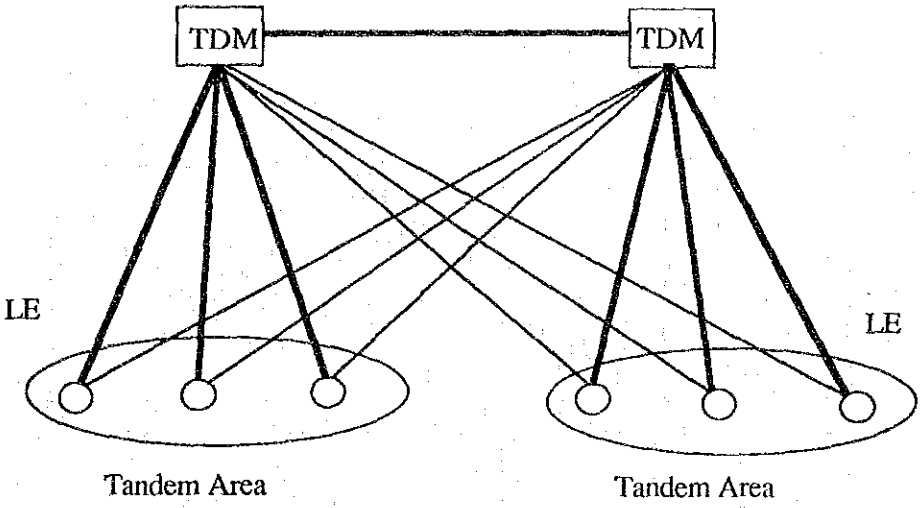


Figure 5.1.2-1 Dispersed Tandem Exchange System

Table 5.1.2 Tandem Exchange Names

	Office Name	Exchange Type	Numbering
T1	Krung Kasem	AXE-10(SPC),ARF(XB)	02-2xx
T2	Phahonyothin	NEAX-61(SPC),C-400(XB)	02-2xx
T3	Phloen Chit	NEAX-61(SPC)	02-2xx
T4	Lak Si	NEAX-61(SPC)	02-5xx
T5	Thon Buri	C-400(XB)	02-4xx
T6	Phra Khanong	NEAX-61(SPC)	02-3xx
T7	Surawong	C-400(XB)	02-2xx
T8	Lat Ya	NEAX-61(SPC)	02-4xx

The XB tandem exchanges serve local calls for the XB local exchanges. The SPC tandem exchanges serve local and long distance calls for both XB and SPC local exchanges.

A local exchange in each tandem area has the final route to its own superior tandem exchange. In case that the originating traffic volume is more than 15-20 erlangs, a high usage route is set up to another tandem exchange. A high usage route is also set up between local exchanges if the traffic volume is more than 15-20 erlangs. The modularity of a trunk group is 30 (1 DTI).

Traffic routing in the BMA is shown in Figure 5.1.2-2.

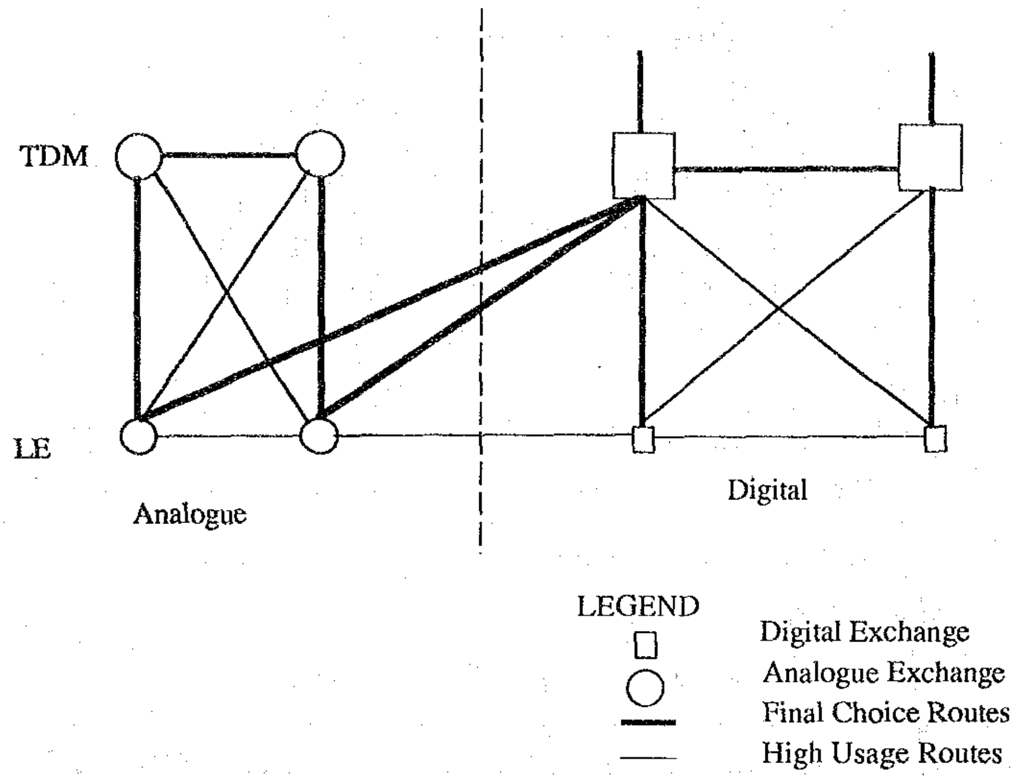


Figure 5.1.2-2 Traffic Routing in the BMA

5.1.3 Network Configuration of Special Call in Metropolitan Area

Figure 5.1.3 shows the network configuration of special calls in the Metropolitan area.

5.1.4 Network Configuration of Special Calls in the Provincial Areas

The network configuration of special calls in the provincial areas is shown in Figure 5.1.4.

