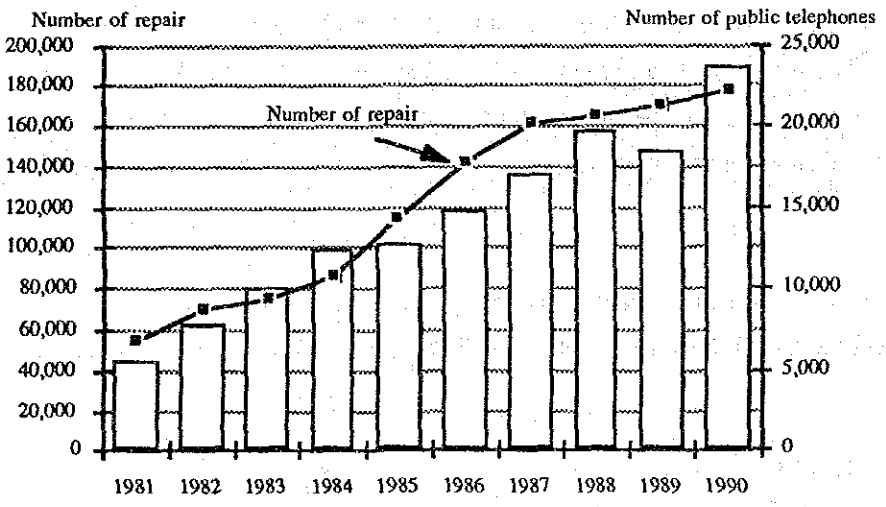

Figure 6.3-4 Number of Public Telephones and Repairs on Telephone Sets in the Whole Kingdom

6.4 Switching Facilities

The number of line units in the BMA is approximately one million one hundred and twenty-six thousands (1,126,000) at the end of FY 1990 and shares 66.8% of the total line capacity in the whole Kingdom. The number of digital switch line units in the BMA is approximately seven hundred and eighty-one thousands (781,000) in 1990 and is 69.4% of the line capacity in the BMA.

The number of line units in the provincial areas is approximately five hundred and fifty-nine thousands (559,000) in FY 1990. The number of digital switch line units in the provincial

areas is approximately four hundred and twenty-four thousands (424,000) in FY 1990 and is 75.7% of the line capacity in the provincial areas.

The number of the connected lines in the BMA is approximately nine hundred and one thousands (901,000) at the end of FY 1990 and is 80.0% of the line capacity in the BMA. The number of connected lines in the provincial areas is approximately four hundred and twenty-four thousands (424,000) at the end of FY 1990 and is 75.7% of the line capacity in the provincial areas. Figure 6.4 shows the total line capacities and the connected lines during the past five years.

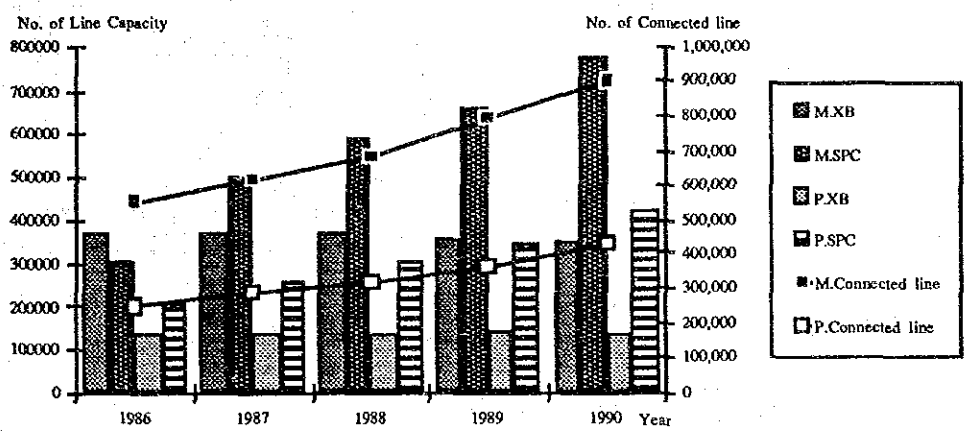

Figure 6.4 Development of Line Capacity and Connected Line

6.5 Transmission Facilities

1) Long-distance Transmission System

Figure 6.5 shows the long-distance transmission network in the BMA after the fifth and the sixth expansion projects. Optical fiber communications systems such as 140 Mb/s and 565 Mb/s, and microwave communications systems such as 34 Kb/s, 68 Kb/s and 140 Mb/s of digital systems, and 960 CH, 1,800 CH and 2,700 CH of analog systems are introduced as the long-distance transmission systems. The total number of DTI (Digital Trunk Interface: 1 DTI has 30 channels) for the long-distance transmission systems in the study area is expected to reach 130 at the end of the 6th project in the Study Area.

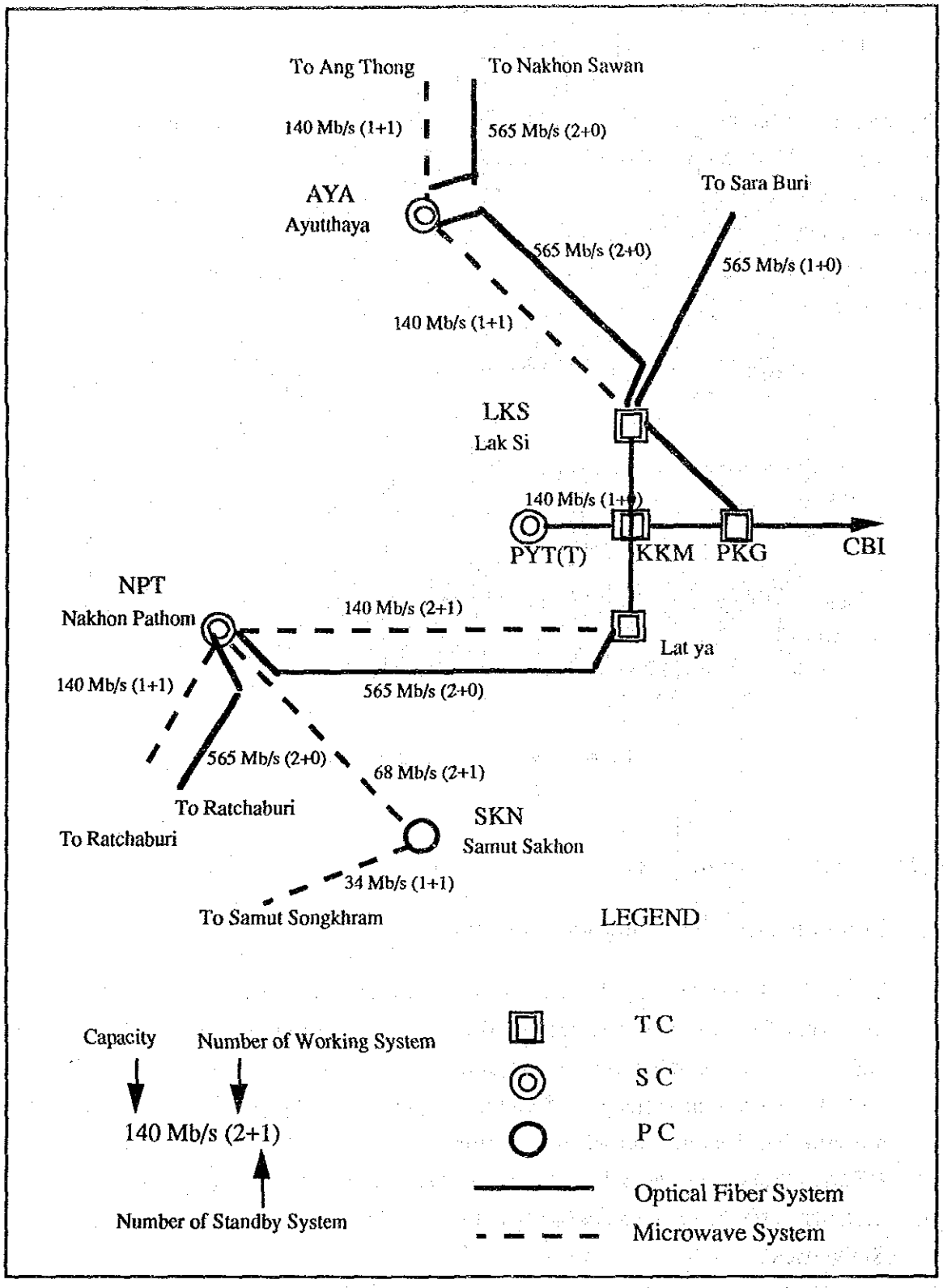

Figure 6.5 Layout of Long-distance Digital Transmission Systems after the Fifth and the Sixth Expansion Projects

2) Tandem Trunk Link Transmission System

Optical fiber communications systems such as 140 Mb/s and 565 Mb/s are used as the tandem trunk link transmission systems. The total number of DTIs in the Study Area is expected to become 2,154 at the end of the 6th project.

3) Local Trunk Link Transmission System

Optical fiber communications systems such as 34 Mb/s, 140 Mb/s and 565 Mb/s , and PCM (Pulse Code Modulation) -30 systems are used as the local trunk link transmission systems. The total number of DTIs in the Study Area is 3,102 at the end of 6th project.

CHAPTER 7 PRESENT ORGANIZATION AND MANAGEMENT

7.1 Present Organization of TOT

The organization structure of TOT consists of three (3) bureaus and four (4) offices under the Board of Director and Managing Director as of May in 1992. The three (3) bureaus are General Affairs, Operations and Engineering and Project. The four (4) offices are Corporate Affairs, Internal Audit, Corporate Planning and ISDN promotion. The number of employees is 18,885 as of May in 1992.

The organization chart of TOT is shown in Figure 7.1-1. The organization chart of Bureau of Operations is also shown in Figure 7.1-2.

ORGANIZATIONAL STRUCTURE IN 1991

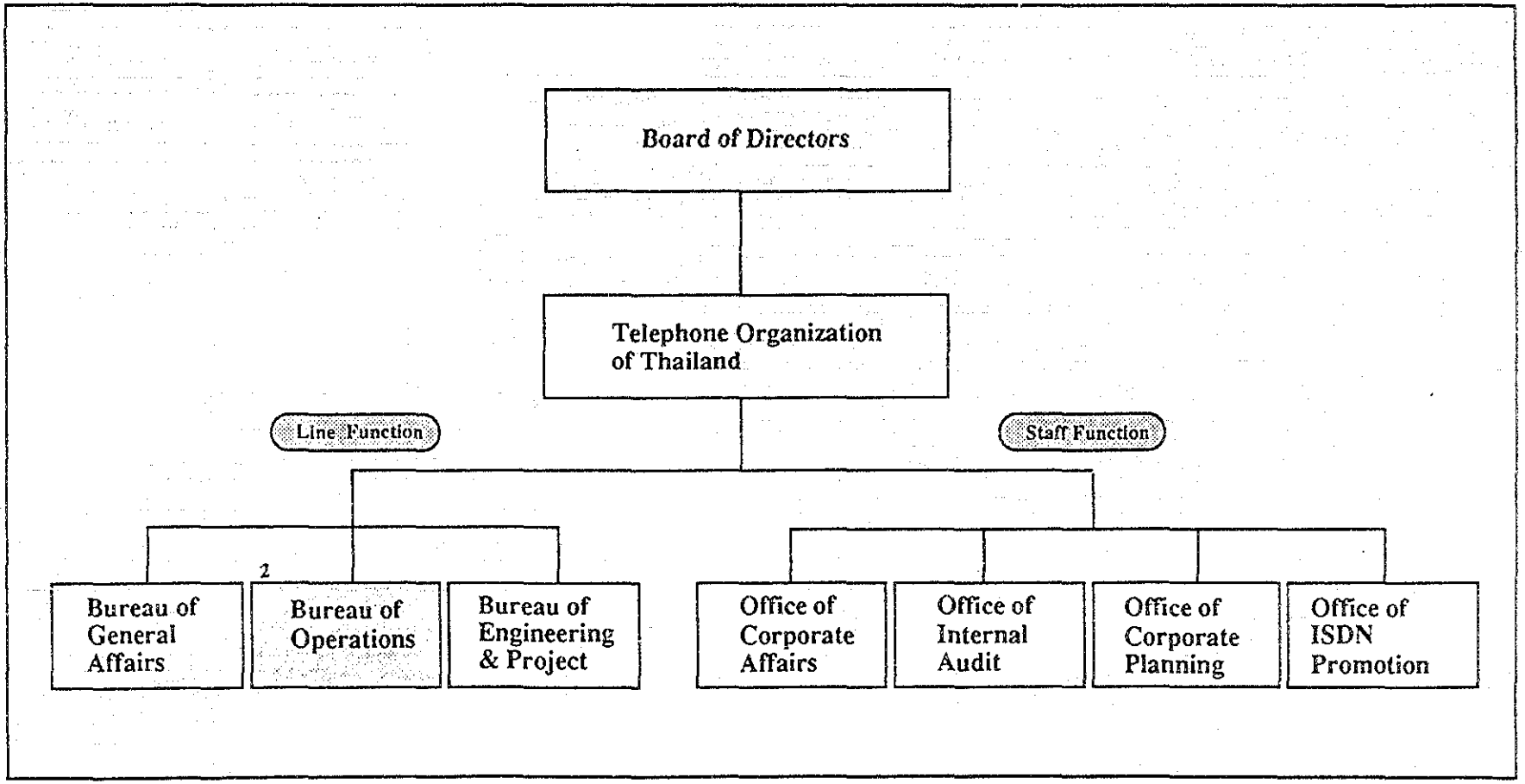

Figure 7.1-1 Organizational Chart (Bureau / Office) of Telephone Organization of Thailand