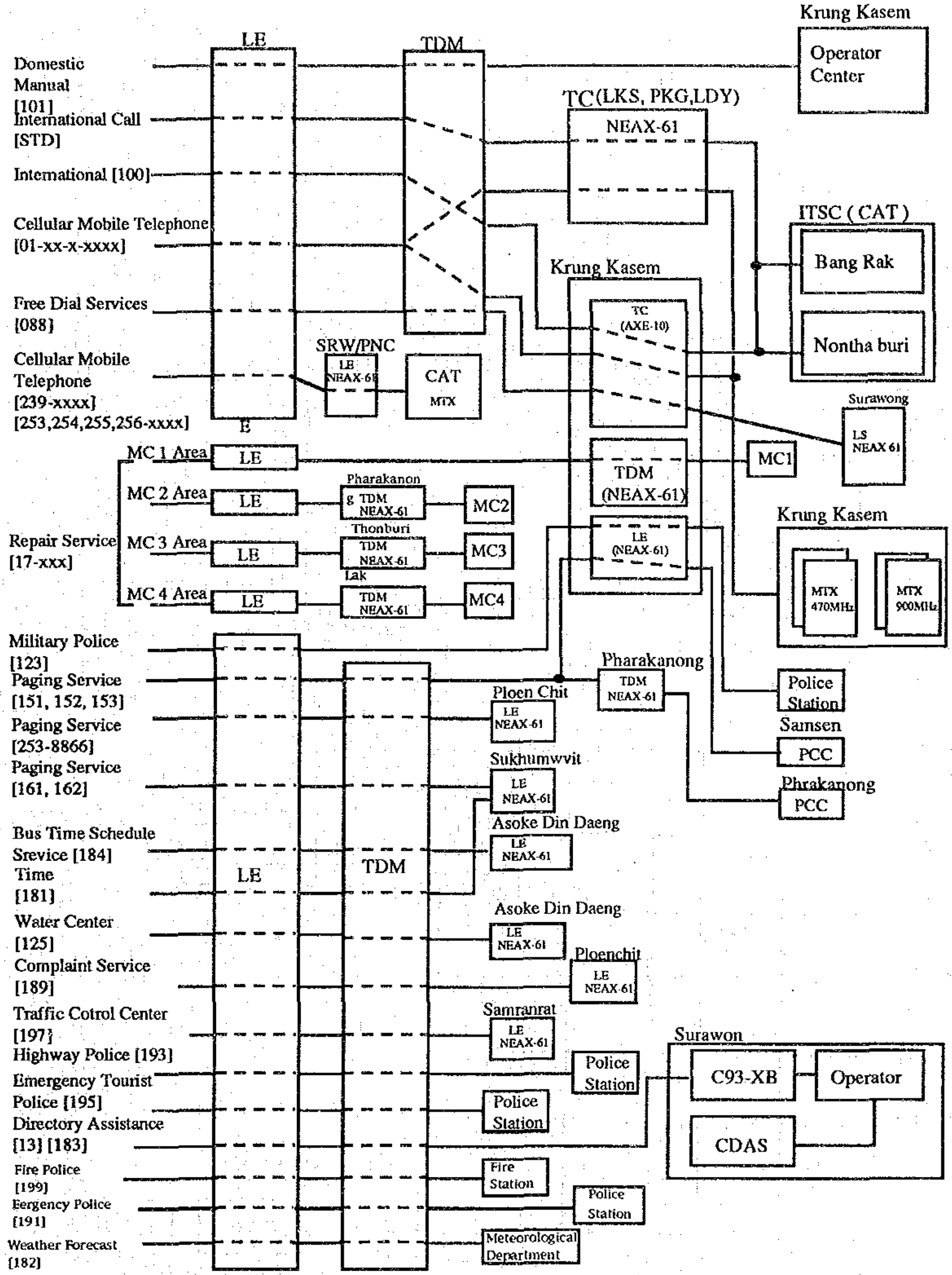


Figure 5.1.3 Network Configuration of Special Calls in the Metropolitan Area

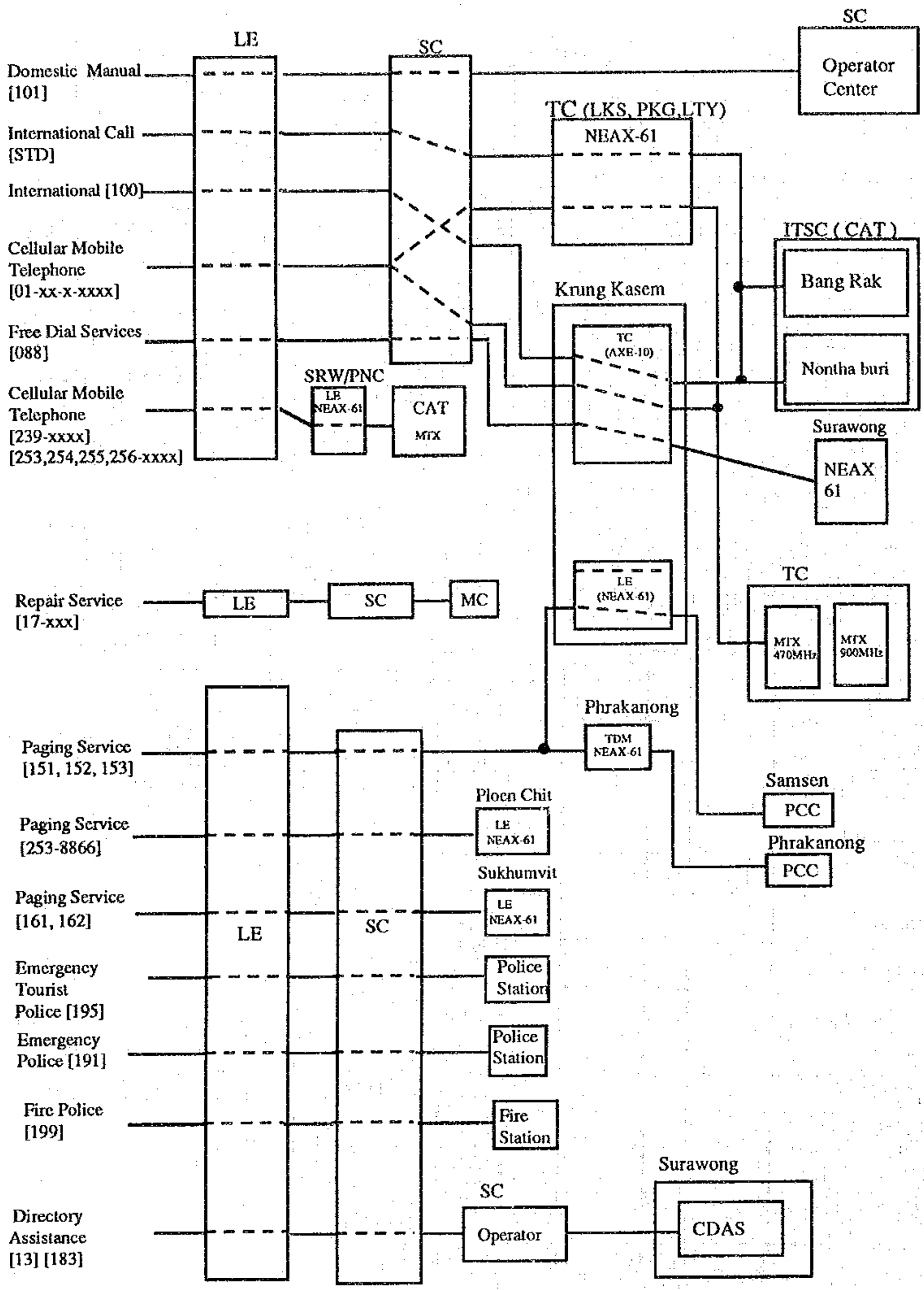


Figure 5.1.4 Network Configuration of Special Calls in the Provincial Areas

5.2 Numbering Plan

The present Numbering Plan for ordinary telephone is as follow:

- "0" is used for STD prefix
- "00" is used for ISD prefix

In case of the call to Malaysia "09" is used

The configuration of National Significant Number are:

Trunk Prefix"0"+Trunk Code +Exchange Code + Station Number

Metropolitan Area   A-BCD-EFGH

Provincial Area   AB-CD-EFGH

Table 5.2 shows the present state of Numbering Plan.

Table 5.2 Present State of Numbering Plan

		B Code									
		1	2	3	4	5	6	7	8	9	0
A Code	1		METRO"2"	PROV."3"	PROV."4"	PROV."5"		PROV."7"			
		TOT Cellular Mobile Telephone									
	2		Bangkok Metropolitan								
	3		Phetchaburi		Nakhon-Pathom	Ayutthaya	Saraburi	Prachinburi	Chonburi	Chantanuri	
	4		UdonThani	Khon Kaen	Nakhon Ratchasima	Udon Racha-thani					
	5			Chiang Mai	Lam Pang	Phitsamulok	Nakhon Sawan				
	6										
	7			Yala	Songkla	Nakhonsi-Thammarat	Phuket	Surat Thani			
	8								TOLL free		
	9	International Call to Malaysia									
	0	International Call									

5.3 Signalling System (Inter Exchange Signalling System)

TOT adopts DC line signalling and E&M signalling for line signalling, MFC-R2 for register signalling.

a) Line Signalling

i) DC line signalling uses DC loop signalling for supervisory.

ii) E&M line signalling uses out-band frequency (3825 Hz).

b) Register Signalling

The inter-register signalling is performed end to end using a 2-out-of 6 in band multi-frequency code with forward and backward compelled signalling.

MFC-R2 is designed to use six signalling frequencies (1380, 1500, 1620, 1740, 1860 and 1980 Hz) in the forward direction and six signalling frequencies (1140, 1020, 900, 780, 660,and 540 Hz) in the backward direction.

End to end signalling is a method for signalling between registers over two or more links in tandem without signal regeneration at the various switching point.

CHAPTER 6

PRESENT STATE OF TELECOMMUNICATIONS FACILITIES

CHAPTER 6 PRESENT STATE OF TELECOMMUNICATIONS FACILITIES

This chapter focuses on the present telecommunications facilities in the Study Area. At first, existing expansion projects are briefly outlined. Next, the present state of outside plant, switching, and transmission facilities are summarized. The present network management system is described in Chapter 12.

6.1 Outline of Existing Expansion Projects

TOT has carried out its Economic and Social Development Plans (hereinafter referred to as "the ESDP") to improve the telecommunication services and expanded the telecommunication facilities in order to cope with the rapidly increasing demand and public and national security in conformity with the National Economic and Social Development Plans (hereinafter referred to as "NESDP"). The relation between the NESDPs and ESDPs with respect to their periods is shown in the following Table.

Table 6.1-1 Relationship between the ESDPs and NESDPs

Year	72 76 81 86 92
NESDP	72 3rd 76
	77 4th 81
	82 5th 86
	87 6th 91
ESDP	77 4th 87
	84 5th 92
	89 UETP 92

Source: The Sixth National Economic and Social Development Plan (1987~1991), NESDB, Office of the The Prime Minister.
1986 Annual Report, Telephone Organization of Thailand.

1) Outline of the 4th ESDP (1977~1987)

The 4th ESDP was initially planned to be completed at the end of 1984, but the period was extended for three more years to 1987 mainly because of the introduction of digital stored program control switching equipment. As a result, the digitization of the telecommunication networks in Thailand has made a rapid progress. One more feature of the 4th ESDP was the introduction of Rural Long Distance Public Telephones in ampoes and king ampoes. Therefore, the communications service among the metropolitan area, urban areas in the provinces and the rural areas was improved considerably.

The telephone density in 1987 became about three times higher than that of in 1977.

2) Present State of the 5th ESDP (1984~1992)

This Project was extended from 1988 to 1992 aiming to coordinate installation work.

The objectives of the 5th ESDP are expansion of the ordinary telephone network to 1,070,000 lines, provision of telephone service to rural communities at tambon level and introduction of new services such as cellular mobile telephone, leased data and videotex services.

During the period of this project, the domestic telephone lines in operation reached one million in September of 1988. TOT is now making a considerable effort to complete the 5th ESDP by the end of FY 1992. During FY 1989, TOT was able to expand the number of telephone lines in the existing exchanges by additional 127,676 lines and to complete the construction of 407,050 cable pairs of the local network, 61 routes of the junction network or the signal transmission network, and 22 routes of the trunk transmission network.

The supply and installation of the local cable network on this project have been carried out by 8 contractors, which are firms or joint ventures, in each area divided by 8 areas in the metropolitan areas and provincial areas respectively. These contractors have been executing the detailed survey for demand forecasting, basic design, detailed design, cost estimation and construction work under the TOT approval.

3) UTEP (1989 ~ 1992)

TOT started a next expansion project (Urgent Telephone Expansion Project) as a supplementary plan to the TOT Project (1984-1992), which will last for 4 years from 1989 to 1992, to expand both the telephone network and services more extensively and to improve the quality of these services. The Urgent Telephone Expansion Project 1989 - 1992 involves the comprehensive expansion of the telephone service and other transmission services in areas where there are high demands or urgent needs.

According to the concept of this plan, 207,300 subscriber lines will be installed in high demand areas such as the Metropolitan area, Eastern Seaboard area, industrial estates and tourist areas, and in order to improve the quality of the telephone service. A line maintenance center (LMC), operator consoles and test line units will be also installed. There will be 167,900 lines in the Metropolitan area and 39,400 lines in the provincial areas. The budget for this project amounts to Bath 8,955.5 million.

After the completion of these projects, it is expected to install public telephone by about 3.6 lines per 1,000 inhabitants.

The following table shows the summaries of the 4th ESDP, 5th ESDP and UTEP.

Table 6.1-2 Summary of 4th ESDP (1977~1987)

Category	Object	Result by the end of FY 1986	Targets of FY 1987
Budget	19,894 m.Baht	18,018 m.Baht	1807.6 m.Baht
Switching	569,000 lines	542,176 lines	10,200 lines
Long distance			
Radio	50 routes	48 routes	2 routes
Optical fiber	20 routes	19 routes	1 routes
Rural long distance			
Radio	740 stations	691 stations	49 stations
Multiplex	652 stations	645 stations	7 stations
Rural long distance Telephone	468 amphoes	379 amphoes	142 amphoes

Table 6.1-3 Result of Project Implementation under ESDP 1984-1992

Items	Operating Target	Operating Result as at Sept. 30, 1989	Operating Results in FY 1989	Operating Result as at Sept. 30, 1990
Switching Equipment Work (lines)	1,057,000	571,574	127,676	699,250
Local Network Work (cable pairs)	1,687,100	544,050	407,050	951,100
Signal Transmission Work (routes)	219	140	61	201
Trunk Transmission Work (routes)	360	47	22	69
Rural Long Distance Work (location)	1,813	662	604	1,266

Table 6.1-4 Summary of 5th ESDP (1984~1992)

Category	Object	Result by the end of FY 1986	Targets of FY 1987
Budget	44,107 m.Baht	3,633 m.Baht	114 m.Baht
Land	165 plots	145 plots	
Building		15 locations	
Repeater station		21 locations	
RSU, RLU		4 locations	
Switching	1,160,754 lines	67,072 lines	
		(NEAX-61)	197,672 lines
		(AXE-10)	20,608 lines
Celluar mobile		10,447 lines	
Long distance			
1st phase	8 routes	6 routes	2 routes
Local network			44,300 pairs
Junction network	15 routes	12 routes	3 routes
Rural long distance	1,813 areas		
Telephone	(5,439 lines)		

Source: Annual Report, TOT

Table 6.1-5 Summary of UTEP (1989~1992)

Category	
Expenditure	8,955.5 Million Baht
Subscriber Line	207,300 lines
Long distance	8,000 circuits
Junction network	50,000 circuits (9 routes)
Local network	660,000 pairs/Km
Data service	6,600 terminals
Public telephones	6,000 sets
CMSC	1 LMC, 4 operator consoles 59 test line units

6.2 TOT Seventh ESDP

6.2.1 Background

TOT has been making all the efforts to meet the rapidly increasing demand of telephones through implementing carrying out many telephone expansion projects. However, the telephones installation is not enough to satisfy all the subscription demands.

The Thai government has restricted foreign loans for government and governmental enterprise projects. The limit of the foreign loans was $ 1 billion in 1986, $ 1.2 billion in 1989, and $1.5 billion in 1991 in total. On that account, the foreign loans which TOT was able to use were within the range between $100 million and $150 million. Therefore, TOT could only install one hundred thirty thousand (130,000) to one hundred fifty thousand (150,000) lines a year during the above period.

In order to improve the financial condition, privatization of TOT was once examined but was not realized since negotiations between management and the labor union did not go smoothly. Afterward, utilization of private enterprises was examined as a way of expanding the network. TOT awards private enterprises concessions and makes them install, maintain and operate telecommunication facilities on behalf of TOT. The right of ownership of the telecommunication facilities installed by the private enterprises will be transferred to TOT immediately after the installation. This is called a BTO (Build, Transfer, and Operation) scheme.

6.2.2 Transition of BTO Scheme

1) In February of 1990, MOTC (Ministry of Transports and Communications) announced that two million telephone lines and one million telephone lines will be installed respectively in Bangkok metropolitan area and provincial areas in the period of the 7th ESDP (Economic and Social Development Plan) of TOT (Oct. 1991 to Sep. 1996) by selected enterprises through an international competitive bidding.

2) In October of 1990, the Thai government selected CP (Charoen Pokphand)-BT (British Telecom) group for the Bangkok metropolitan area project and provincial area project among five groups participated in the bidding.

3) In February of 1991, the contract negotiation was finished and scheduled for signing.

4) In February of 1991, the coup d'etat occurred.

5) In June of 1991, the Thai government and CP-BT group reached a compromise at the final round of the negotiations.

6) In August of 1991, CP Telecom was awarded a contract to provide two million telephone lines only in the Bangkok metropolitan area.

6.2.3 Seventh Telephone Expansion Project

1) Outline of TOT Plan

a) Project Period : FY 1992 to 1996
b) Investment cost : one hundred fifty billion Bhat
c) Installation Plan : three million telephone lines (two million lines in BMA, one million lines in the provincial area)

2) Main Terms of Agreement (Telephone Expansion Project in BMA)

The contract between the government (TOT) and CP Telecom was finalized in August 1991. The main terms of agreement are as follows:

a) Area for installation : Bangkok metropolitan telephone service area,
b) Telephone lines to be installed : two million lines,
c) Concession period : 25 years,
d) Period for installation : 5 years,
e) Protection period : 5 years,
f) Submission of master plans:
   - Within 3 months after agreement, submission of master plan for 1992,
   - Within 6 months after agreement, submission of master plan for two million telephone lines,
g) Revenue sharing:
   CP Telecom will pay a royalty of 16 % of the total revenue to TOT as a concession fee. In addition, TOT is entitled to claim 30 % of the net profits of Telecom Asia if the return of equity of Telecom Asia ranges between 16 % to 20 %; 60 % of the net profits of CP Telecom if the return of equity of CP Telecom is more than 20 %,
h) CP Telecom does not seek any tax privileges for the project,
i) Equity share:
   CP Telecom must hold at least 80 % of the total equity in the early stage.

Note CP Telecom changed the name to Telecomasia in December of 1992.

3) Telephone Expansion Project in the Provincial Areas

The one million telephone line expansion project in the provincial areas is also planned to be executed as a BTO scheme. An international competitive bidding for the expansion project was executed in March of 1992. Afterwards, TOT has evaluated proposals submitted by four (4) company groups, and has awarded a concession for the project to TT&T (Thai Telephone & Telecom.) in July of 1992. TT&T is a joint company of Loxley Bangkok group as a group of four group companies bidded to the project.

6.3 Present State of Outside Plant Facilities

The present issues of the outside plant facilities in TOT can be summarized as follows:

1) They are in short supply,
2) They are not maintained in a good condition.

6.3.1 Configuration of Local Cable Network

TOT has been providing its telecommunication services by local cable pairs, radio subscriber links and subscriber carrier systems in its local exchange areas. The radio subscriber links are generally used in the rural areas. The subscriber carrier systems are used for areas which lack the local cable pairs. The subscriber carrier systems have been gradually decreasing as the local cables have expanded.

Generally, an exchange area has been divided into many cabinet areas which are units of demand forecasts and facility control. The local cable network can be divided into two parts. One is the primary cable part installed between exchanges and cabinets. The other is the secondary cable part installed from cabinets to subscribers. Usually, the primary cables are laid in conduit pipes buried under ground and secondary cables are installed on electric power poles.

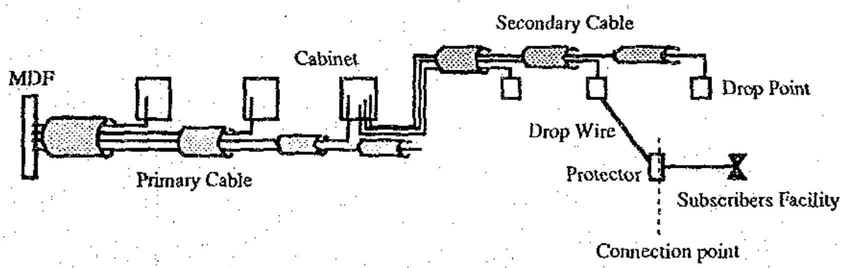


Figure 6.3.1 Configuration of Local Cable Network

TOT has adopted a fix distribution system on the local cable network. In the fix distribution system, the number of primary cable pairs to be connected with terminals in each cabinet depends on telephone subscription demand of five years ahead. And the number of secondary cable pairs to be connected with terminals in each drop point depends on telephone subscription demand of ten years ahead. Primary cable pairs and secondary cable pairs are connected with jumper wires in cabinets. Secondary cable pairs and subscriber premises equipment are connected with drop wires. Connection points between TOT facilities and subscriber premises equipment are set on protectors which usually are installed in or on customer buildings.

The fix distribution system on the local cable network has given some problems to the installation cost and the quality of the drop wires. The fix distribution system does not have enough flexibility against demand fluctuations. If actual demand at some drop point is more than forecasted demand, installation of drop wire between a subscriber premise equipment and a drop point would be impossible. In that case, drop wire would be installed between subscriber premises equipment and the next available drop point. Therefore, the fix distribution system is one of the major causes of longer and crowded drop wires.

Additionally, the fix distribution system will be an obstacle to improvement in the rate of the used local cable pairs in the cause of its inflexibility. It means increase of the expansion cost.

6.3.2 Public Telephone

Local calls, Subscriber Trunk Dialing (STD) calls can be made by public telephones. Most of them makes of a coin deposit type. TOT has recently introduced a card-operated type. Since some coins with the same face values have different shapes in Thailand, users have to select a public telephone according to their purpose and coins which they have. Furthermore, to introduce more card-operated public telephones will not only bring big convenience to users but also be effective for TOT to economize coin collection works and prevent them against coin burglaries.

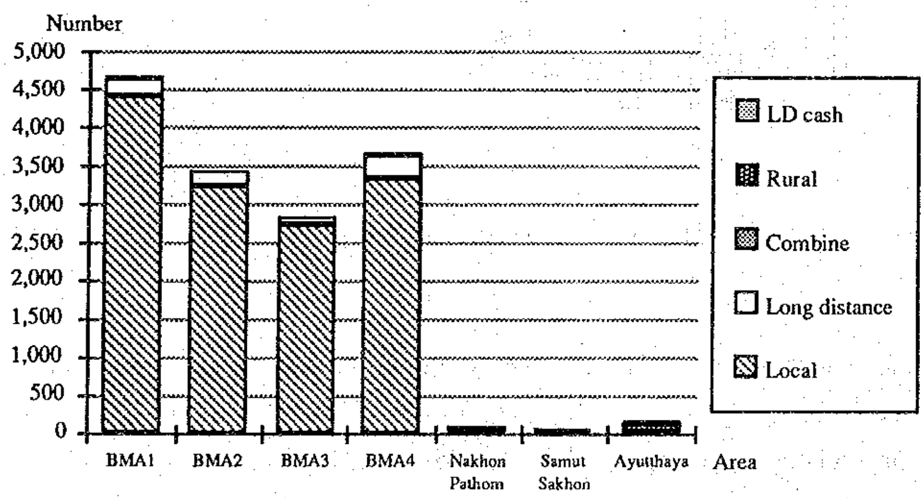


Figure 6.3.2 Number of Public Telephones in the Study Area at the End of 1990

6.3.3 Capacity of Local Cable Network

At present, TOT has about 1.47 million pairs of primary cables in the Study Area as of the end of May 1991. Approximately ninety-six percent of them, about 1.42 million pairs, have been installed in the BMA. The average occupancy rate of the local cable pairs in the Study Area is seventy-three percent. At some exchanges (about 20%) in the Study Area, it has exceeded to ninety percent level.

Figure 6.3.3-1 shows the present number of primary cable pairs in the Study Area. Figure 6.3.3-2 shows how many cable pairs are used in the Study Area. These figures show that primary pairs are in great shortage in the BMA1.