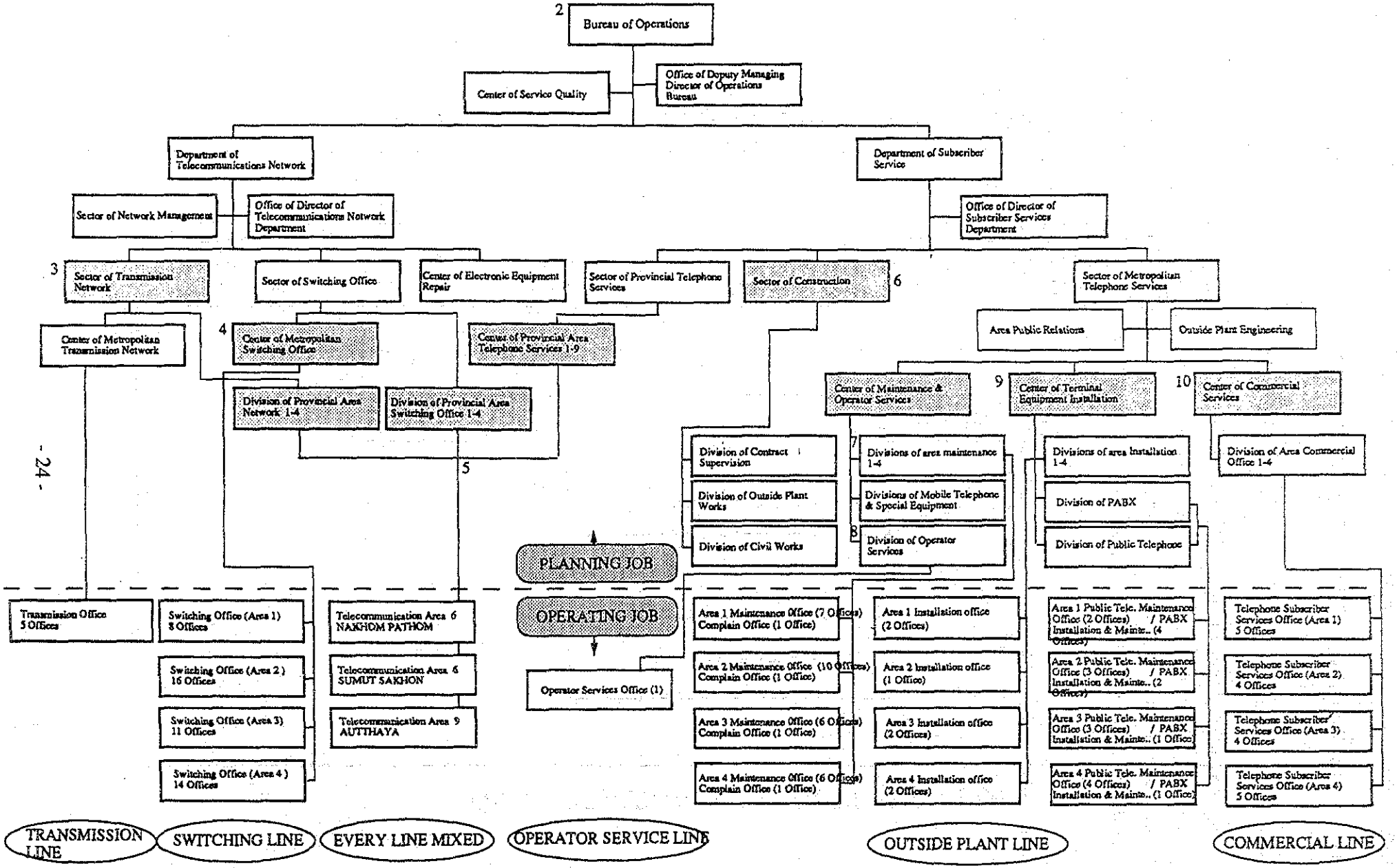

Figure 7.1-2 Organizational Chart of Operations Bureau

7.2 Present Situation of Operation and Maintenance

Table 7.2-1 shows the number of employees in each department, classification and telecommunications areas of TOT as of May in 1991. Figure 7.2-1, Figure 7.2-2 and Figure 7.2-3 show the situation of staffing in each type and area. Table 7.2-2 shows the number of main telephone lines per employee of twenty-seven countries.

Table 7.2-1 Number of Employees in TOT (1/2)

DEPARTMENT	SECTOR	CENTER	TYPE	BMA1	BMA2	BMA3	BMA4	SUB	OTHER	HQ	TOTAL
General Affairs			Engineer	0						227	227
			Administrator	0						1,019	1,019
			Craftsman	0						302	302
			Clerical	0	0					946	946
			Special Official	0						39	39
			Worker	0						389	389
Sub Total				0	0	0	0	0	0	2,922	2,922
Operations	Transmission		Engineer	0						114	114
			Administrator	0						15	15
			Craftsman	0						116	116
			Clerical	0						27	27
			Special Official	0						2	2
			Worker	0						31	31
	Sub Total			0	0	0	0	0	0	305	305
	Switching		Engineer	74	70	60	72			103	379
			Administrator	1	1	2	1			24	29
			Craftsman	156	150	104	137			38	585
			Clerical	9	6	6	7			41	69
			Special Official	6	6	2	3			0	17
			Worker	18	31	13	42			15	119
	Sub Total			264	264	187	262	0	0	221	1,198
	Construction		Engineer	0						147	147
			Administrator	0						34	34
			Craftsman	0						344	344
			Clerical	0						55	55
			Special Official	0						29	29
			Worker	0						217	217
	Sub Total			0	0	0	0	0	0	826	826
	Metro	Maintenance	Engineer	56	45	46	55			17	219
	Telephone		Administrator	17	21	20	16			18	92
	Services		Craftsman	306	287	237	270			7	1,107
			Clerical	98	73	89	97			11	368
			Special Official	16	15	12	14			0	57
			Worker	21	15	28	11			5	80
		Sub Total		514	456	432	463	0	0	58	1,923
		Operator	Engineer	0						4	4
		Services	Administrator	0						50	50
			Craftsman	0						0	0
			Clerical	0						423	423
			Special Official	0						0	0
			Worker	0						7	7
		Sub Total		0	0	0	0	0	0	484	484
		Mobile	Engineer	0						15	15
		Telephone	Administrator	0						0	0
		& Special	Craftsman	0						24	24
		Equipment	Clerical	0						7	7
			Special Official	0						0	0
			Worker	0						9	9
		Sub Total		0	0	0	0	0	0	55	55
		Terminal	Engineer	28	25	15	17			37	122
		Equipment	Administrator	10	6	8	2			22	48
		Installation	Craftsman	137	135	100	125			43	540
			Clerical	45	34	37	49			46	211
			Special Official	5	1	5	2			4	17
			Worker	16	8	8	11			8	51
		Sub Total		241	209	173	206	0	0	160	989

Source: Department of Human Resources of TOT, May, 1991

Table 7.2-1 Number of Employees in TOT (1/2)

DEPARTMENT	SECTOR	CENTER	TYPE	BMA1	BMA2	BMA3	BMA4	SUR	OTHER	HQ	TOTAL
General Affairs			Engineer	0						227	227
			Administrator	0						1,019	1,019
			Craftsman	0						302	302
			Clerical	0	0					946	946
			Special Official	0						39	39
			Worker	0						389	389
Sub Total				0	0	0	0	0	0	2,922	2,922
Operations	Transmission		Engineer	0						114	114
			Administrator	0						15	15
			Craftsman	0						116	116
			Clerical	0						27	27
			Special Official	0						2	2
			Worker	0						31	31
	Sub Total			0	0	0	0	0	0	305	305
	Switching		Engineer	74	70	60	72			103	379
			Administrator	1	1	2	1			24	29
			Craftsman	156	150	104	137			38	585
			Clerical	9	6	6	7			41	69
			Special Official	6	6	2	3			0	17
			Worker	18	31	13	42			15	119
	Sub Total			264	264	187	262	0	0	221	1,198
	Construction		Engineer	0						147	147
			Administrator	0						34	34
			Craftsman	0						344	344
			Clerical	0						55	55
			Special Official	0						29	29
			Worker	0						217	217
	Sub Total			0	0	0	0	0	0	826	826
	Metro	Maintenance	Engineer	56	45	46	55			17	219
	Telephone		Administrator	17	21	20	16			18	92
	Services		Craftsman	306	287	237	270			7	1,107
			Clerical	98	73	89	97			11	368
			Special Official	16	15	12	14			0	57
			Worker	21	15	28	11			5	80
		Sub Total		514	456	432	463	0	0	58	1,923
		Operator	Engineer	0						4	4
		Services	Administrator	0						50	50
			Craftsman	0						0	0
			Clerical	0						423	423
			Special Official	0						0	0
			Worker	0						7	7
		Sub Total		0	0	0	0	0	0	484	484
		Mobile	Engineer	0						15	15
		Telephone	Administrator	0						0	0
		& Special	Craftsman	0						24	24
		Equipment	Clerical	0						7	7
			Special Official	0						0	0
			Worker	0						9	9
		Sub Total		0	0	0	0	0	0	55	55
		Terminal	Engineer	28	25	15	17			37	122
		Equipment	Administrator	10	6	8	2			22	48
		Installation	Craftsman	137	135	100	125			43	540
			Clerical	45	34	37	49			46	211
			Special Official	5	1	5	2			4	17
			Worker	16	8	8	11			8	51
		Sub Total		241	209	173	206	0	0	160	989

Source: Department of Human Resources of TOT, May, 1991

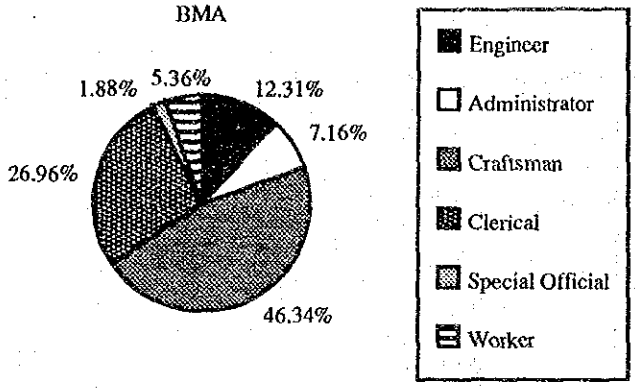

Figure 7.2-1 Staffing in Bangkok Metropolitan Area as of May, 1991

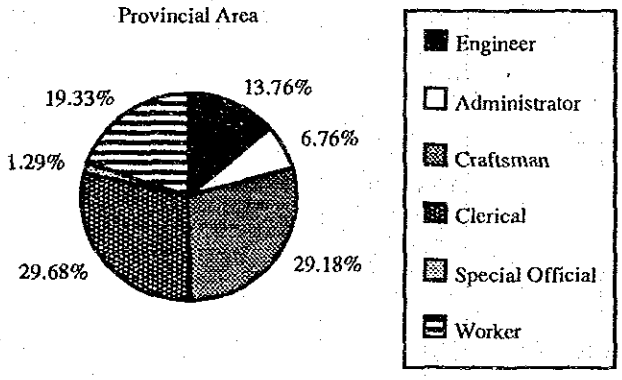

Figure 7.2-2 Staffing in Provincial Areas as of May, 1991

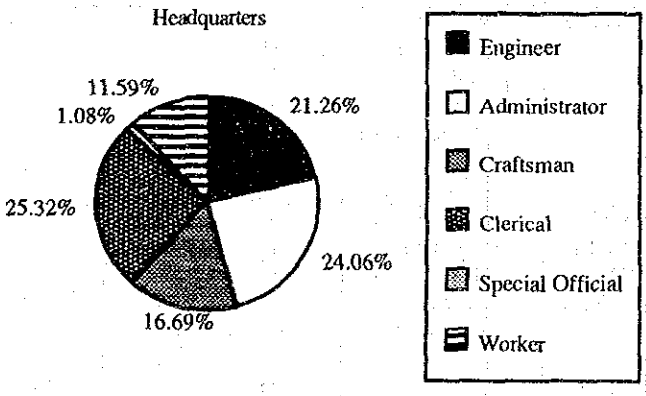

Figure 7.2-3 Staffing in Headquarters as of May, 1991

Table 7.2-2 The Number of Main Telephone Lines per Employee

Country	Main Lines	Employees	Lines / Employee
SRI LANKA	105,483	9,587	11
KENYA	168,683	12,714	13
Thailand (Other Area) '91	438,656	9,189	48
PERU	530,674	15,926	33
PHILIPPINES	570,643	19,053	30
CHILE *88	625,466	11,315	55
PAKISTAN *88	636,590	44,690	14
INDONESIA	863,814	41,815	21
SINGAPORE	981,723	10,112	97
Thailand (Study Area) '91	**1,020,535**	**9,696**	**105**
THAILAND (Total)	1,158,014	18,885	61
MALAYSIA *88	1,247,687	28,168	44
NEW ZEALAND	1,451,743	18,326	79
VENEZUELA *88	1,457,771	17,913	81
NORWAY	2,070,249	16,252	127
HONG KONG *88	2,153,776	12,800	168
INDIA *87	3,487,908	312,303	11
GREECE	3,786,429	29,654	128
MEXICO	4,702,439	49,203	96
CHINA	5,680,400	404,400	14
AUSTRALIA	7,602,572	88,003	86
BRAZIL	8,852,540	104,560	85
SPAIN	11,797,159	71,155	166
KOREA (REPUBLIC OF)	12,003,839	53,033	226
CANADA	13,919,840	103,010	135
ITALY	21,265,518	116,391	183
UNITED KINGDOM *87	22,137,000	223,084	99
FRANCE	26,942,452	157,313	171
JAPAN	52,034,176	276,992	188

Source: ITU, Yearbook of Common Carrier Telecommunication Statistics (18th edition) (Chronological Series 1980-1989)

Note: Data without asterisk are as of 1989.