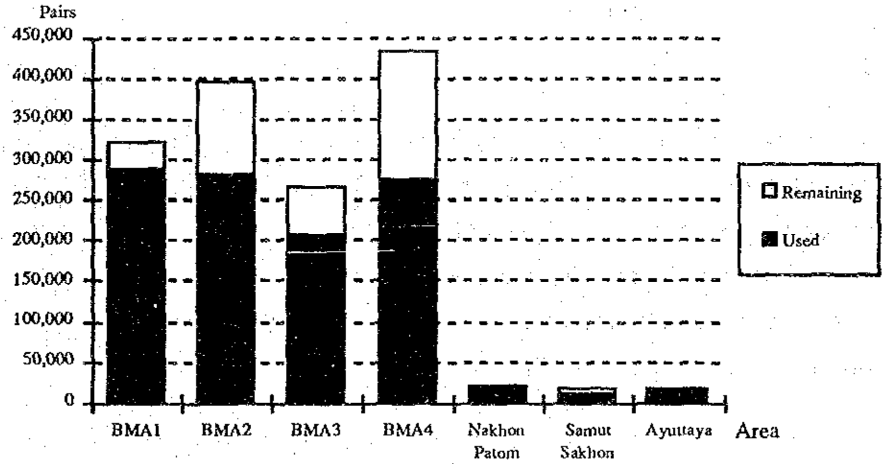


Figure 6.3.3-1 Number of Primary Cable Pairs in May 1991

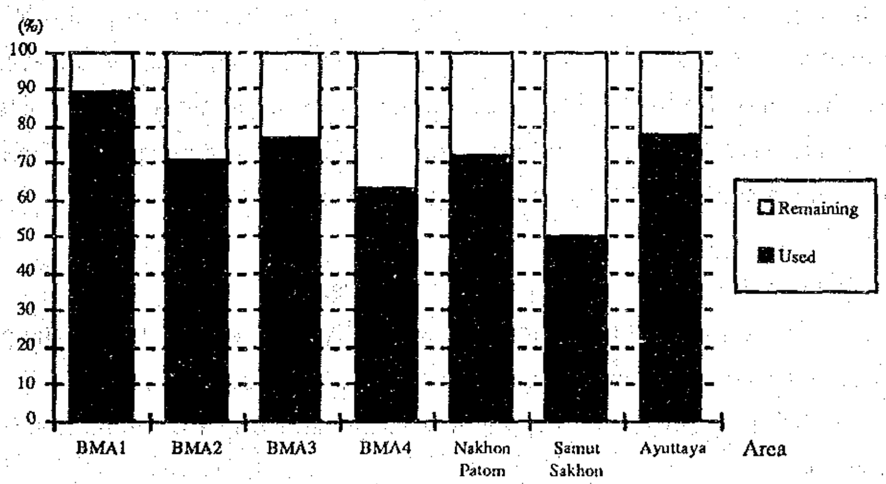


Figure 6.3.3-2 Rate of Used Primary Cable Pairs in May 1991

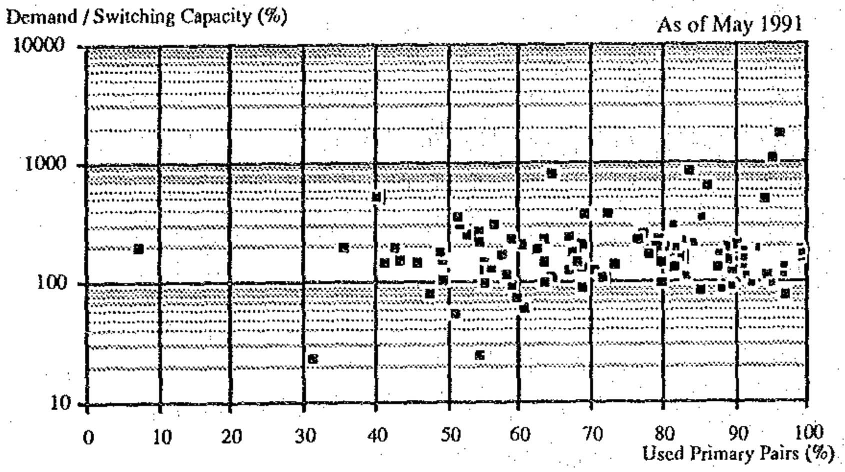


Figure 6.3.3-3 Size of Telephone Subscription Demand and Rate of Used Primary Pairs in Each Exchange in the BMA

Figure 6.3.3-3 shows the telephone subscription demand per switching capacity and the rate of used primary cable pairs at each exchange in the BMA as of May 1991. There are some exchanges which have rather low rate of used primary cable pairs in spite of that there is a large gap between the line capacity and the telephone subscription demand. This indicates that some mistakes exist in the past implementation or the design method or the micro-demand forecast for expansion of the outside plant facilities.

6.3.4 Expansion Projects

TOT has carried out most of expansion projects of the outside plant facilities by contract bases with external organizations. At present, TOT is carrying out the 5th and 6th ESDP. With regard to the Study Area, the main target of those projects is to construct about 1.43 million pair lines in the BMA and 65 thousand pair lines in the surrounding areas. The projects have been in a slow progress in the local cable expansion. On the other hand, switching capacity expansion has been successful as shown in Figure 6.3.4-1 and Figure 6.3.4-2.

The main reasons of this delay are supposed as follows:

1) lack of underground facilities (conduits) especially at the central area in Bangkok,
2) delay of construction permissions for the external organizations concerned,
3) delay of TOT acceptance for the telephone subscription demands forecasted by contractors,
4) limitation of work time for construction of the underground facilities at the central area in Bangkok,
5) practice of process tests by the census method.

The 7th project will use a BTO method; however it is necessary for TOT to consider the best way for constructing outside plant facilities for future projects because a large amount of local cables must be installed after the 7th project. The present work flow of the project with regard to the outside plant is shown in Figure 6.3.4-3.

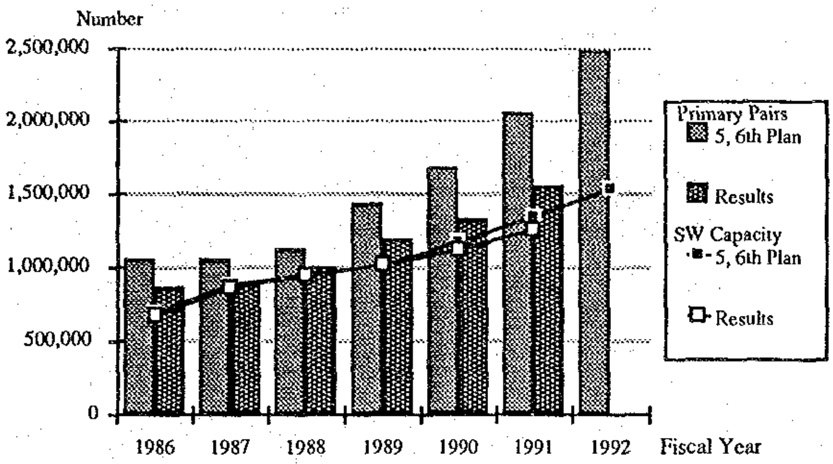


Figure 6.3.4-1 Progress Condition of the 5th & 6th Projects (BMA)

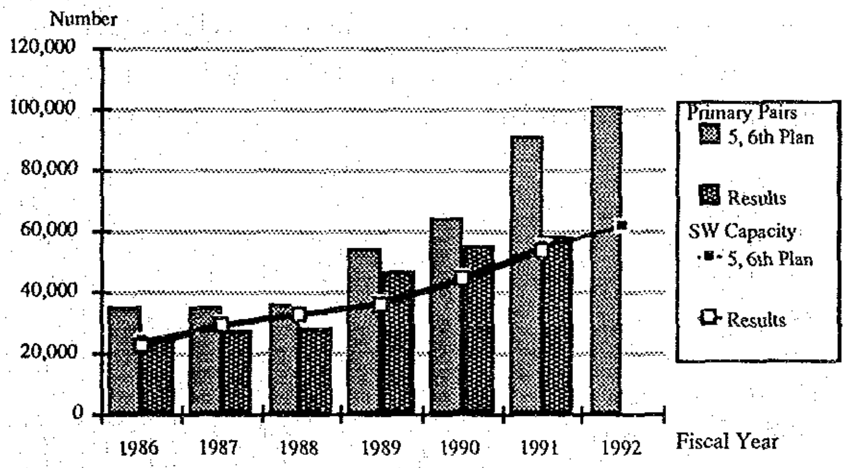


Figure 6.3.4-2 Progress Condition of the 5th & 6th Projects (Surrounding Area)

Note; The number of result in 1991 in Figure 6.3.4-1 and Figure 6.3.4-2 were estimated with increase from October 1990 to May 1991.

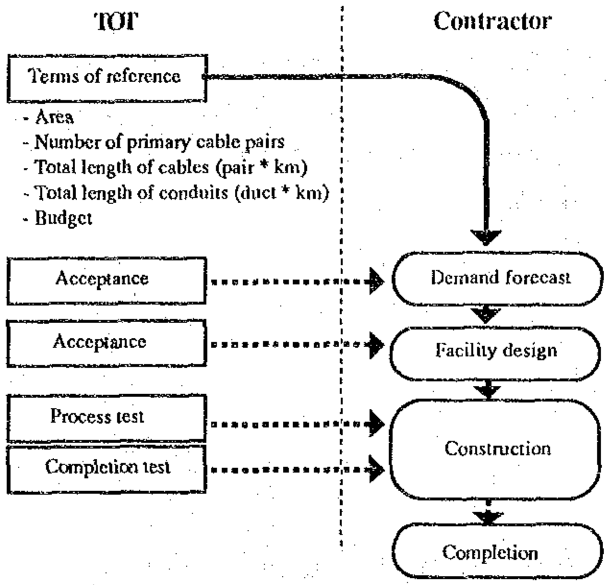


Figure 6.3.4-3 Work flow of the Expansion Project

6.3.5 Quality of Local Cable Network

Figures 6.3.5-1 and 6.3.5-2 show the data of service breakdowns in the BMA and the provincial areas. The number of faults per connected line has steadily decreased from 1985 in the BMA. The number of repairs has not been increasing in spite of the facility expansion. On the other hand in the provincial areas, the number of faults per connected line has not decreased since 1984, and the number of repairs has been increasing with the facility expansion.

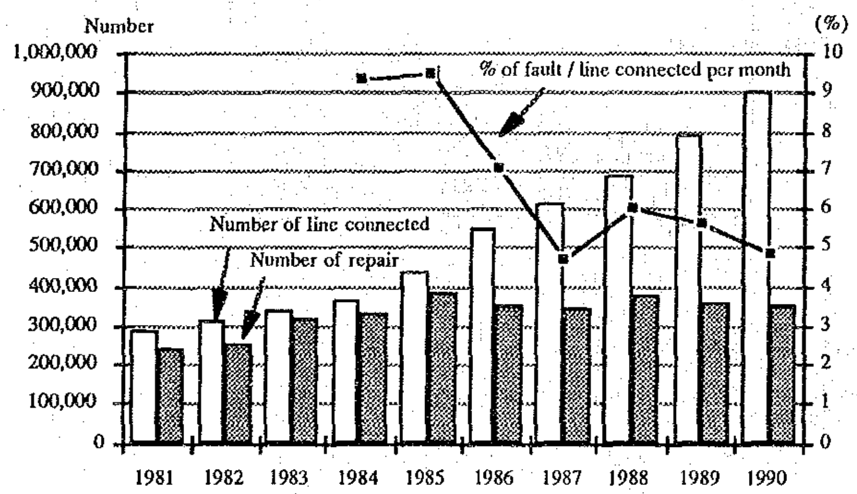


Figure 6.3.5-1 Number of Repairs and Percentage of Faults per Line Connected per Month in the BMA

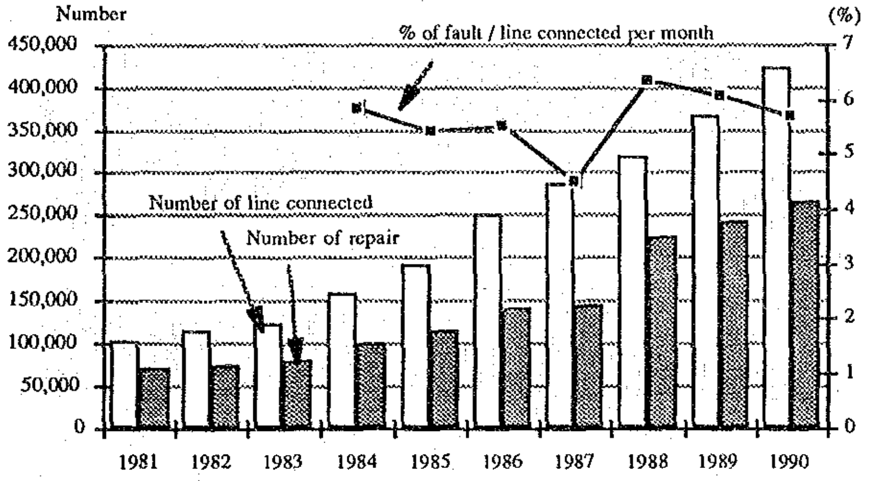


Figure 6.3.5-2 Number of Repairs and Percentage of Faults per Line Connected per Month in the Provincial Area

Figures 6.3.5-3 and 6.3.5-4 show the contents of the faults. The number of faults on telephone sets, drop wires and cables account for about eighty-one percent of all faults in the BMA and about sixty-four percent of all faults in the provincial areas. Both areas have the same fault conditions. The main causes of the faults exist in the outside plant. In the BMA, the percentage of telephone set faults have been increasing and the percentage of test of good condition has been decreasing. In the provincial area, the percentage of telephone set faults has been increasing also, but the percentage of drop wire faults has been decreasing year by year. According to the recent data from the maintenance center, approximately 87 percent of the telephone set faults are related to public telephones.