7.3 Training

TOT has one training center in Bangkok at present. It is observed that the present training center has been providing necessary opportunities and courses for the TOT stuff. TOT has a plan to establish three provincial training centers in order to provide more training chances for the staff in the provincial areas. Figure 7.3 shows the total number of trainees, total number of training weeks and weeks per trainees in FY 1990.

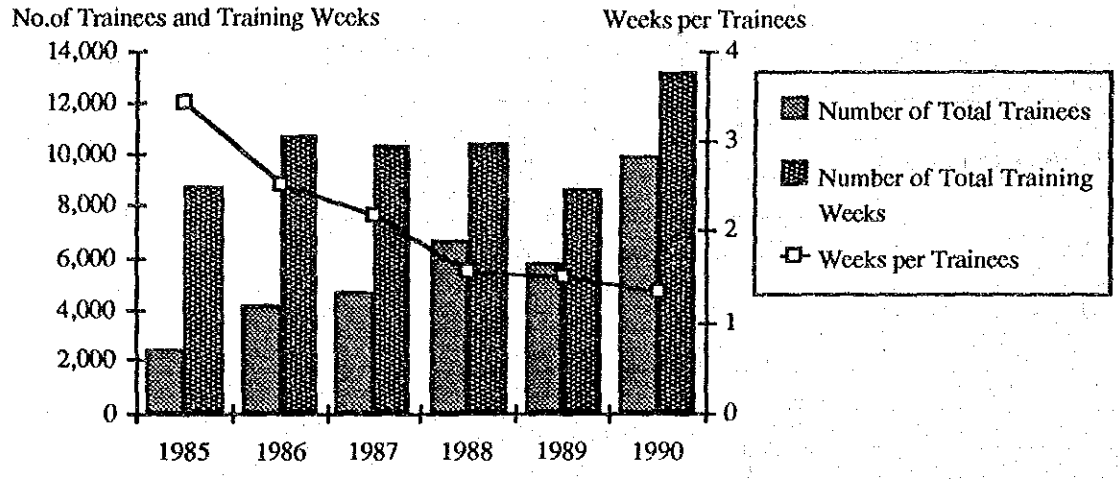

Figure 7.3 Trainees, Training Weeks and Weeks per Trainee

7.4 Financial Situations of TOT

1) Financial Statement of TOT (1985-1990)

a) Balance Sheet of TOT

Table 7.4-1 shows the balance sheets of TOT from FY 1985 to 1990.

Table 7.4-1 Balance Sheets of TOT

(Unit: Million Baht)

Assets	1985	1986	1987	1988	1989	1990
1. Land, Building, Telephone Exchange and Equipment	11,963	15,660	23,139	27,374	31,156	35,700
Less Accumulated Depreciation	4,053	4,782	6,206	7,676	9,406	11,762
Fixed Assets - Net	7,910	10,878	16,933	19,698	21,750	23,938
2. Plant under Construction and Work in Progress	12,491	15,276	11,663	12,210	16,583	23,239
3. Right of the Thai-Malaysia Submarine Cable Usage				314	293	277
4. Investment	1	1	1			
5. Current Assets	6,277	5,158	4,226	5,283	7,706	9,841
6. Other Assets	1,217	1,383	1,713	2,652	4,041	5,178
Total Assets	27,894	32,696	34,536	40,157	50,373	62,472
Liabilities and Equity						
1. Total Equity	5,859	5,781	5,169	7,059	12,882	18,318
1.1 Total Capital	586	628	696	749	808	974
1.2 Total Retained Earnings	6,763	9,017	10,114	11,800	16,426	22,163
1.3 Loss from Baht Devaluation	-1,490	-3,865	-5,641	-5,490	-4,351	-4,819
2. Total Long-Term Debt	16,896	20,728	23,015	25,315	27,897	29,751
2.1 Foreign Loan	12,040	15,673	15,422	19,593	21,557	25,127
2.2 Local Loan				150	994	1,483
2.3 Loss on Exchange Risk Pooling System			1,810	724	612	756
2.4 Yen Private Placement Bonds	611	853	799	764	648	
2.5 Subscriber Bonds	4,245	4,202	4,985	4,085	4,085	2,385
3. Deposit	1,599	2,013	2,320	2,675	3,338	4,006
4. Customer Advance Payments	332	127	62	49	42	66
5. Unclaimed Accounts Payable				5	5	7
6. Accrued Bond Interest	580	926	1,307	1,721	2,174	2,666
7. Total Current Liabilities	2,597	3,102	2,651	3,332	3,871	7,658
8. Other Liabilities	31	21	12	2	165	0
Total Liabilities and Equity	27,894	32,696	34,536	40,157	50,373	62,472

Source: Office of the Auditor General of TOT, Financial Statement and Auditors Report, 1986, 1988, and 1990

The total amount of assets of TOT at the end of FY 1990 has increased 2.24 times larger than that of FY 1985; however, the total long-term debt has become 1.76 times larger within the same period. The long-term debt had 60.6% share on the total assets at the end of FY 1985 but 47.6% at the end of FY 1990. On the other hand, the total equity has become 3.13 times larger within the same period.

This relatively low increase of the long-term debt is the result of the strict debt control by the Ministry of Finance. The financial policy on the state enterprises made by the Government is that investment from state enterprise revenues should

not fall below 25 % of total investment and their debt service coverage ratio should be maintained at 1.5:1 (internal cash generation to debt).[1]

b) Income Statements of TOT

Table 7.4-2 shows the income statements of TOT from FY 1985 to 1990.

Table 7.4-2 Income Statement

(Unit: Million Baht)

Revenue	1985	1986	1987	1988	1989	1990
1. Local Service	2,703	3,931	5,052	5,870	6,845	8,383
2. Trunk Service	1,900	2,834	3,565	4,490	5,457	6,980
3. Revenue from Other Service	614	1,062	789	678	904	1,047
4. Total Operating Revenues	5,217	7,828	9,407	11,039	13,206	16,410
5. Other Income	288	277	147	252	390	626
6. Total Revenues	5,505	8,105	9,553	11,291	13,596	17,036
7. Total Revenue Increase Rate		47.24%	17.87%	18.19%	20.42%	25.30%

Expenses of TOT	1985	1986	1987	1988	1989	1990
1. Administrative Expenses	1,774	1,921	2,213	2,465	2,701	3,217
2. Bad Debt Expenses	34	9	19	0	8	9
3. Repair and Maintenance	261	349	358	363	393	501
4. Depreciation	687	971	1,714	1,656	1,777	2,130
5. Right of the Thai-Malaysia Submarine Cable System				14	16	16
6. Total Operating expenses	2,757	3,250	4,305	4,498	4,895	5,873
7. Other Expenses	1,839	2,092	2,744	4,066	2,913	3,122
8. Total Expenses	4,595	5,342	7,049	8,563	7,808	8,995
9. Total Expenses Increase Rate		16.25%	31.95%	21.48%	-8.81%	15.20%

Operating Income	2,460	4,578	5,101	6,541	8,311	10,537
Net Profit	910	2,763	2,504	2,728	5,788	8,041
Remittance to the Treasury	370	1,105	751	819	1,737	2,413
Net Income Transferred to Retained Earning	401	1,356	1,462	1,565	3,481	4,862
Operating Ratio	52.85%	41.52%	45.77%	40.74%	37.07%	35.79%

Source: Same as Table 7.4.1-1.

The average annual increase rate of the total revenue during the past six years from FY 1985 to FY 1990 is 25.3%, while that of the total expenses is 14.4%. Because of this high increase rate of the revenue, the net profit became approximately 9 times larger within 6 years from 910 million Baht at FY 1985 to 8,041 million Baht at FY 1990.

1 NESDB, Government of Thailand The Sixth National and Social Development Plan (1987 - 1991), p. 200

This high rate of revenue increase is the result of the increasing subscription demand and call traffic demand stimulated by the recent high economic growth.

The operating ratio, which derived by dividing the operating expenses by the operating revenue, improved from 52.85% in FY 1985 to 35.79% in FY 1990.

The total revenue increased 47% in FY 1986 compared with the previous year. This is mainly because the telephone tariff increase in FY 1986 which is around 50% higher than before.

2) Labor Productivity

Table 7.4-3 shows the labor productivity of TOT in the past 6 Years.

Table 7.4-3 Labor Productivity of TOT in the Past 6 Years

	1985	1986	1987	1988	1989	1990
1. Number of Employees	16,926	17,399	17,746	17,956	18,243	18,788
2. Increase Rate of 1		2.79%	1.99%	1.18%	1.60%	2.99%
3. Main Telephone Lines	626,498	798,912	901,622	1,005,872	1,158,014	1,324,522
4. Main Tel. Lines/Employee	37.01	45.92	50.81	56.02	63.48	70.50
5. Operating Income (Million Baht)	2,459.735	4,577.678	5,101.227	6,540.933	8,310.889	10,537.340
6. Operating Income per Employee (Thousand Baht)	145.323	263.100	287.458	364.276	455.566	560.855
7. Increase Rate of 6		81.05%	9.26%	26.72%	25.06%	23.11%

Source: TOT, Telephone Statistical Report, 1989, 1990.

The number of employees of TOT was 18,788 in FY 1990. The average growth rate was 2.1% per year during FY 1985 to FY 1990. The number of main telephone line per employee was 37.01 in FY 1985, which was improved to become 70.50 in FY 1990. The operating income per employee was 145 thousand Baht in FY 1985, which increased to become 561 thousand Baht in FY 1990. The average increase rate was 31% per year during these years.

CHAPTER 8 DEMAND FORECAST

8.1 Telephone Service Subscription Demand

In this study, the future demands is forecasted through two steps. The first step is a macro level for the BMA and the Surrounding Area, witch is called the macro forecast. The second step is a micro level forecast for each telephone service area, which is called the micro forecast. Figure 8.1 shows the forecasting procedure for the subscription demand.

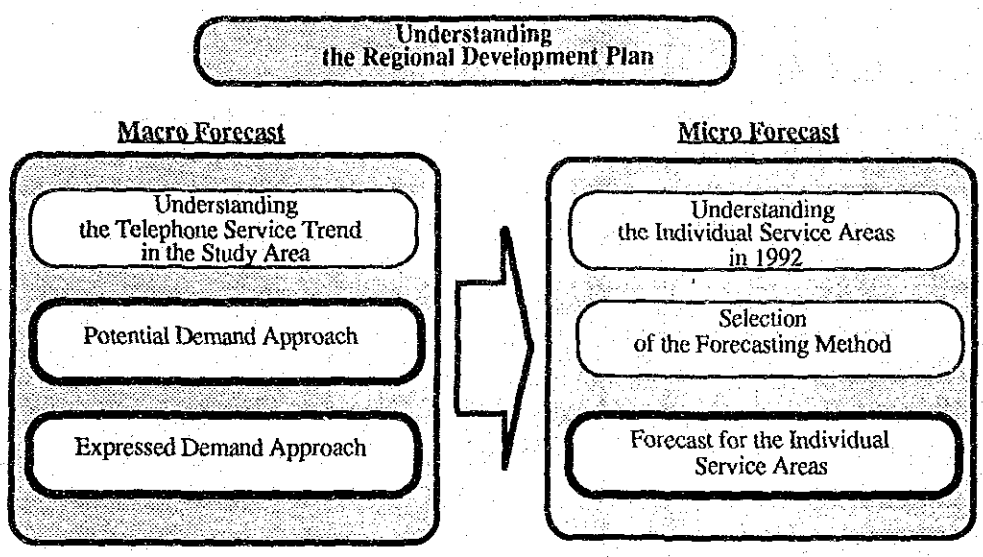

Figure 8.1 Telephone Subscription Forecasting Procedure

Table 8.1-1 shows the result of the demand forecast.

Table 8.1.1 Total Telephone Demand and Telephone Demand per 100 Persons

		1992 (2535)	1997 (2540)	2002 (2545)	2007 (2550)
Telephone Demand	BMA	2,103,989	3,511,014	4,961,677	5,955,994
	Nakhon Pathom	55,055	91,883	150,299	220,360
	Samut Sakhon	69,616	103,992	144,425	185,847
	Ayutthaya	41,621	57,133	76,618	100,511
Telephone Demand per 100 persons	BMA	25.21	38.28	49.80	55.44
	Nakhon Pathom	8.54	13.07	19.75	26.87
	Samut Sakhon	19.83	26.60	33.43	39.21
	Ayutthaya	5.61	7.11	8.85	10.87

Note: Figures inside parentheses indicate Thai calendar years.

8.2 Other Telecommunications Services

The trends of other telecommunications service demands are shown in Figure 8.2-1 and 8.2-2.

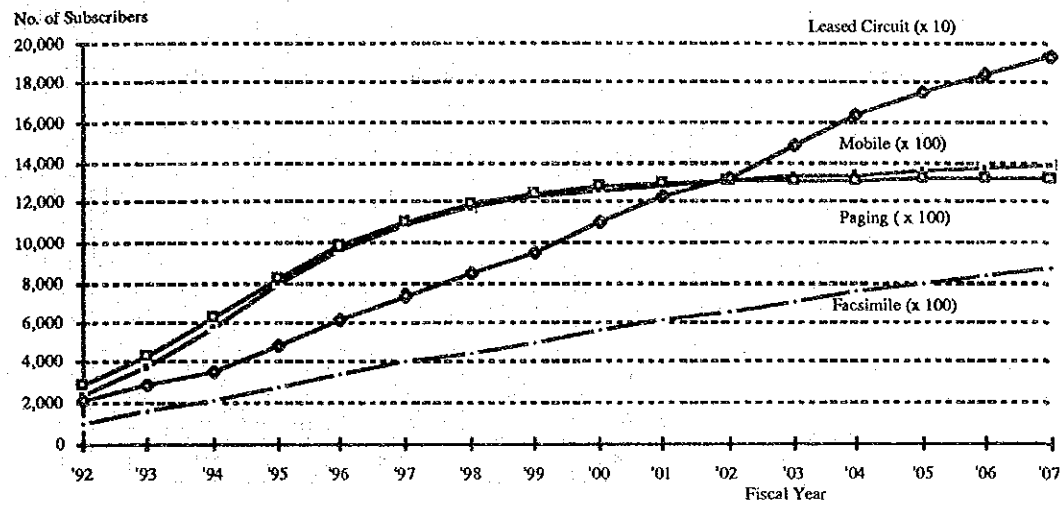

Figure 8.2-1 Trends of Other Telecommunications Service Demands in the Whole Kingdom (existing *1)

Note: *1 existing : the telecommunication services which are offered in the country at present.

The trends of new telecommunications service demands are shown in Figure 8.2-2.

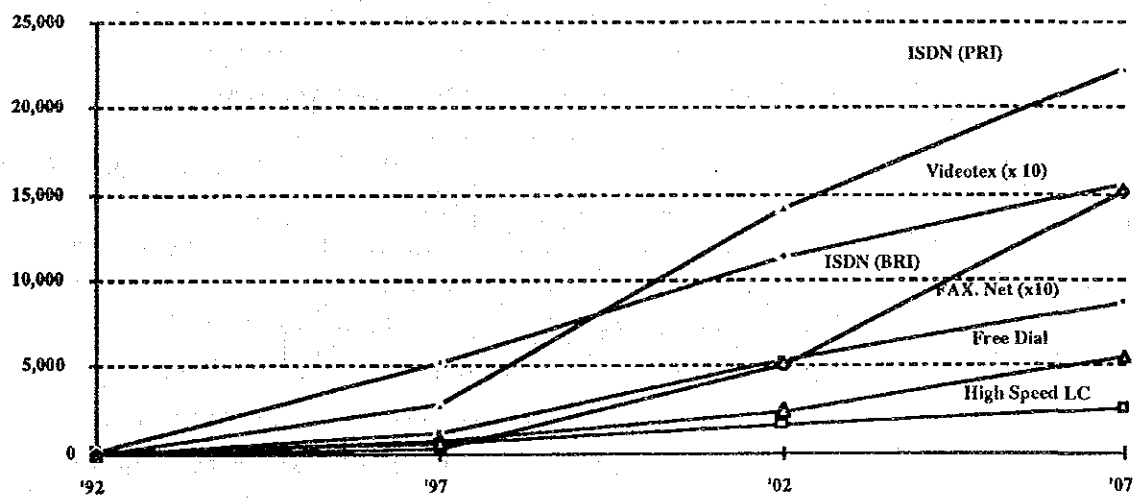

Figure 8.2-2 Trends of New Telecommunication Service demands (not-existing *2)

Note: *2 not existing : the new telecommunication services which are not offered in the country yet.

The demand for other telecommunication services are estimated with nation wide range because of being difficult to get time series data in the Study Area and the provincial areas.

1) Mobile Telephone

The mobile telephone service in Thailand has started in 1986. Table 8.2-1 shows the development of the mobile telephone service in Thailand.

Table 8.2-1 Mobile Telephone Service Development (whole kingdom)

Year	TOT		CAT	Total	No. of Subscribers /
	470 MHz	900 MHz	800 MHz	No. of Subscribers	100 person
1986	822			822	0.002
1987	4,413		1,116	5,579	0.01
1988	10,612		6,972	17,584	0.03
1989	20,936		14,171	35,107	0.06
1990	31,981		31,242	63,223	0.11
1991	42,712	36,486	44,243	123,541	0.22

Source: TOT, August 1992

The demand for the mobile telephone service is forecasted with an exponential curve model for the short-term period because rapid demand growth is expected; and a logistic curve model using the time series data in Table 8.2-1 and the saturation level K to be 2.0, the number of subscribers per 100 persons the demand will be considered to saturate at a certain level. Table 8.2-2 shows the result of the demand forecast in Thailand.

Table 8.2-2 Forecasted Demand for Mobile Telephone (whole kingdom)

Year	Whole Country Demand	Density per 100 persons
1992	234,000	0.40
1997	1,091,000	1.75
2002	1,311,000	1.99
2007	1,383,000	2.00

2) Paging Phone

The paging phone service in the Kingdom started in 1984. Table 8.2-3 shows the development of the service in the past 8 years from 1984 to 1991.

Table 8.2-3 Change in Paging Phone Service Subscribers in the Whole Kingdom

	'84	'85	'86	'87	'88	'89	'90	'91
Phonelink (TOT)							59,607	80,453
Page phone (TOT)								17,258
Paclink (CAT)				17,000	20,000	40,000	60,000	80,000
CAT	6,233	7,992	7,953	6,091	6,791	7,518	9,970	10,000
Total	6,233	7,992	7,953	23,091	26,791	47,518	129,577	187,711
Population (thousand)	50,583	51,796	52,969	53,873	54,961	55,538	56,341	57,196
Penetration (per 100 persons)	0.01	0.02	0.02	0.04	0.05	0.09	0.23	0.33

Note : Phonelink, Page phone and Paclink serve under concession basis of TOT and CAT.

The demand for the paging phone service is forecasted with a logistic curve employing the time series data in Table 8.2-3. Table 8.2-4 shows the result of the demand forecast in the whole Kingdom.

Table 8.2-4 Forecasted Paging Phone Demand and Estimated Penetration Rate (Whole Kingdom)

Year	Demand (thousand)	Population (thousand)	Penetration Rate (per 100 persons)
1992	286	58,041	0.49
1997	1,108	62,102	1.78
2002	1,307	65,865	1.98
2007	1,320	69,165	1.91

3) Leased Circuit Service

a) Leased Circuit Service

Table 8.2-5 shows the present state of the leased circuit service in Thailand. The demand for the leased circuit service is forecasted by using the percentage of the leased circuit to the business telephone in Japan. Table 8.2-6 shows the result of the demand forecast in whole Kingdom.

Table 8.2-5 Relationship Between Business Telephones and Leased Circuits (whole kingdom)

Year	No. of Business Telephones	No. of Leased Circuits	Ratio (Leased C./Business Tel)
1988	276,541	12,630	4.6%
1989	305,363	14,989	4.9%
1990	343,342	16,862	4.9%
1991	450,525	17,620	3.9%

Note : Ratio is between the number of leased circuits and the number of business telephones.

Table 8.2-6 Forecasted Demand for Leased Circuit Service (whole kingdom)

	1992	1997	2002	2007
Leased Circuit (A)	21,000	74,000 (74,021)	132,000 (132,009)	193,000 (193,177)
Business Telephone. (B)	506,649	1,480,413	2,303,814	2,985,728
Percentage (%) (C)	4.23	5.00	5.73	6.47

Note: A = B x C / 100

b) High Speed Digital Leased Circuit Service

The demand for the high speed digital leased circuit service (more than 60 kb/s) in Thailand is forecasted by employing the ratio of the high speed digital leased circuits to the leased circuits in Japan. Table 8.2-7 shows the result of the demand forecast in the whole Kingdom, assuming that the service starts in 1992.

Table 8.2-7 Forecasted Demand for High Speed Leased Circuits

Year	Percentage of H.S.D.L.S	No. of Leased Circuits
1997	1.04 %	58,914
2002	1.82 %	93,045
2007	2.38 %	105,800

4) Facsimile Communications

a) Facsimile Terminal

The number of facsimile terminals in Thailand for the past three years is estimated by multiplying five to the data obtained from TOT, referring to the customer opinions in the marketing research done by the Study Team. Table 8.2-8 shows the revised number of facsimile terminals for the past three years.

Table 8.2-8 Revised Number of Facsimile Terminals (whole kingdom)

Year	Business Telephone	Facsimile Sub.	Revised Fax. Sub.	Rate X	Rate X'
	A	Y	Y'=5 x Y	X=Y/A	X'=Y'/A
1988	277,000	6,036	30,180	0.02	0.11
1989	305,000	9,144	45,720	0.03	0.15
1990	343,000	10,304	51,520	0.03	0.15

The demand for the facsimile terminals is forecasted by using the ratio of facsimile terminals to business telephone lines in Thailand in comparison with the ratio of facsimile terminals to business telephone lines in Japan. Table 8.2-9 shows the result of the demand forecast in Thailand.

Table 8.2-9 Forecasted Number of Facsimile Terminals (whole kingdom)

Year	No. of FAX.(A)	No. of Business Telephone (B)	Ratio (A/B)
1992	104,000	450,525	0.21
1997	405,000	1,480,413	0.27
2002	661,000	2,303,814	0.29
2007	872,000	2,985,728	0.30

b) Facsimile Network Service

The demand for the facsimile network service in Thailand is forecasted with the estimated percentage of the facsimile network service subscribers to the business telephone lines in Japan. Table 8.2-10 shows the result of the demand forecast in Thailand, assuming that the service starts in 1992.

Table 8.2-10 Forecasted Number of Facsimile Network Service Subscribers (whole kingdom)

Year	No of Fax. Net Subscribers	No. of Business Telephones	Percentage (%)
1997	11,000	1,480,413	0.76
2002	53,000	2,303,814	2.32
2007	87,000	2,985,728	2.92

5) Videotex Services

The demand forecast of the videotex services is also examined by considering its cross country data. Table 8.2-11 shows the result of the demand forecast, assuming that the service starts in 1992.

Table 8.2-11 Estimated Videotex Service Demand

Year	1992	1997	2002	2007
Demand	2,000	53,000	114,000	155,000

6) ISDN Services

The demand forecast of the ISDN services is examined applying the logistic curve model to the result of the market research. Table 8.2-12 shows the forecasted demand for the ISDN Services, assuming that the services start in 1992.

Table 8.2-12 Reviewed Demand of ISDN Services

(Unit: Thousand)

	Year	1992	1997	2002	2007
BMA	BRI	0.43	21.0	429	1,180
	PRI	0.02	3.0	11	18
Prov.	BRI	0.24	5.0	77	327
	PRI	0.01	0.3	3	4
Total	BRI	0.67	26.0	506	1,507
	PRI	0.03	3.0	14	22

Note: Figure of Prov. includes the Surrounding Area's demand
BRI: 64 kb/s
PRI: 1 Mb/s

7) Message Service

To estimate the demand for message service, the development of that in Japan is applied. Table 8.2-13 shows the estimation result of the message calls, assuming that the service starts in 1992.

Table 8.2-13 Estimated Message Service Demand

(Unit: Thousand)

	1992	1993	1994	1995	1996	1997
No. of Message Calls (A)	5,983	6,629	8,470	9,541	10,321	11,299
No. of Tel. Call (B)	3,099,000	3,379,000	3,659,000	3,939,000	4,218,000	4,498,000
Ratio (A/B)	0.0019	0.0020	0.0023	0.0024	0.0025	0.0025

8) Free Dial Service

To estimate the demand for free dial service, the development of that in Japan is applied. Table 8.2-14 shows the estimation result of the free dial service demand, assuming that the service starts in 1992.

Table 8.2-14 Estimated Free Dial Service Demand

Year	1985	1986	1987	1988	1989	1990
No. of Lines	2,000	14,000	43,000	80,000	143,000	213,000

CHAPTER 9 OBJECTIVES AND STRATEGIES OF TELECOMMUNICATIONS IN THE LONG-TERM PLAN

9.1 Long-term Development Objectives

The long-term development objectives are as follows:

1) Fulfillment of telephone demand,
2) Upgrade of service quality,
3) Diversification of services,
4) Improvement of management.

For the sake of planning, the period of the long-term plan is divided into three phases as follows:

Phase-1:	From FY 1993 to FY 1997
Phase-2:	From FY 1998 to FY 2002
Phase-3:	From FY 2003 to FY 2007

9.2 Development Strategies and Targets

The development strategies and targets are shown in Figure 9.2. The countermeasures of the main targets are as follows.