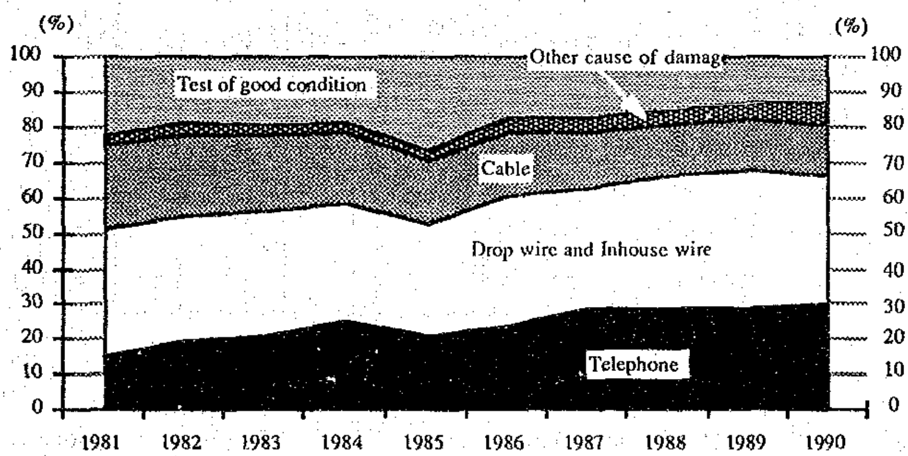


Figure 6.3.5-3 Percentage of Repairs Classified by Each Category in the BMA

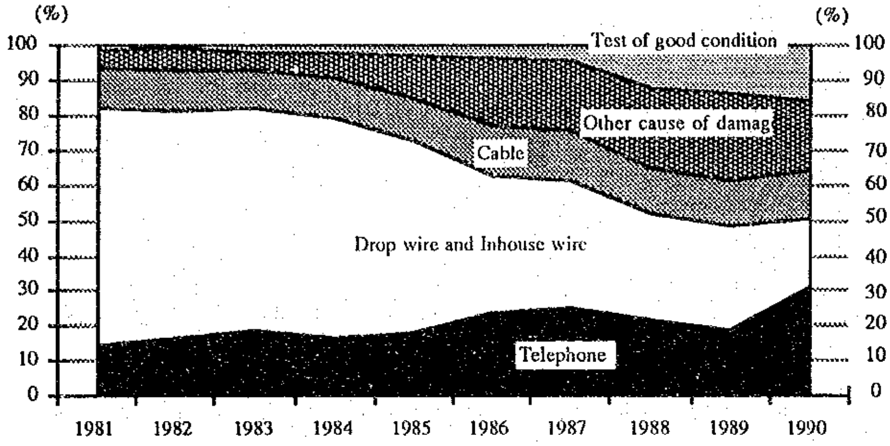


Figure 6.3.5-4 Percentage of Repairs Classified by Each Category in the Provincial Area

Figure 6.3.5-5 shows that the number of repairs on telephone set damages has been increasing according to the increase of the number of public telephones. The major cause of the faults is damages made by people such as telephone users and coin thefts, deformed coins stayed in the coin slots. TOT has recently introduced card-type public telephones. It is effective to reduce damages caused by stealing coins.

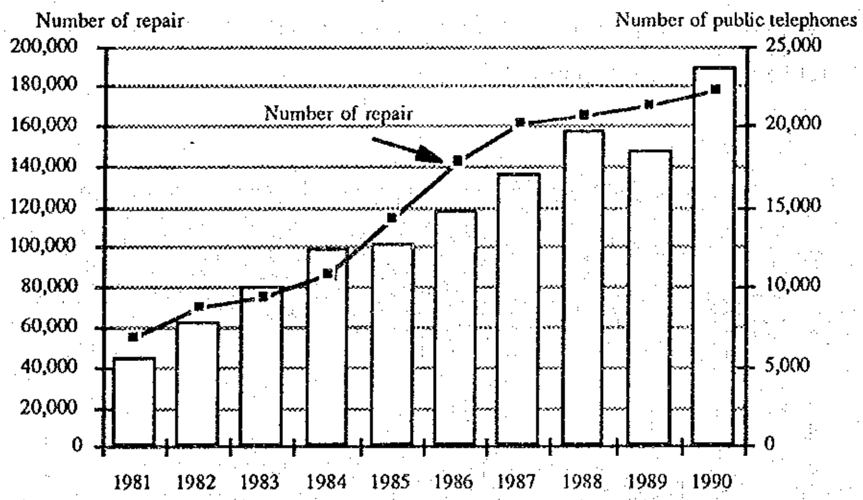


Figure 6.3.5-5 Number of Public Telephones and Number of Repairs on Telephone Sets in the Whole Kingdom

Figure 6.3.5-6 shows the trend of the number of faults on drop wires and cables. The number of faults occurred on drop wires has decreased in recent years. This is a result of efforts made by TOT such as reshape works of drop wires; however, reshape is not a fundamental solution but just a patch work. A fundamental problem of drop wires is length. The average length of drop wires installed in 1990 is 110 meters in the BMA and 220 meters in the provincial areas. This condition is caused by the local cable distribution system as mentioned before. These long drop wires cause a high rate of faults. Because faults on drop wires usually occur when something rubs against them. Faults will increase in proportion to the length of drop wires.

In addition, some repair marks on drop wires were left in temporary repair jobs without any protection measure. Those drop wires will fall into faulty conditions instantly. Therefore, improvement of those conditions will give better quality on the drop wires.

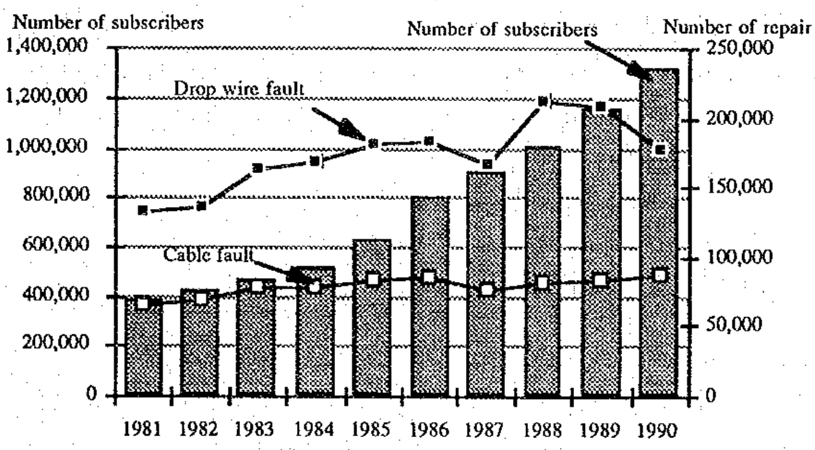


Figure 6.3.5-6 Number of Subscribers and Number of Repairs on Cable and Drop Wire in the Whole Kingdom

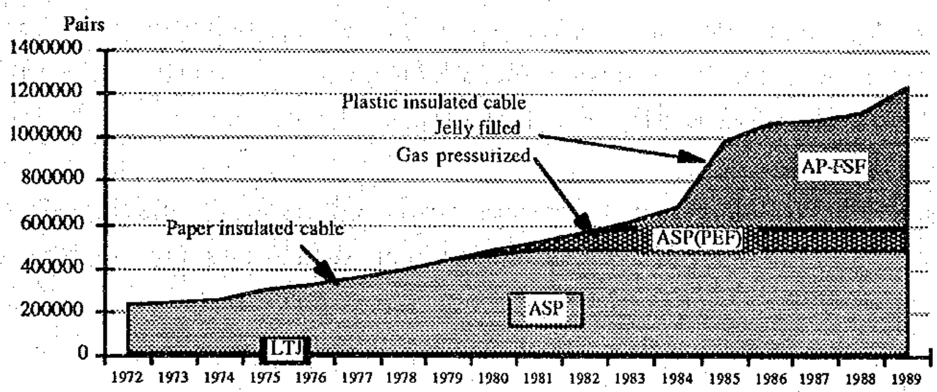


Figure 6.3.5-7 The Share of Primary Cable Pairs Classified by Type of Cable in the BMA

As for the quality of the local cables, Figure 6.3.5-6 shows that the number of faults on the local cables has not increased after 1984. Figure 6.3.5-7 shows that jelly filled cables have been introduced and increasing rapidly after 1983.

Reduction of the number of faults on the local cables can not be expected without changing the cables from the paper insulated type to the jelly filled type.

Many secondary cable lines have been installed on one electric power pole and hence there is not enough space to install new cables. If TOT would like to install new cables on electric power poles, it is necessary to replace the existing cables with another larger capacity cables.

Additionally, many cable closures are not restored completely after repair work of cable faults. This situation also causes faults on the cable pairs instantly. Therefore, those closures should be restored completely or changed to new types as soon as possible.

6.3.6 Characteristics of Local Cables

TOT has a plan to introduce ISDN services in the near future. For the basic rate ISDN services, TOT should make the best use of the existing local metallic cable network. In order to select the most suitable ISDN digital transmission system, it is necessary to investigate the existing local cable network characteristics.

There are two kinds of digital transmission methods for metallic subscriber loops. One is the Echo Canceler Transmission Method, and the other is the Time Compression Multiplex Method. Both methods have their own distinctive features. According to the Progress Report of Investigation on Local Cable Network for ISDN and some specifications of local cables of TOT, the both methods can be adopted to the existing local cable network.