1) Reduction of Waiting Applicants

Targets:	Elimination of Waiting Applicants
the BMA	Phase-1
the Surrounding Area	Phase-2

2) Public Telephone

Targets:	Public Telephone Density per 1,000 Inhabitants		
	Phase-1	Phase-2	Phase-3
the BMA:	4	6	8
the Surrounding Area	2	3	4

3) Completion of Network Digitization

Switching Systems

Targets:	100% Digitization
the BMA	Phase-2
the Surrounding Area	Phase-1

4) Decrease of Outside Plant Faults

Targets	Fault Rate per 1,000 Lines per Month		
	Phase-1	Phase-2	Phase-3
the BMA	25	20	15
the Surrounding Area	30	20	15

9.3 Priority Order of the Strategic Target Areas in the Study Area

Areas are ranked according to the following classification as a result of the analysis made in Chapter 2. The area rank for each local exchange area is shown in Figure 9.3-1.

The Highest Priority Area (P-1 Area)	Central Business Area
The Second Highest Priority Area (P-2 Area)	Rapidly Growing Suburban Area
The Third Highest Priority Area (P-3)	Industrial Area
The Fourth Highest Priority Area (P-4)	Outer Area

Therefore, the implementation of the long-term plan must be executed by the targets and the area ranking.

Objectives

1. Fulfillment of Telephone Demand
2. Upgrade of Services
3. Diversification of Services
4. Improvement of Management

Present State of the Sector

1. Existing Socioeconomic Development Plan in the Area
2. Existing Government Telecommunications Development Plan
3. Existing Telecommunications Development Plan of the Sector
4. Present Situation of Telecommunications in the Country

Environmental Condition

1. Socioeconomic Development
2. Technology Development Trend
3. Regional Development
4. Market Development

Strategies & Targets

Phase -1 | Phase-2 | Phase-3

Fulfillment of Telephone Demand

Reduction of Waiting Applicants

BMA
The Surrounding Area
New Telephone Lines

	Phase -1	Phase-2	Phase-3
	2,352,000 lines	1,476,000	1,014,000
BMA	(38 lines / 100 persons)	(50)	(55)
NPT	48,000 (10)	75,000 (20)	64,000 (27)
SKN	56,000 (20)	56,000 (33)	34,000 (40)
AYA	30,000 (5)	34,000 (9)	24,000 (11)

Increase of Public Telephones

	Phase -1	Phase-2	Phase-3
BMA	4 lines per 1,000 persons in BMA	6 lines per 1,000 persons in BMA	8 lines per 1,000 persons in BMA
Prov	2 lines per 1,000 persons in Prov	3 lines per 1,000 persons in Prov.	4 lines per 1,000 persons in Prov.

Upgrade of Services

Replacement of Deteriorated Facilities

- Replacement of XB Switches in the BMA
- Replacement of XB Switches in the Surrounding Area
- Replacement of PCM - 30 Systems
- Local Cable Rehabilitation

Target

	Phase -1	Phase-2	Phase-3
Switching Degitization	100 % Switching Degitization in the Surrounding Area	100 % Switching Degitization in the BMA	
Fault Rate per 1,000 lines per month in Outside Plant	BMA: 25 the Surrounding Area: 30	The Study Area: 20	The Study Area: 15

Improvement of Operation and Maintenance

- Establishment of Network Management System
- Reinforcement of OPMC
- Improvement of Network Reliability
- Improvement of T & D Center

Diversification of Services

	Phase -1	Phase-2
ISDN Services	Introduction of ISDN Services	Expansion of ISDN Services
CCS No. 7	Introduction of CCS No. 7	Expansion of CCS No. 7
SDH	Introduction of SDH	Expansion of SDH
Various Services	Introduction and Expansion of Various Services	

Improvement of Management

- Improvement of O & M Organization (including O & M System)
- Improvement of Human Resource Management
- Improvement of Human Resource Development

Beyond Universal Basic Service

Figure 9.2 Strategies and Targets

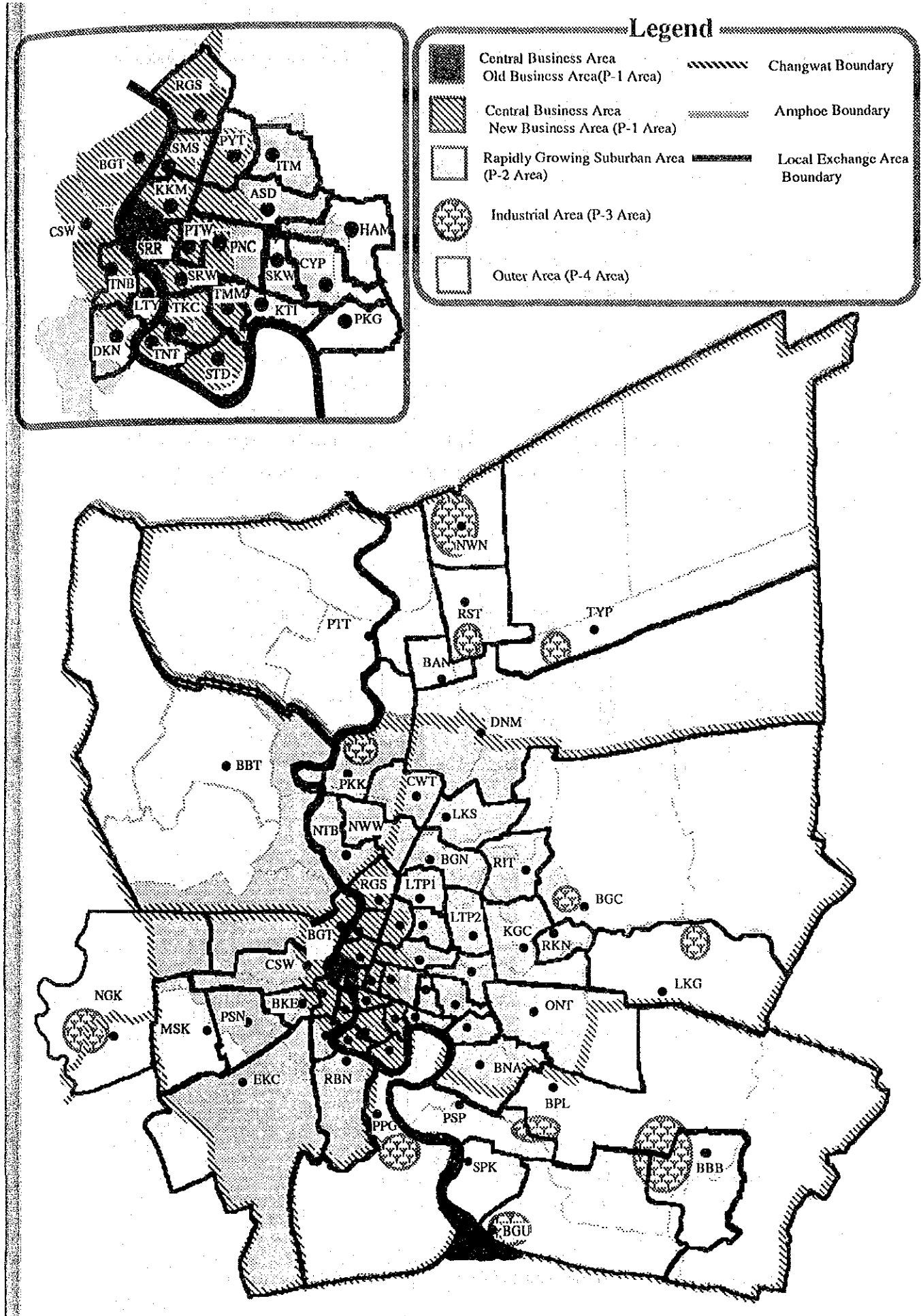

Figure 9.3 Strategic Target Areas of the BMA

CHAPTER 10 TRAFFIC FORECAST

10.1 Methodology

In this study, the future traffic demand is forecasted by two steps. The first step is macro level forecast, which forecasts the whole traffic volume of each message area in the Study Area. The second step is micro level forecast, which forecasts the traffic volume of each switch unit in the message areas.

10.2 Macro Forecast

The forecasting equations in this study are specified for forecasting the traffic growth of the study period. The results of the macro traffic forecast of the message areas in the Study Area are shown in Figure 10.2-1 to Figure 10.2-4.

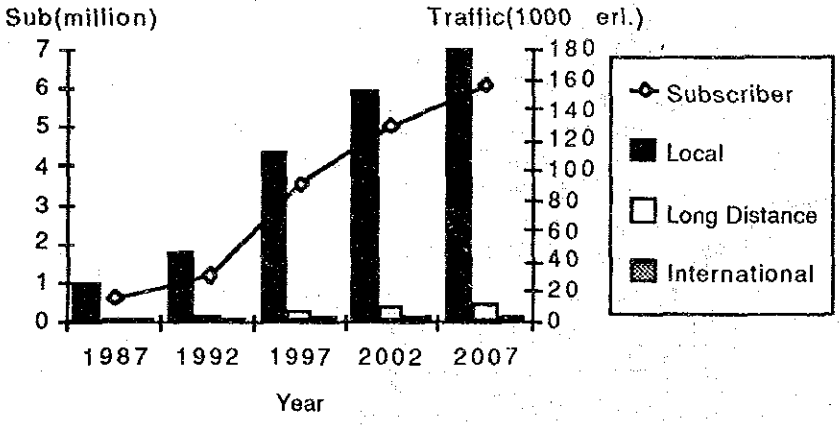

Figure 10.2-1 Forecasting Result of Originating Traffic (BMA)

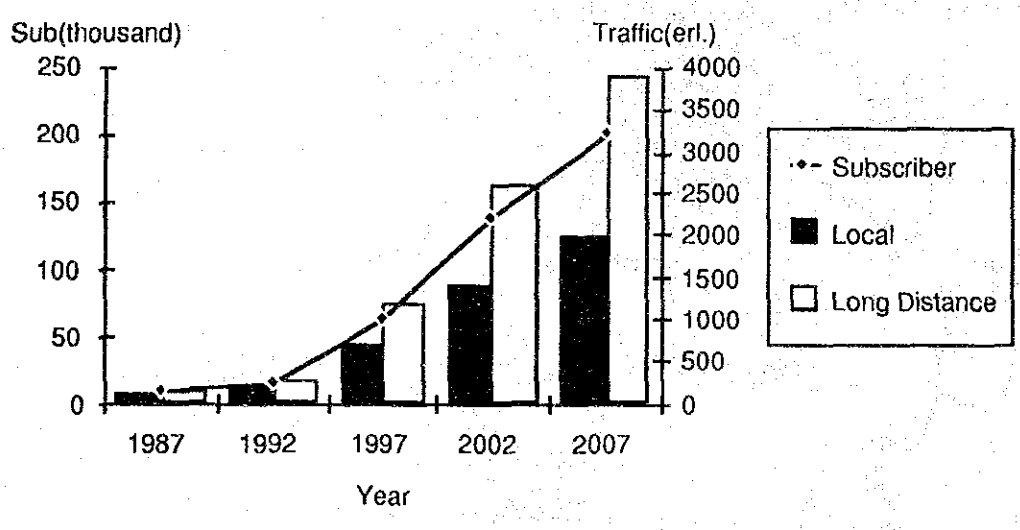

Figure 10.2-2 Forecasting Result of Originating Traffic (Nakhon Pathom)

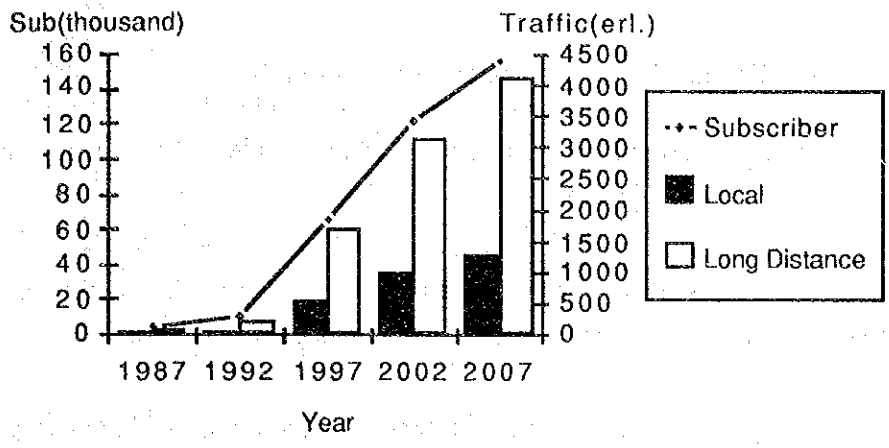

Figure 10.2-3 Forecasting Result of Originating Traffic (Sumut Sakhon)

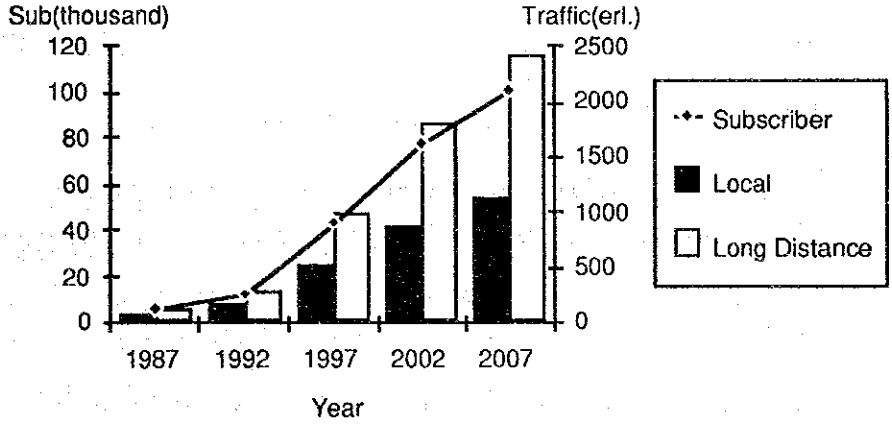

Figure 10.2-4 Forecasting Result of Originating Traffic (Ayutthaya)

10.3 Micro Forecast

The future originating traffic volume in each switch unit is estimated in this study, based on the calling rate of each switch unit in 1987 and adjusted by the macro traffic.