The investigated characteristics and some specifications of the local cables of TOT are shown below. There are some unfinished investigation items such as bit error rate, burst error rate through the metallic subscriber loops. Those items should be investigated in the trial introduction of the ISDN services which will be started in 1992.

a) Conclusion of the Investigation

i) 91% of local lines have less than 4,000 m of length.
ii) 79% of local lines have a single conductor diameter.

iii) There is no bridge tap.
iv) 83% of drop wires have less than 100 m of length.
v) 94% of local lines have less than 1,000 Ω of loop resistance.
vi) 95% of local lines have less than 41dB and 48dB of line loss at 80kHz and 160kHz respectively.
vii) 90% of local lines have less than 20mV and 700mV of AC and DC voltage respectively.

Details are shown in APPENDIX.

Table 6.3.6-1 Comparison between the Echo Canceler Transmission Method and the Time Compression Multiplex Method

Item	Echo Canceler Transmission (EC)	Time Compression Multiplex (TCM)
Transfer Rate	Information Rate	approx. Information Rate * 2
Burst Phase Synchronization	needless	need
Propagation Delay Variance	little	longer than EC
Waveform Distortion by Bridge Blanch	less than TCM	big
Hardware	complexity	simple
Transmission Performance		
Transmission Loss	middle	high
Influence by Impulse Noise	middle	high
Near End Crosstalk	high	low
Far End Crosstalk	low	low
Induced Noise by Broadcast Signal	low	high
Introduced Countries	United State of America, Canada, France, Germany, United Kingdom	Japan

Table 6.3.6-2 Type of the Existing Cables of TOT

Type of Cable		ASP	AP	AP-FSF
Conductor Twisting		Pair		
Conductor Insulation		Paper	Polyethylene	Foamed Polyethylene
Mutual Capacitance	at 1kHz	0.052 µF/km		
Mutual Conductance	at 1kHz	2 µmho/km		
Far End Crosstalk Loss (RMS)	at 150 kHz	68 dB/km	67.8 dB/km	
Far End Crosstalk Loss (pair-pair)	at 150 kHz	57.8 dB/km		
Near End Crosstalk Loss	at 772kHz	56-81 dB (depend on unit size)		
Insulation Resistance	at 100~550 DC v	1,600 MΩ•km		

ASP : Paper or Wood Pulp Insulation STALPETH Sheathed Cable
AP : Polyethylene Insulation ALPETH Sheathed Cable
AP-FSF : Form/Skin Insulation ALPETH Sheathed Filled Cable

Table 6.3.6-3 Loop Resistance and Attenuation of Cable Pair

Conductor Diameter	mm	0.4	0.5	0.65	0.9
Conductor Loop Resistance	Ω/km	144.40	90.20	57.10	28.50
Attenuation at 1 kHz	dB/km	1.80	1.43	1.11	0.78
Attenuation at 150 kHz	dB/km	11.35	8.31	6.20	4.40
Attenuation at 772 kHz	dB/km	22.83	18.52	14.63	10.40

6.4 Switching Facilities

6.4.1 Status of Switching Facilities

The ordinary telephone network is composed of the following switches. In the BMA, at the end of 1990, the network is composed of the following office rank:

- Tertiary Center (TC)	4 switches	Krung Kasem, Phra khanong, Lat Ya and Lak Si
- Tandem Center (TDM)	10 switches	Krung Kasem, Pahonytothin, Ploenchit, Lak Si, Thon Buri, Phara Khanong, Surawong and Lat Ya
- Local Exchanges (LE)	100 switches	

In the Surrounding Area, at the end of 1990, the network is supported by the following office rank:

- Secondary Center (SC)	2 switches	Nakhon Pathom, Ayuthaya
- Primary Center (PC)	1 switches	Samut Sakhon

These two SCs in Nakhon Pathom and Ayuthaya have functions of a PC and LE. The PC in Samut Sakhon also functions as a combined switching type of a LE.

Table 6.4.1-1 and Figure 6.4.1-1 show how the number of the switches has increased for the past five years throughout the whole Kingdom.

For the past five years, two XB switches were replaced by SPC digital switches in the BMA.

Table 6.4.1-1 Development of Number of Switches

		1986	1987	1988	1989	1990
Total number of switches	BMA	116	117	115	117	125
	Prov..	239	242	281	317	362
	(Prov.)	(19)	(19)	(19)	(19)	(18)
Number of digital switches	BMA	73	74	72	75	84
	Prov.	137	150	189	223	270
	(Prov.)	(12)	(12)	(12)	(12)	(11)
Number of analog switches	BMA	43	43	43	42	41
	Prov.	102	92	92	94	92
	(Prov.)	(7)	(7)	(7)	(7)	(7)

Note: The figure in ( ) shows the number of surrounding area and is included in the number of Prov.

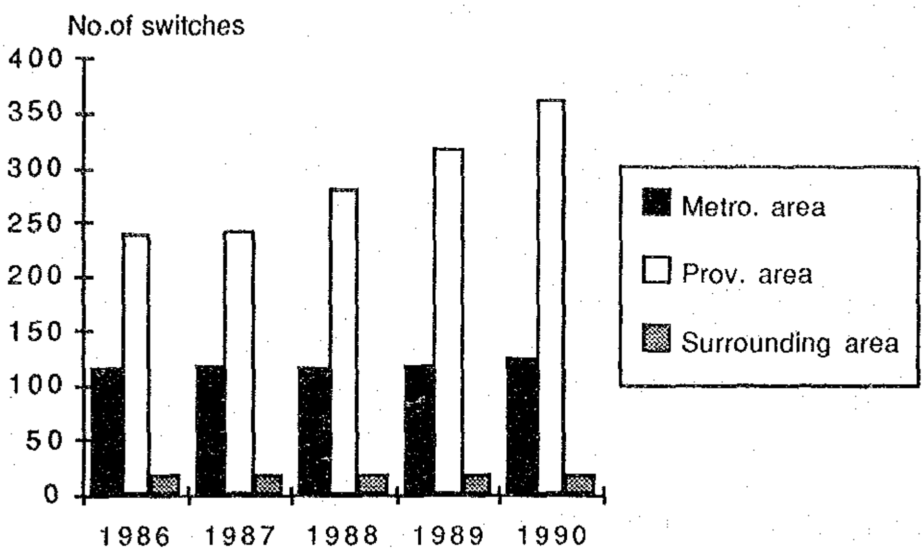
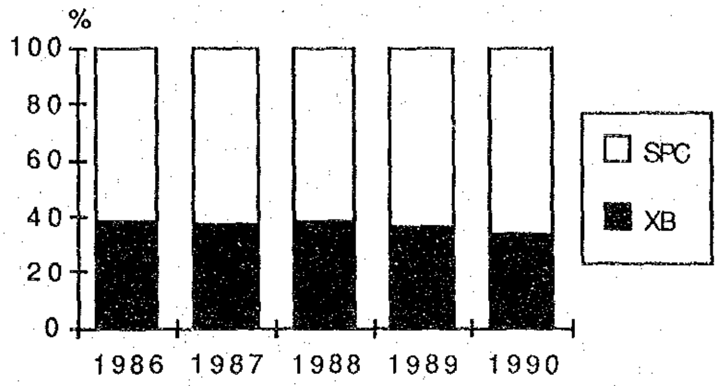
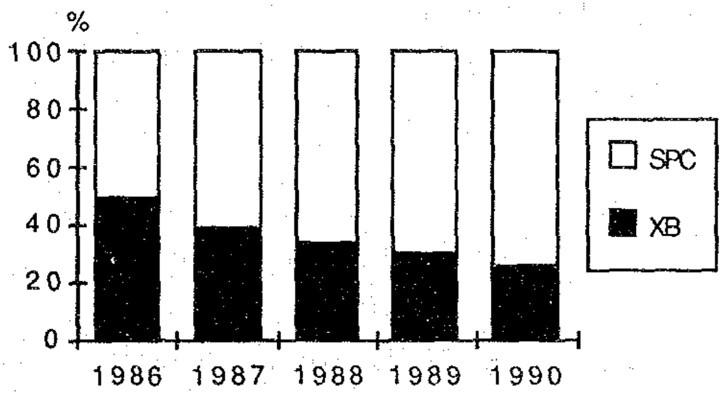


Figure 6.4.1-1 Development of Number of Switches

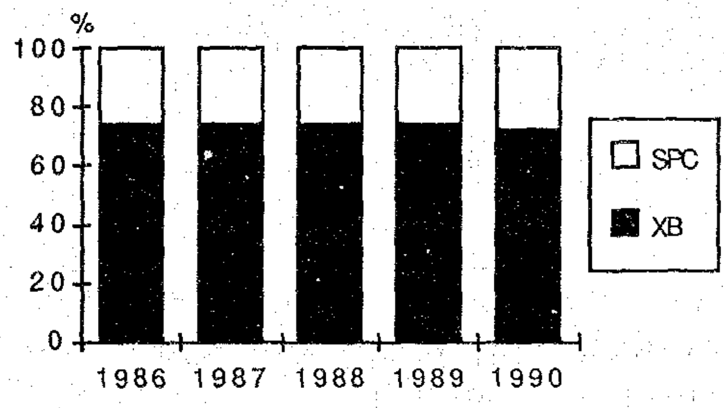
Figure 6.4 1-2 shows the shaves of XB and SPC switches in the BMA, the provincial area and the Surrounding Area.



(a) BMA



(b) Provincial Area



(c) Surrounding Area

Figure 6.4.1-2 Ratio of Number of XB and SPC Switches

Table 6.4.1-2 and Figure 6.4.1-3 show the development of line capacities and the connected lines for the past five years.

Table 6.4.1-2 Development of Line Capacities and Connected Lines

		1986	1987	1988	1989	1990
No. of	Metro .	670,782	861,392	946,574	1,011,498	1,125,602
line capacities	Prov.	337,227	389,710	439,106	481,940	559,358
sub total	(PROV.)	24,170	30,186	33,258	36,330	40,874
No. of digital	Metro .	306,408	497,018	582,200	656,924	781,028
switch line capacities	Prov.	209,666	254,064	301,860	342,494	423,628
sub total	(PROV.)	14,144	20,160	23,232	26,304	30,848
No. of connected lines	Metro .	548,080	614,707	686,151	792,203	900,941
total	Prov.	250,832	286,915	319,721	365,811	423,581

Note: The Figure in ( ) show the number of surrounding area and is included in the number of Prov.