The terminating traffic volume in each switch unit is calculated by using the terminating to originating traffic volume ratio measured in 1987.

CHAPTER 11 NEW SERVICE INTRODUCTION PLAN

11.1 Marketing Research on Telecommunications Services

A marketing research on telecommunications services was executed to grasp customers needs in the study period.

Five seminars were held to carry out the marketing research smoothly. 228 representatives from 131 companies and governmental organizations attended the seminars.

Questionnaires were delivered to three hundred (300) companies and two hundred and twenty-three (223) questionnaires were collected.

1) Usage of Existing Telecommunications Services

a) Ordinary Telephone

i) Call Destination

Approximately 60% of the respondents telephone calls are local calls, 15% to 30% are long-distance calls, and 10% to 15% are international calls.

ii) Call Party

Most of the firms expressed that their telephone calls are made between their headquarters and their branch offices. One exception is the retail sector that makes calls between the wholesale sector.

iii) Purpose of Domestic Calls

The first purpose of domestic callings are mainly for "banking", "contact one's own company" and "make for purchase orders". The first purpose of international callings are "banking procedure", "sale of product and services", "contact company", and "order for purchase".

b) Cellular Mobile Services

The calls made by cellular mobile telephones are mainly for local calls in both originating and terminating. Its international calls is lower than those of the ordinary telephones.

c) Facsimile Communications

Facsimile communications pattern is quite similar to the other service usage patterns. For instance, the manufacturing sector has in the total terminating calls 58% of local, 22% of long-distance, and 20% of international calls. For the originating calls, the sector has 61% of local, 21% of long-distance, and 18% of international calls.

d) Leased Circuit

These companies use leased circuit for mostly the point-to-point connections. However, the finance and the real estate companies use 66% of leased circuits for the point-to-multipoints connections. Most of their connections are made between their head offices and branch offices. International leased circuit is not so common; however, connections between their offices and U.K., U.S.A., and Hong Kong are many.

2) Average Expenditure for Telecommunications Services

Expenditure for the telecommunications services is approximately 8% to 10% in their total expenditures on average all the sectors. In the case of the manufacturing sector, the share is 9%. The construction sector expends 10.5%, the wholesale sector expends 8%, the retail sector expends 9%, the real estate sector expends 10%, the agriculture and mining sectors expend 1.5%, and the government sector expends 3.3% of their total for telecommunications services.

3) Requests and Comments for Telecommunications Services

Many companies expect that they can use the telephone service at any time when needed and they expect that one calling attempt can make a successful call connection. They have complaints such as "they need to install more lines", "they wait telephone installations for long time", and "it is difficult to make a complete call without many calling attempts".

4) New Services

a) ISDN

Most of the companies do not have any interest for ISDN services. There are three reasons for the responses.

i) The merit of ISDN is not popular for them and the ISDN concept is difficult to understand.

ii) The applications of ISDN are under developing.

iii) The tariff of ISDN is not revealed; therefore, it is difficult for them to find any economical merit of ISDN.

b) The Other Services

i) Companies showed small interests on "facsimile message store and forward service" as well as "virtual network services". However, one third of them expressed their interests for these new services.

ii) They showed high favorite responses for the simple circuit resale or linking public telephone lines with leased circuits between headquarters and branch offices with lower cost.

iii) The introduction of "detail charging bill services" and "consulting services" also interested companies in the agriculture, construction and restaurant and hotel sectors.

iv) The introduction of "voice mail service" partially interested companies except in the manufacturing, utilities, construction, wholesale and retail sector.

v) The introduction of "one stop shopping services" seems to interest companies to small extent. The introduction of the "television and telephone conference service" do not strongly interest companies.

vi) The introduction of "high speed more than 2 Mb/s leased circuit" interested companies in the utility sector.

vii) For information providing services through telephone and facsimile, companies in restaurant, hotel and utilities sectors show their needs stronger than other sectors.

11.2 Introduction Plan

The exchange offices were classified by the revenue per line, growth rate of the revenue per line, the number of leased circuits, the number of facsimile terminal sets, and the number of companies in order to implement new telecommunications services efficiently. Table 11.2 shows the ranking of the exchange offices.

Table 11.2 Ranking of Exchange Offices

Priority Order	Name of Exchange
Highest Priority Office Areas	SURAWONG, PHLOEN CHIT, SAMRAN RAT, PHAHONYOTIN, AMARIN PLAZA, ASOK DIN DAENG, CENTRAL PLAZA, KRUNG KASEM, PATHUM WAN,KHLONG TOEI, THAI WA
The second Highest Priority Office Areas	MAH BOONKRONG, SATHU PRADIT, BANG PLI-BANG BO, POM PHARACHOOL, PU CHAO SAMINGHARA, BANG PHLI, BANG POO, CHAIYA PHRUK, HUA MUK, LAT PHARAO 1,SUKUMWIT, THUNG MAHAMEK
The Third Highest Priority Office Areas	CHARAN SANIT WONG, EKA CHAI, TROK CHAN and other 17 Exchange Areas
The Fourth Priority Office Areas	BANGNA and other 25 exchange areas

Figure 11.2 shows the ISDN demand in the initial stage. The Area No.1 has many demands for ISDN since many companies and the governmental offices locate in this area.

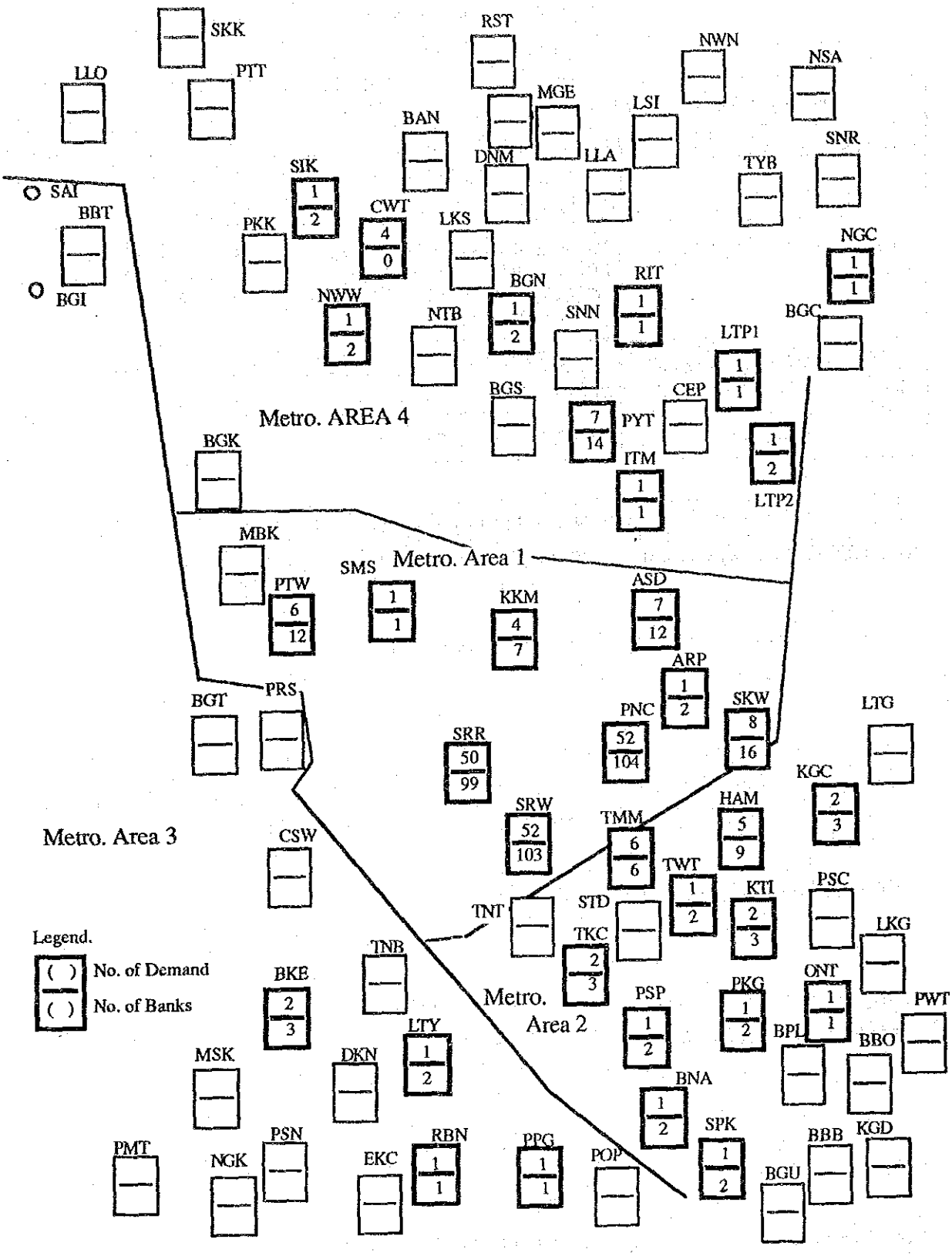

Figure 11.2 ISDN Demand at Initial Stage

CHAPTER 12 TELECOMMUNICATIONS NETWORK PLAN

12.1 Network Structure

In this study the same network structure as the existing one is applied. Because, it is considered that for the network that has six million subscribers by the end of the study period, the existing two level network structure is suitable. Figure 12.1 shows the basic network structure in the BMA.

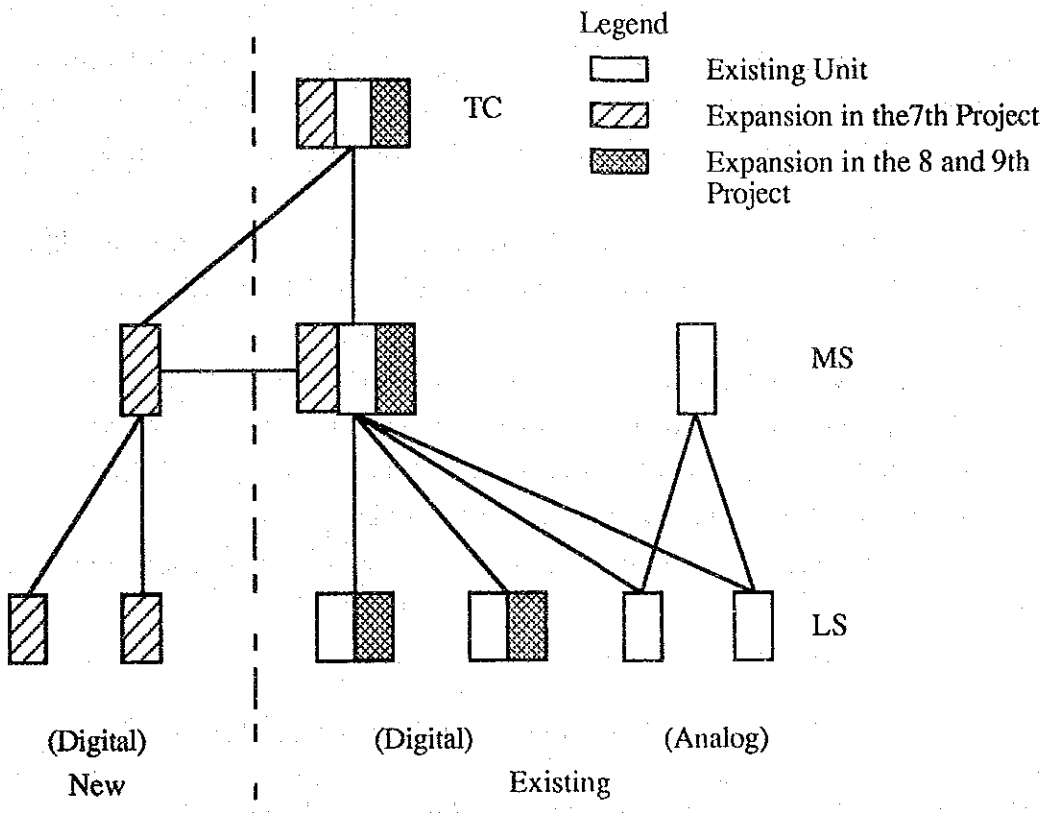

Figure 12.1 Basic Network Structure in the BMA

12.2 Signaling System No.7

CCS No. 7 should be introduced not only for ISDN services but as an infrastructure of intelligent telecommunications network services from now on. At present, applications for ISDN have not been developed enough for providing practical services; therefore, for the time being, TOT should modernize the existing networks rather than expanding ISDN services in the near future until new promising services come up . The targets to complete the signaling network for smooth and effective introduction of new services are as follows:

1) Every new switch unit which is to be installed during and after the seventh TOT ESDP expansion project plan period is equipped with CCS No. 7. The network with CCS No. 7 is established by an overlay structure on the present public switched telephone network (PSTN) with R-2 signaling system.

2) Signaling Transfer Areas (an area in which a Signaling Transfer Point [STP] have responsibility for signal transfer: STA) is assigned to the same area as the Tertiary Center Area of the present PSTN (Public Switched Telephone Network).