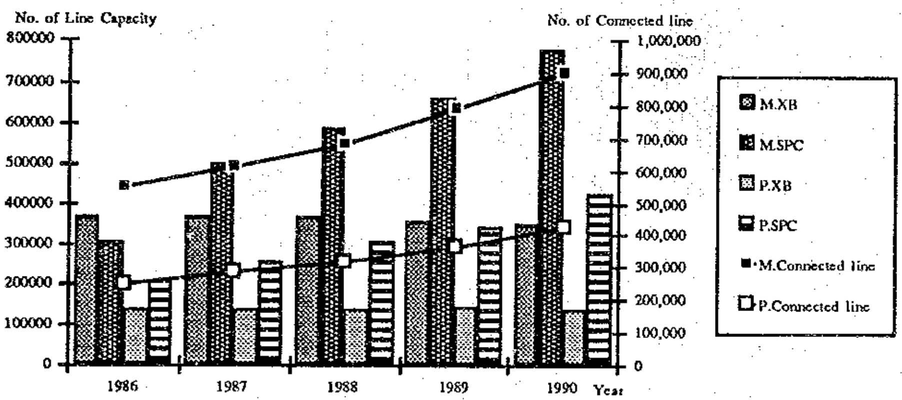
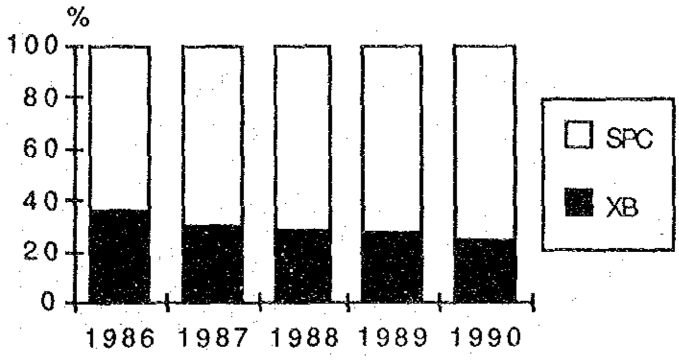
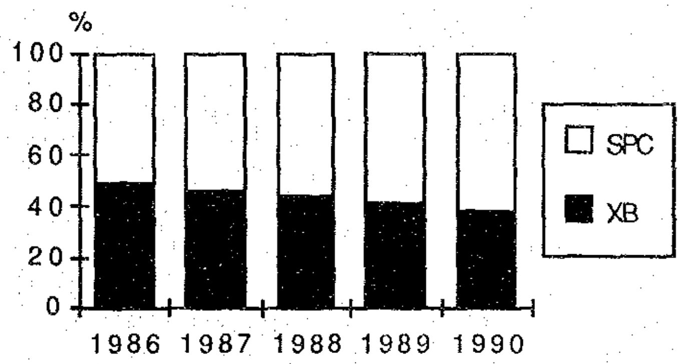


Figure 6.4.1-3 Development of Line Capacity and Connected Line

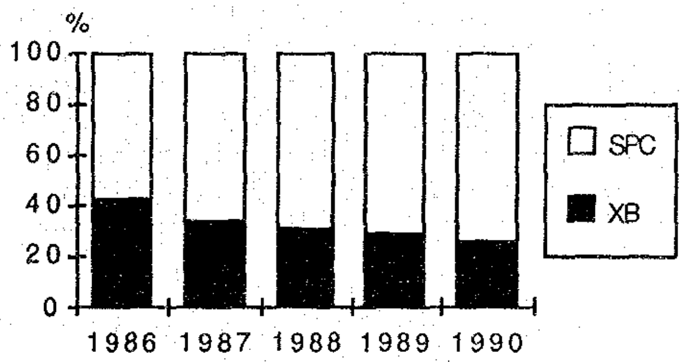
Through the fifth and sixth projects, the SPC switch capacities have been increased to reduce the large number of waiting applicants. As a result, the share of XB switches in the total amount of line capacity has been gradually decreased as shown in Figure 6.4.1-4.



(a) BMA



(b) Provincial Area



(c) Surrounding Area

Figure 6.4.1-4 Line Capacity Shares of XB and SPC Switches

6.4.2 XB Switch

Three kinds of cross bar switches: C400, ARF-102 and PC1000, have been used as tandem switches for PCs and LEs throughout the whole Kingdom.

Table 6.4.2 lists these XB switches in the BMA and provincial area to be studied.

Table 6.4.2 XB Switches in the Study Area

Area	Unit Name	Opening Year	Line Capacities	Type	Area	Unit Name	Opening Year	Line Capacities	Type
1	PNC-1	1971	12000	C400	3	TNB-1	1970	20000	C400
1	PNC-2	1971	10000	C400	3	BKE-1	1971	6000	C400
1	SRR-1	1970	10000	C400	3	DKN-1	1971	12000	C400
1	SRR-2	1970	10000	C400	3	PPG-1	1969	3310	C400
1	SRR-3	1978	10000	C400	3	PSN-1	1979	5000	C400
1	KKM-2	1970	10000	C400	3	CSW-1	1979	5100	C400
1	SRW-1	1976	10000	C400	3	BGT-1	1976	11000	C400
1	SRW-2	1976	10000	C400					
1	SRW-3	1978	10000	C400	4	ITM-1	1971	10000	C400
1	SMS-1	1980	5800	C400	4	BGN-1	1970	10000	C400
1	ASD-1	1979	10000	C400	4	BGS-1	1970	10000	C400
1	PTW-1	1980	3384	C400	4	NWW-1	1969	5300	C400
					4	DNM-1	1970	3480	C400
2	BNA-1	1970	12000	C400	4	PYT-1	1967	12000	C400
2	CYP-2	1970	13000	C400	4	PYT-2	1976	5800	C400
2	KGC-1	1971	13000	C400	4	LKS-1	1976	6000	C400
2	TMM-1	1968	10000	C400	4	NTB-1	1979	3300	C400
2	STD-1	1971	3250	C400	4	LTP-1	1979	5200	C400
2	TNT-1	1970	5250	C400	4	LTP-2	1979	3200	C400
2	PSP-1	1977	7000	C400					
2	PKG-1	1979	8000	C400	6	SPR-1	1975	1000	ARF-102
2	HAM-1	1979	8000	C400	6	SKN-1	1978	2000	ARF-102
2	TKC-1	1979	10000	C400	6	NPT-1	1971	3000	PC1000
2	SPK-1	1964	5000	ARF-102					
					9	BPN-1	1979	1000	ARF-102
					9	WNI-1	1979	1000	ARF-102
					9	PCI-1	1979	1000	ARF-102
					9	AYT-1	1973	1426	PC1000

6.4.3 Expansion Project

The fifth expansion Project has been carried out since 1984, and the sixth expansion project is implemented from 1989 to 1992 in parallel with the fifth expansion project.

After the fifth and sixth expansion projects, it is expected that the number of switches will increase from 125 (including RSU) to 391 in the BMA, and those in the Surrounding Area will increase from 18 (including RSU) to 44. The number of line units will increase from 1,125,602 to 1,536, 456 in the BMA, from 40,874 to 61,466 in the Surrounding Area as shown in Table 6.4.3-1 and Table 6.4.3-2. Table 6.4.3-3 shows the expected number of tandem circuits after the fifth and sixth expansion projects. Table 6.4.3-4 shows the expected number of toll circuits after the fifth and sixth expansion projects in the BMA.

Table 6.4.3-1 Expected Number of Switches after the Fifth and Sixth Expansion Projects

Metropolitan Area	Total	Surrounding Area	Total
C400	40	PC1000	2
ARF-102	1	ARF-102	5
sub total	41	sub total	7
MSU NEAX-61	39	MSU NEAX-61	1
RSU NEAX-61	149	RSU NEAX-61	10
MSU NEAX-61 LSI	18	RLU NEAX-61	1
RSU NEAX-61 LSI	49	MSU NEAX-61 LSI	1
RLU NEAX-61 LSI	1	MOBILE NEAX-61	2
MSU(EWSD)	3	MSU AXE-10	2
RSU(EWSD)	88	RSU AXE-10	17
MOBILE NEAX-61	3	RLU AXE-10	3
sub total	350	sub total	37
TOTAL	391	TOTAL	44

Source; Tentative Plan, May 1991 by TOT

Table 6.4.3-2 Expected Number of Line Capacities after the Fifth and Sixth Expansion Projects

Metropolitan Area	Total	Surrounding Area	Total
C400	339,374	PC1000	4,426
ARF-102	5,000	ARF-102	6,000
sub total	344,374	sub total	10,426
MSU NEAX-61	670,418	MSU NEAX-61	9,840
RSU NEAX-61	151,192	RSU NEAX-61	7,328
MSU NEAX-61 LSI	202,240	RLU NEAX-61	256
RSU NEAX-61 LSI	54,784	MSU NEAX-61 LSI	4,096
RLU NEAX-61 LSI	256	MOBILE NEAX-61	2,000
MSU(EWSD)	21,504	MSU AXE-10	11,264
RSU(EWSD)	89,088	RSU AXE-10	15,872
MOBILE NEAX-61	2,600	RLU AXE-10	384
sub total	1,192,082	sub total	51,040
TOTAL	1,536,456	TOTAL	61,466

Source; Tentative Plan, May 1991 by TOT

Table 6.4.3-3 Expected Number of Tandem circuits after Fifth and Sixth Expansion Projects

SPC Tandem	No of circuits	XB Tandem	No of circuits
KKM T-1	11,037	SRW T-7	1,952
PYT T-2	9,531	TNB T-5	1,357
PNC T-3	24,894	PYT T-2	849
LKS T-4	26,309	KKM T-1	1,505
PKG T-6	24,225	TOTAL	5,663
LTY T-8	19,999		
TOTAL	115,995		

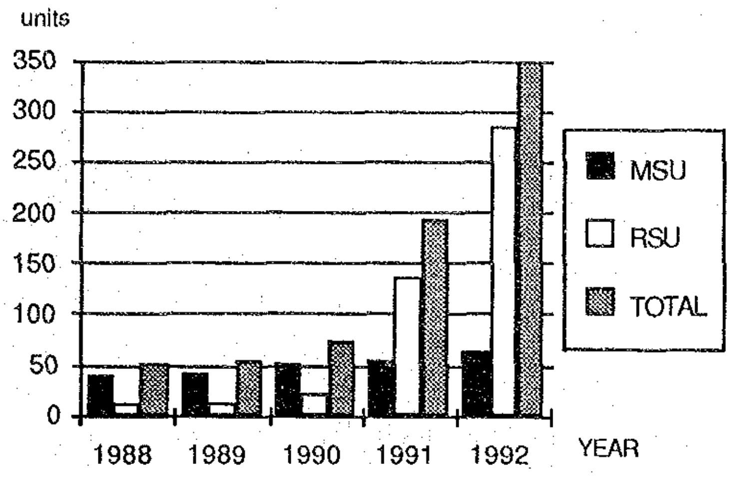
Source : Fifth and Sixth Project Routing Plan of TOT

Table 6.4.3-4 Expected Number of Toll Circuit after Fifth and Sixth Expansion Project in the BMA

	LKS TC	PKG TC	LTY YC
Total Toll Circuit	2,790	2,310	3,390

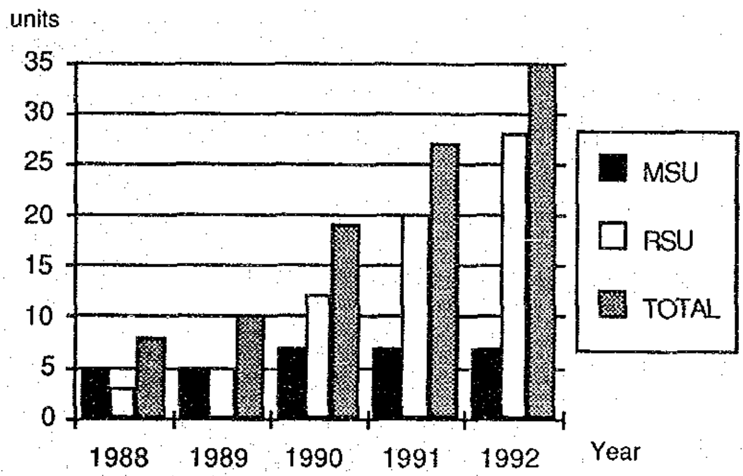
Source : Fifth and Sixth Project Routing Plan of TOT

All of the switches installed during the fifth and sixth projects are SPC switches. The number of SPC switches will rapidly increase in the BMA as shown in Figure 6.4.3-1.