3) Two (2) STPs are installed in one STA. One STP in every STA forms one plane (called A plane) connected by a mesh structure and another STP in every STA establishes another plane (called B plane) with the same mesh structure.

4) From the viewpoint of the present network structure and transmission routes, STPs are assigned to the Tertiary or Secondary Centers listed below:

- Krung Kasem and Lak Si for "02" Area
- Phra Kanong and Lat Ya for "03" Area
- Nakhon Ratchasima and Khon Ken for "04" Area.
- Phisanulok and Nakhon Sawan for "05" Area, and
- Sura Thani and Hat Yai for "07" Area.

12.3 Numbering Plan

1) Changing the digits in the Metropolitan Area

At present, the BMA numbering system uses 7 digits (exchange code: 3 digits, station number: 4 digits). Changing the numbering system such as changing exchange codes from 3 digits to 4 digits in the BMA is examined by taking into considerations of not only ordinary telephone numbering capacity but also new services such as the mobile telephone and ISDN, PBX dial-in services and easiness of network management. The results indicate that the shortage of numbering capacity is expected to occur before FY 2002 in the case of 3 digit office codes.

2) New Numbering Plan for Cellular Mobile Telephone

It is better to give an identification code to the cellular mobile telephone service for identifying the network, and simplifying the numbering style. A new numbering style is shown in Table 12.3.

Table 12.3 New Numbering Style

Numbering style	Carrier	Composition
0+1.0+AB(I.D.)+ Subscriber No.	TOT	0+10+AB+5 digits
	CAT	0+10+I.D.+ Subscriber No.
	New Carrier	0+10+I.D.+ Subscriber No.

12.4 Network Management Development Plan

1) Issues at Present and in the Future

a) National Center

Regarding the TOT network management systems, the issue is that the supervisory and management systems are not established as one unit and they are working independently. In the switching field, an O & M system is established by each manufacturer in different offices even though each system has its own national center. In the transmission field, a national center which is able to monitor both the long-distance and the junction transmission networks has not been established yet. However, it is required to establish a national center which can monitor both the transmission network and the switching network.

b) Monitoring of the Private Sector Network

It is decided that the TOT seventh telecommunications expansion project in the BMA is implemented by a private firm and it will be the same also in the provincial areas. However, it is necessary that TOT should monitor the overall network performance throughout the country because TOT has responsibility for all network users as a government enterprise. As the size and complexity of the telephone network expands, a need for large quantity of more accurate information in the network evolves.

2) Proposal of Establishment of Integrated Network Management System

Considering the above mentioned situation, it is essential for TOT to establish an integrated network management system. The system will consolidate the existing systems and utilization of the existing facilities will bring benefits. The conceptual system configuration is shown in Figure 12.4. In the system, relay computers will be

used to transfer protocols, data formats and characters which are peculiar to each system, to the national center. The system will be established in the Phase-1.

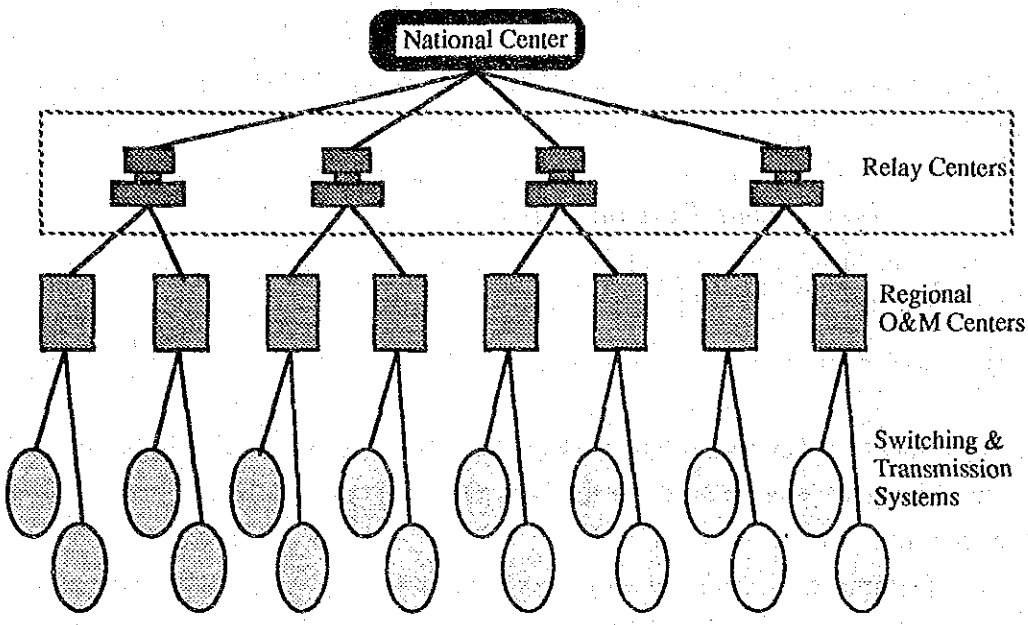

Figure 12.4 System Configuration of Integrated Network Management System

12.5 Reliability Development Plan of Telecommunications Network

1) Telecommunications Network Reliability Improvement Plan of TOT

The long-distance microwave and optical fiber transmission system is used to connect most of the SCs (Secondary Centers) and TCs (Tertiary Centers) with looped or doubled routes.

2) Telecommunications Network Recovery Plan against Disasters in TOT

The restoration plan against disasters has not been completely improved yet. It is considered that the restoration plan against disasters should be implemented as soon as possible. Because, interruptions of communications will give big social and economic losses to the society. Following plans are recommended.

a) Improvement, allocation and grade up of mobile power supply systems
b) Provision of mobile satellite earth stations
c) Introduction of a portable radio transmission system
d) Introduction of an emergency telecommunications system (ETS)

CHAPTER 13 TELECOMMUNICATIONS FACILITY PLAN

13.1 Installation Schedule of Main Telephone Line (Sales Plan)

Table 13.1 shows the number of main telephone lines to be connected in the Study Area for the three phases.

Table 13.1 Main Telephone Installation Plan for Each phase

	BMA	Nakhon Pathom	Samut Sakhon	Ayutthaya	Total Study Area	Share
Phase-1 (1993-1997)	2,371,100	49,100	56,600	31,600	2,508,400	47%
Phase-2 (1998-2002)	1,499,600	75,600	56,200	34,800	1,666,100	31%
Phase-3 (2003-2007)	1,040,600	64,900	34,800	25,000	1,165,300	22%
Total	4,911,300	189,600	147,600	91,400	5,339,800	100%

Note: The above figures include:
1) subscriber main telephone lines to be connected, and
2) public telephone lines.

13.2 Outline of the Expansion Plan

Table 13.2-1 shows the outline of the expansion plan.

Table 13.2-1 Outline of Expansion Plan

Facility			Phase-1	Phase-2	Phase-3	Total
Telephone	Main Telephone	(line)	2,486,000	1,641,000	1,139,000	5,266,000
	Public Telephone	(set)	22,500	25,500	26,200	74,200
Outside Plant Facility	Pair Cable					
	(BMA)	(primary cable pair)	4,237,000	1,813,000	1,120,000	7,170,000
	(Provincial)	(primary cable pair)	224,000	221,000	156,000	601,000
	(total)		4,461,000	2,034,000	1,276,000	7,771,000
	Replacement of Pair Cable					
	(BMA)	(primary cable pair)	178,500	95,400	156,900	430,800
Switching Facility	Local Switch					
	BMA	(line)	2,601,000	1,305,000	1,015,000	4,921,000
	Provincial	(line)	261,000	113,000	122,000	496,000
	(subtotal)		2,862,000	1,418,000	1,137,000	5,417,000
	Tandem	(circuit)	83,000	30,000	13,000	126,000
	Toll Switch	(circuit)	19,100	11,900	5,600	36,600
	Replacement (XB switch)					
	1) Local (BMA)	(line)	235,000	110,000		345,000
	(Provincial)	(line)	10,500	0	0	10,500
	(Subtotal)		245,500	110,000	0	355,500
	2) Tandem	(circuit)	1,500	4,200	0	5,700
	Replacement (SPC switch)					
	(BMA)	(line)	0	683,000	509,000	1,192,000
	(Provincial)	(line)	0	27,200	23,600	50,800
Transmission Facility	Long Distance	(circuit)	17,000	11,000	4,000	32,000
	Junction	(circuit)	138,000	74,000	44,000	256,000
	Spur	(circuit)	19,000	25,000	30,000	74,000
	Replacement (PCM)	(cir.)	34,000	33,000	20,000	87,000
	Replacement (Existing Digital)	(cir.)	56,000	56,000	56,000	168,000
Mobile Services	Cellular Mobile	(line unit)	857,000	220,000	72,000	1,149,000
	Paging	(line unit)	822,000	199,000	13,000	1,034,000
Investment Cost	(Billion Baht)		91.9	59.1	47.2	198.2

1) Outside Plant Facility

a) Telephone Expansion Plan

Table 13.2-2 shows the expansion plan of ordinary telephone and public telephone in each phase. The installation of the ordinary telephone is planned to meet the

target of the long-term plan based on the telephone demand forecast. The installation of the public telephone is also planned to meet the public telephone density target of the long-term plan.

Table 13.2-2 Telephone Expansion Plan

(Unit: Expansion/ Thousand: Cost/ Million Baht)

	Phase-1		Phase-2		Phase-3		Total	
	Installation	Cost	Installation	Cost	Installation	Cost	Installation	Cost
Ordinary Telephone	2,486	1,492	1,641	984	1,136	682	5,263	3,158
Public Telephone	23	2,090	25	2,272	29	2,635	77	6,998
Total	2,509	3,582	1,666	3,255	1,165	3,317	5,340	10,154

Note: 1. Installation of Ordinary Telephone includes only the new installation of drop wires from DP (Drop Point) to subscribers premises.
2. Installation of Public Telephone includes all installation steps from DP to the public telephone terminal sets.

b) Local Cable Expansion Plan

The number of primary cable pairs to be installed in each phase is proposed as shown in Table 13.2-3. This is estimated by the procedure described in APPENDIX. To make more accurate estimation it must be done on the basis of a field survey in each cabinet area.

Table 13.2-3 Number of Primary Cable Pairs to be Installed in Each Phase

(Unit: 1,000 pairs, Million Baht)

	Phase-1		Phase-2		Phase-3		Total	
	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
BMA 1	1,086	8,629	394	3,128	253	2,011	1,733	13,768
BMA 2	1,084	8,613	490	3,890	292	2,321	1,865	14,824
BMA 3	876	6,960	388	3,081	236	1,876	1,500	11,917
BMA 4	1,191	9,463	541	4,295	339	2,695	2,071	16,453
(Sub Total)	4,237	33,664	1,813	14,394	1,120	8,903	7,170	56,962
Nakhom Pathom	83	659	108	857	83	660	274	2,177
Samut Sakhon	85	675	75	595	43	342	203	1,613
Ayutthaya	56	445	38	302	30	238	125	985
(Sub Total)	224	1,780	221	1,755	156	1,240	601	4,774
Total	4,461	35,444	2,033	16149	1,277	10143	7,770	61,736

C) Rehabilitation Plan of Local Cable and Wire

The main purpose of the rehabilitation of local cable networks is to improve the service quality such as to reduce the fault ratio. The paper insulated cables tend to cause burst errors when digital signals are transmitted through metallic loops. The Study Team proposes replacement of those existing paper insulated cables. In order to implement the replacement work effectively and economically, it should be scheduled to be implemented with the local cable expansion projects.

The number of the local cables to be replaced was estimated by the following method.

i) The paper insulated cables installed 20 years ago must be replaced.

ii) The years when these paper insulated cables were installed are estimated by examining the number of local cables connected in each year during the last 18 years.

iii) The replaced number of the local cables is shown in Table 13.2-4. The cost estimation procedure for the replacement of local cables is described in APPENDIX of the Main Report.

Table 13.2-4 Number of Cables to be Replaced in Each Phase

(Volume Unit: Primary Cable Pairs, Cost Unit: Million Baht)

Area	Phase 1		Phase 2		Phase 3		Total	
	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
BMA 1	68,700	873	23,100	294	40,600	516	132,400	1,683
BMA 2	48,900	622	22,800	290	54,800	697	126,500	1,609
BMA 3	31,300	398	18,200	231	30,000	382	79,500	1,011
BMA 4	29,600	376	31,300	398	31,500	401	92,400	1,175
Total	178,500	2,269	95,400	1,123	156,900	1,996	430,800	5,478

Table 13.2-5 shows the detail of the local cables to be replaced.

Table 13.2-5 Replacement Plan of Paper Insulated Cable

Area	Exchange Name	Phase 1			Phase 2			Phase 3		
		Cable Type	Lines	Pairs	Cable Type	Lines	Pairs	Cable Type	Lines	Pairs
BMA 1	Phloen Chit	ASP &LTJ	9	9,600	ASP	2	6,000	ASP	5	8,800
		ASP	9	16,600						
BMA 1	Samran Rat	ASP	6	12,800						
BMA 1	Krung Kasem	ASP	10	18,300	ASP	2	4,500			
BMA 1	Surawong	ASP	4	11,400	ASP	4	12,600	ASP	5	15,600
BMA 1	Sam Sen							ASP	1	3,000
BMA 1	Asok-Din Daeng							ASP	3	9,000
BMA 1	Pathum Wan							ASP	2	4,200
BMA 2	Chaiyaphruk	ASP	10	23,700	ASP	1	3,000			
BMA 2	Bang Na	ASP	3	6,300	ASP	1	2,700	ASP	3	7,200
BMA 2	Samut Prakhan				ASP	1	2,700	ASP	2	3,900
BMA 2	Khlong Chan	ASP	1	3,000	ASP	2	5,400	ASP	2	5,100
BMA 2	Thungmahamek	ASP	7	11,700	ASP	1	3,000			
BMA 2	Sathu Pradit	ASP	1	1,200	ASP	1	2,100			
BMA 2	Thanon Tok	ASP	1	3,000	ASP	1	2,100			
BMA 2	Pu Chao Saming Phrai				ASP	1	1,800	ASP	3	9,800
BMA 2	Phra Khanong							ASP	4	10,200
BMA 2	Hua Mak							ASP	4	10,800
BMA 2	Trok Chan							ASP	3	7,800
BMA 3	Thon Buri	LTJ	3	1,100	ASP	2	8,000	ASP	1	3,000
		ASP	6	13,800						
BMA 3	Bang Khae	ASP	2	5,100	ASP	1	2,400	ASP	1	2,100
BMA 3	Dao Khanong	ASP	2	5,400	ASP	2	2,400	ASP	3	7,800
BMA 3	Phra Pradaeng				ASP	1	2,400			
BMA 3	Bang Phlat	ASP	3	5,900	ASP	1	3,000	ASP	1	2,400
BMA 3	Phanu Rangsi							ASP	1	900
BMA 3	Phasi Charoen							ASP	2	5,400
BMA 3	Charansanitwong							ASP	3	8,400
BMA 4	Phahon Yothin	LTJ	8	3,500	ASP	2	6,100	ASP	3	3,600
		ASP	4	9,000						
BMA 4	Intramara	ASP	2	6,000	ASP	1	2,700			
BMA 4	Bang Khen	ASP	2	4,200	ASP	1	1,200			
BMA 4	Bang Su	ASP	2	4,200	ASP	4	9,900	ASP	1	2,400
BMA 4	Ngam Wong Wan				ASP	3	8,400			
BMA 4	Don Muang	ASP	1	1,200	ASP	1	3,000			
BMA 4	Nonthaburi							ASP	3	6,000
BMA 4	Lat Phrao 1							ASP	3	8,400
BMA 4	Lak Si	ASP	1	1,500				ASP	2	5,700
BMA 4	Lat Phrao 2							ASP	2	5,400
	TOTAL		97	178,500		36	95,400		63	156,900

Note: ASP stands for "Paper or Wood Pulp Insulation Stalpeth Sheathed Cable".
LTJ stands for "Lead Sheathed Paper Insulated Lead Sleeve Joint Cable".

2) Switching Facility

a) Expansion Plan

The expansion plan is formulated based on the objectives and strategies described in Chapter 9, the demand forecast in Chapter 8, and the traffic forecast in Chapter 10 with the existing switching line capacity and the construction period taken into consideration.

b) Replacement Plan

Replacement of the existing XB switches to SPC switches should be planned based on the following factors taken into consideration:

i) available exchange office space for the future expansion,
ii) new services introduction plan,
iii) replacement work volume leveling,
iv) availability of maintenance and spare parts,
v) efficient operation and maintenance staff allocation.

Table 13.2-6 shows the outline of the expansion and the replacement for each plan period and area. Table 13.2-7 shows the XB switch replacement plan in detail.

Table 13.2-6 The Outline of the Expansion Plan for Switching Facility

	Switch Type		Area	Phase-1		Phase-2		Phase-3		Total	
				Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
Expan-		Local Switch	BMA	2,600	18,083	1,305	9,076	1,014	7,052	4,920	34,211
sion		(Lines)	SA	261	1,817	113	788	122	852	496	3,457
			Sub Total	2,861	19,900	1,418	9,864	1,136	7,904	5,416	37,668
	SPC	Tandem Switch	BMA	83	812	30	292	13	125	126	1,229
		Toll Switch	BMA	19	102	12	63	6	30	37	195
		Total			20,814		10,219		8,059		39,092
		Land &	BMA	5.1	78	2.5	39	0.8	12	8.4	129
		Building	SA	1	16	0.6	9	0.4	6	2	31
			Sub Total	6.1	94	3.1	48	1.2	18	10.4	160
	Total Investment Cost				20,908		10,267		8,077		39,252
Replace-		Local Switch	BMA	235	1,671	110	780	0	0	345	2,451
ment	XB	(Lines)	SA	10	82	0	0	0	0	10	82
			Sub Total	245	1,753	110	780	0	0	355	2,533
		Tandem Switch	BMA	1.5	33	4.2	118	0	0	5.7	151
		Local Switch	BMA	0	0	683	4,820	509	3,948	1,192	8,768
	SPC	(Lines)	SA	0	0	27	200	24	204	51	404
			Sub Total	0	0	710	5,020	533	4,152	1,243	9,172
	Total Investment Cost				1,786		5,918		4,152		11,856
Grand Total Investment Cost					22,694		16,185		12,229		51,108

Unit: Volume of Switch: thousand line
Volume of Land & Building: thousand square meter
Cost: million Baht

Note: The summation of each volume is not equal to the total volume because of the rounding off the figures.

Table 13.2-7 Replacement Plan of XB Switches

Replacement of XB Local Switches in the BMA

Area	Unit Name	Switch TYP	Open Year	No of Line Capacity	Phase-1 1993	1994	1995	1996	1997	Phase-2 1998	1999	2000	2001	2002	Phase-3 2003	2004	2005	2006	2007
1	PNC-1	C400	1971	12000	22000														
1	PNC-2	C400	1971	10000															
1	SRR-1	C400	1970	10000		30000													
1	SRR-2	C400	1970	10000															
1	SRR-3	C400	1978	10000															
1	KKM-2	C400	1970	10000		10000													
1	SRW-1	C400	1976	10000															
1	SRW-2	C400	1976	10000	30000														
1	SRW-3	C400	1978	10000															
1	SMS-1	C400	1980	5800				5800											
1	ASD-1	C400	1979	10000			10000												
1	PTW-1	C400	1980	5384					5384										
2	BNA-1	C400	1970	12000						12000									
2	CYP-2	C400	1970	13000								13000							
2	KGC-1	C400	1971	13000				13000											
2	TMM-1	C400	1968	10000						10000									
2	STD-1	C400	1971	3250			3250												
2	TNT-1	C400	1970	5250						5250									
2	PSP-1	C400	1977	7000				7000											
2	PKG-1	C400	1979	8000								8000							
2	HAM-1	C400	1979	8000					8000										
2	TKC-1	C400	1979	10000							10000								
2	SPK-1	ARF-102	1964	5000		5000													
3	TNB-1	C400	1970	20000					20000										
3	BKB-1	C400	1971	6000						6000									
3	DKN-1	C400	1971	12000							12000								
3	PPG-1	C400	1969	3310		3310													
3	PSN-1	C400	1979	5000								5000							
3	CSW-1	C400	1979	5100						5100									
3	BGT-1	C400	1976	11000			11000												
4	ITM-1	C400	1971	10000							10000								
4	BGN-1	C400	1970	10000								10000							
4	BGS-1	C400	1970	10000				10000											
4	NWW-1	C400	1969	5300				5300											
4	DNW-1	C400	1970	3480					3480										
4	PYT-1	C400	1967	12000			17800												
4	PYT-2	C400	1976	5800															
4	LKS-1	C400	1976	6000			6000												
4	NTB-1	C400	1979	3300					3300										
4	LTP-1	C400	1979	5200				5200											
4	LTP-2	C400	1979	3200							3200								
			Total	344374	52000	48310	48050	46300	40164	38350	35200	36000	0	0	0	0	0	0	0
Total number of Lines in each phase					234824					109550					0				

Replacement of XB Local Switches in Surrounding Area

Area	Unit Name	Switch TYP	Open Year	No of Line Capacity	Phase-1 1993	1994	1995	1996	1997	Phase-2 1998	1999	2000	2001	2002	Phase-3 2003	2004	2005	2006	2007
6	SPR-1	ARF-102	1975	1000			1000												
6	SKN-1	ARF-102	1960	2000	2000														
6	NPT-1	PC1000	1970	3000		3000													
9	BPN-1	ARF-102	1979	1000			1000												
9	WNI-1	ARF-102	1979	1000				1000											
9	PCI-1	ARF-102	1979	1000					1000										
9	AYT-1	PC1000	1960	1426	1426														
			Total	10426	3426	3000	2000	1000	1000	0	0	0	0	0	0	0	0	0	0
Total number of Lines in each phase					10426					0					0				

Replacement of XB Tandem Switches in the BMA

Unit Name	Switch TYP	No of Circuits	Phase-1 1993	1994	1995	1996	1997	Phase-2 1998	1999	2000	2001	2002	Phase-3 2003	2004	2005	2006	2007
KKM T1	ARF-102	1505					1505										
PYT T2	C400	849								849							
TNB T5	C400	1357								1357							
SRW T7	C400	1952								1952							
	Total	5663					1505			4158							
Total number of Circuits in each phase			1505					4158					0				

3) Transmission Facility

a) Expansion Plan

The expansion of the transmission facility is planned based on the traffic forecast for each plan period. Table 13.2-8 shows the expansion plan in the BMA and Table 13.2-9 shows that of the Surrounding Area.

Table 13.2-8 Expanded Number of Circuits in the BMA

(Cost Unit: Million Baht)

Span	Phase-1	Phase-2	Phase-3
Junction Trunk Circuits	137,913	73,726	44,460
Long Distance (in BMA)	17,193	10,867	3,636
Total	155,106	84,593	48,096
Construction Cost	4,214	2,298	1,307

Note: 1. Unit price :7.17 thousand Baht.
2. A same unit price are used for both the junction trunk circuits and the long distance circuits

Table 13.2-9 Number of Circuits in Spur Route Transmission System

(Cost Unit: Million Baht)

Area Name	No. of Circuits		
	Phase-1	Phase-2	Phase-3
Ayutthaya	5,638	6,943	5,754
Nakhon Pathom	7,444	12,110	20,918
Samut Sakhon	5,688	5,528	3,439
Total	18,770	24,581	30,111
Construction Cost	499	2,694	2,430

Note: 1. Unit price: Phase-1, 26.57 thousand Baht (expansion of microwave system).
2. Unit price: Phase-2, 109.60 thousand Baht. (Optical fiber installation and expansion cost is estimated.)
3. Unit price: Phase-3, 80.70 thousand Baht. (Optical fiber installation and expansion cost is estimated. However, their costs are lower than that of Phase-2 because the route length will be shorter than Phase-2.)

b) Replacement Plan

Replacement of the PCM-30 systems with the optical fiber transmission systems is planned in accordance with the replacement of the crossbar switching facilities. Some PCM-30 facilities have been used for more than 20 years with the crossbar switching facilities. The fault rate of the PCM-30 transmission facilities is in a target range according to the fault data in 1990-1991 of TOT; however, the rate is extremely higher than that of the optical fiber systems in the BMA.

Hence, the PCM-30 systems are planned to be replaced 100% until the end of the long-term plan period. Table 13.2-10 shows the replacement plan.

Table 13.2-10 PCM-30 Facilities Replacement Plan

(Unit: DTI, Cost Unit: Million Baht)

Phase-1		Phase-2		Phase-3	
Span	Systems	Span	Systems	Span	Systems
BGN - LKS	31	CWT - LKS	117	PTT - PKK	34
BGN - NWW	102	KGC - LTP2	86	PKK - CWT	65
BGN - PYT	3	PNC - SKW	86	SIK - DNM	2
NTB - BGS	3	PNC - PKG	15	LKS - RIT	92
BGS - PYT	69	SKW - CYP	72	RIT - KGC	72
PYT - KKM	23	CYP - PKG	8	NGC - BGC	2
PYT - ASD	3	TNB - CSW	81	BGC - KGC	34
PNC - KKM	62	PSP - BNA	18	KGC - LTG	10
PNC - PTW	104	PSP - SPK	5	TMM - TKC	113
PNC - TMM	109	SPK - BGU	20	TMM - STD	2
KKM - PTW	61	BNA - BPL	5	TKC - TNT	50
KKM - SRR	48	TNB - BKE	88	PKG - ONT	55
KKM - TNB	53	TNB - DKN	86	DNM - LKS	131
KKM - ITSC	40	BKE - PSN	9		
ITSC - SRW	35	PSN - MSK	72		
PTW - SRW	127	MSK - NGK	43		
SRW - LTY	40	NGK - BMT	2		
SRW - TNB	85	DKN - RBN	81		
SRW - TMM	122	RBN - PPG	60		
TMM - KTI	24	LTY - DKN	155		
TOTAL	1,144	TOTAL	1,109	TOTAL	662
Cost	912	Cost	834	Cost	528

Note: Unot cost : 791.1 thousand Baht.

The optical fiber system has been applied to the transmission in the BMA since the fifth ESDP project of TOT started in 1984. Working channels of the optical fiber system in the BMA are estimated to reach 5,646 DTIs by the end of the fifth and sixth ESDP of TOT. It has already passed about ten year since the optical fiber system was introduced in the BMA. The Study Team, therefore, planned those transmission facilities which were used for ten years should be rehabilitated.