Source: Telephone Statistics 1990 by TOT

Figure 6.4.3-1 Number of SPC Switches after the Fifth and Sixth Expansion Projects in the BMA



Source: Telephone Statistics 1990 by TOT

Figure 6.4.3-2 Number of SPC Switches after the Fifth and Sixth Expansion Projects in the Surrounding Area

6.5 Transmission Facilities

6.5.1 Introduction

TOT is still executing the 5th expansion project, which was started in 1984 and is expected to be completed by the end of 1992. The 5th expansion project enables most of the Primary Centers (PCs) in the country be connected by digital transmission systems. This means that SPC switching systems can be installed in the whole Kingdom. Many major cities will be connected by looped or doubled transmission links in the long-distance transmission routes by microwave systems and optical fiber systems. This also means that reliability of the telecommunications network is greatly improved.

On the other hand, the main exchange offices in the BMA will be connected to each other by looped or doubled optical fiber systems installed in the 5th expansion project and the existing metallic PCM 30 systems.

In addition to the fifth expansion project, TOT has started the sixth expansion project (UTEP) to meet goals of the national economic and social development plan. In UTEP, TOT intends to increase the telephone capacity by installing approximately 207,300 subscriber lines and related transmission systems.

Owing to the two projects, it is expected that sufficient long-distance and junction trunk lines will be provided for traffic increase. Reliability of the telecommunication networks will be improved much greater than before.

Advanced supervisory systems for both the long-distance and the junction transmission networks will be also established by the 5th expansion project. It is expected that the operation and maintenance of transmission systems would be managed more smoothly and effectively than before by the completion of these systems.

6.5.2 Long-distance Transmission System

1) Digital Transmission System

a) The long-distance digital transmission system in the Study Area is shown in Figure 6.5.2-1. The number of circuits of the long-distance transmission system in the Study Area at the end of the fifth expansion project is shown in Table 6.5.2-1 to Table 6.5.2-3. The figure shows that the Secondary Centers (SCs) have been connected to Bangkok with double routes with microwave systems and an optical fiber systems; however, Samut Sakhon as a Primary Center (PC) is still connected to Bangkok via Nakhon Pathom only by a microwave system.

Samut Sakhon is expected to be an important PC because many industrial estates and residences have been built recently. Additional transmission routes should be, therefore, considered to secure Samut Sakhon as a PC against any microwave system down.

b) From the viewpoint of transmission system reliability in the network of the southern area, both microwave and optical fiber systems pass through the Nakhon Pathom SC. Nakhon Pathom fortunately has never been damaged by either typhoon or flood; however, providing security measures against disasters is necessary because it is located in a key position.

c) Long-distance Digital Transmission System in Bangkok

The long-distance transmission network in the BMA after fifth and sixth expansion projects is shown in Figure 6.5.2-2. This figure shows that digital microwave transmission systems connect key exchange offices in the BMA such as Lat Ya (LTY), Krung Kasem (KKM), Phra Khanong (PKG) and Lak Si (LKS). LKS is the gate office to the northern and the northeastern areas. PKG is the gate office to the eastern and the northeastern areas. LTY is the gate office to the southern area.

Generally, a microwave transmission system requires a shorter period to reconstruct than an optical fiber transmission system when they are destroyed by disasters or damaged.

Therefore, it is better to continue using microwave systems for securing the telecommunications networks against disasters. TOT now considers to continue using microwave transmission systems in the BMA with another frequencies on a case by case basis. Since many skyscrapers are being constructed in the BMA, it becomes important how to avoid interruption of microwave passes.

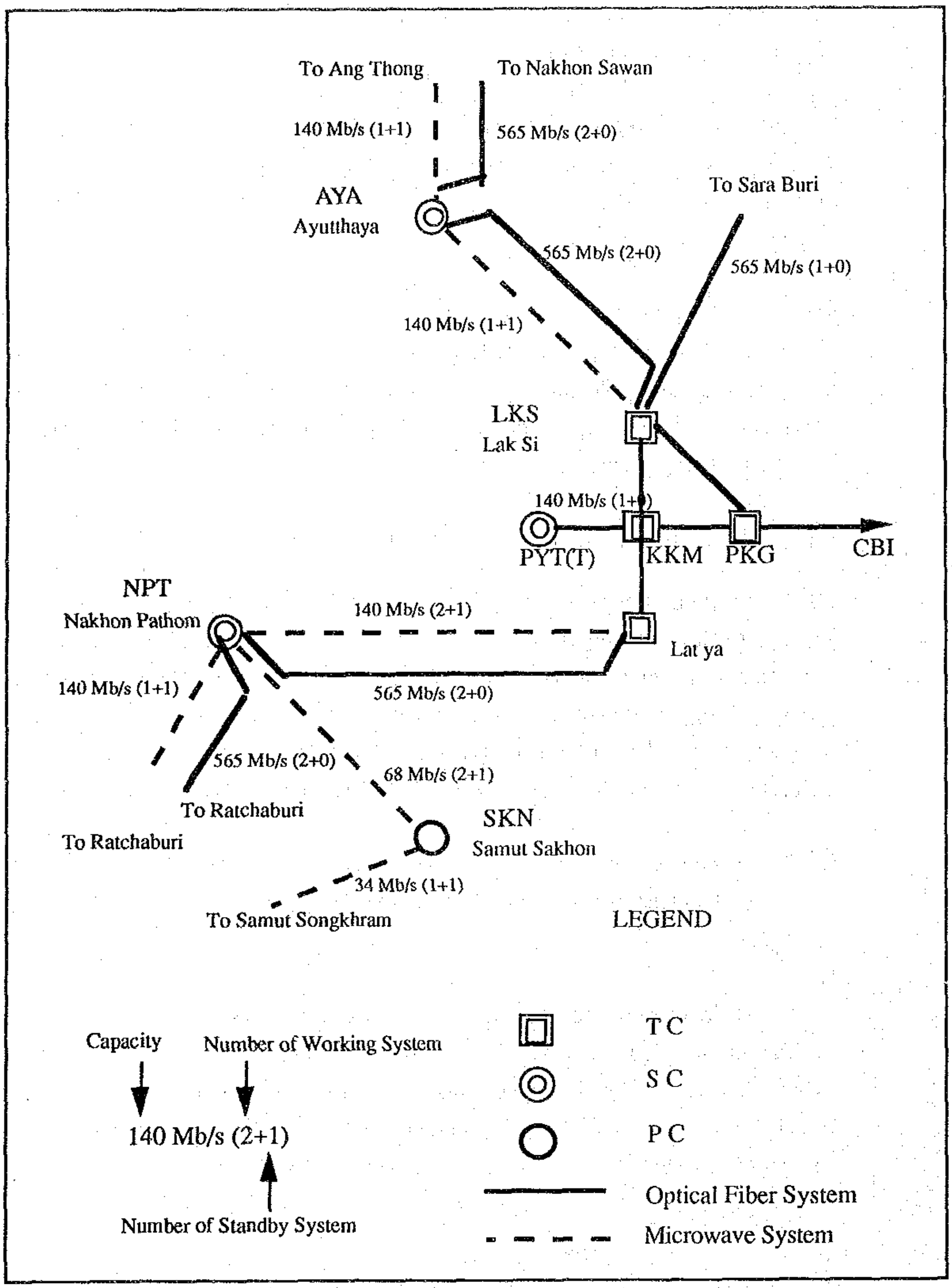


Figure 6.5.2-1 Layout of Long-distance Digital Transmission System after the Fifth and Sixth Expansion Projects

Table 6.5.2-1 The Number of Circuits in Long-distance Transmission between Ayutthaya and BMA after the Fifth and Sixth Expansion Projects

Span			No. of DTI	Remarks
Ayutthaya	-	Lak Si	4	Fiber
Ayutthaya	-	Lat Ya	3	ditto
Ayutthaya	-	Phra Khanong	3	ditto
Ayutthaya	-	Phloen Chit	2	ditto
Ayutthaya	-	Phahonyothin	1	ditto
Ayutthaya	-	Krung Kasem	12	ditto
Total			25	

Table 6.5.2-2 The Number of Circuits in Long-distance Transmission between Nakhon Pathom and BMA after the Fifth and Sixth Expansion Projects

Span			No. of DTI	Remarks
Nakhon Pathom	-	Samut Songkhram	8	Microwave
Nakhon Pathom	-	Samut Sakhon	13	ditto
Nakhon Pathom	-	Lat Ya	3	ditto
Nakhon Pathom	-	Surawong	1	ditto
Nakhon Pathom	-	Khlong Chan	1	ditto
Nakhon Pathom	-	Krung Kasem	29	Microwave 18, Fiber 11
Nakhon Pathom	-	Phitsanulok	1	Fiber
Nakhon Pathom	-	Nakhon Sawan	1	ditto
Nakhon Pathom	-	Phahonyothin	2	Microwave
Nakhon Pathom	-	Phloen Chit	4	ditto
Nakhon Pathom	-	Phra Khanong	4	ditto
Nakhon Pathom	-	Lak Si	4	ditto
Total			71	

Table 6.5.2-3 Number of Circuits in Long-distance Transmission between Samut Sakhon and BMA after the Fifth and Sixth Expansion Projects

Span			No. of DTI	Remarks
Samut Sakhon	-	Nakhon Pathom	13	Microwave
Samut Sakhon	-	Kanchanaburi	1	ditto
Samut Sakhon	-	Lat Ya	2	ditto
Samut Sakhon	-	Phra Khanong	2	ditto
Samut Sakhon	-	Lak Si	3	ditto
Samut Sakhon	-	Krung Kasem	1	ditto
Samut Sakhon	-	Phloen Chit	2	ditto
Total			24	

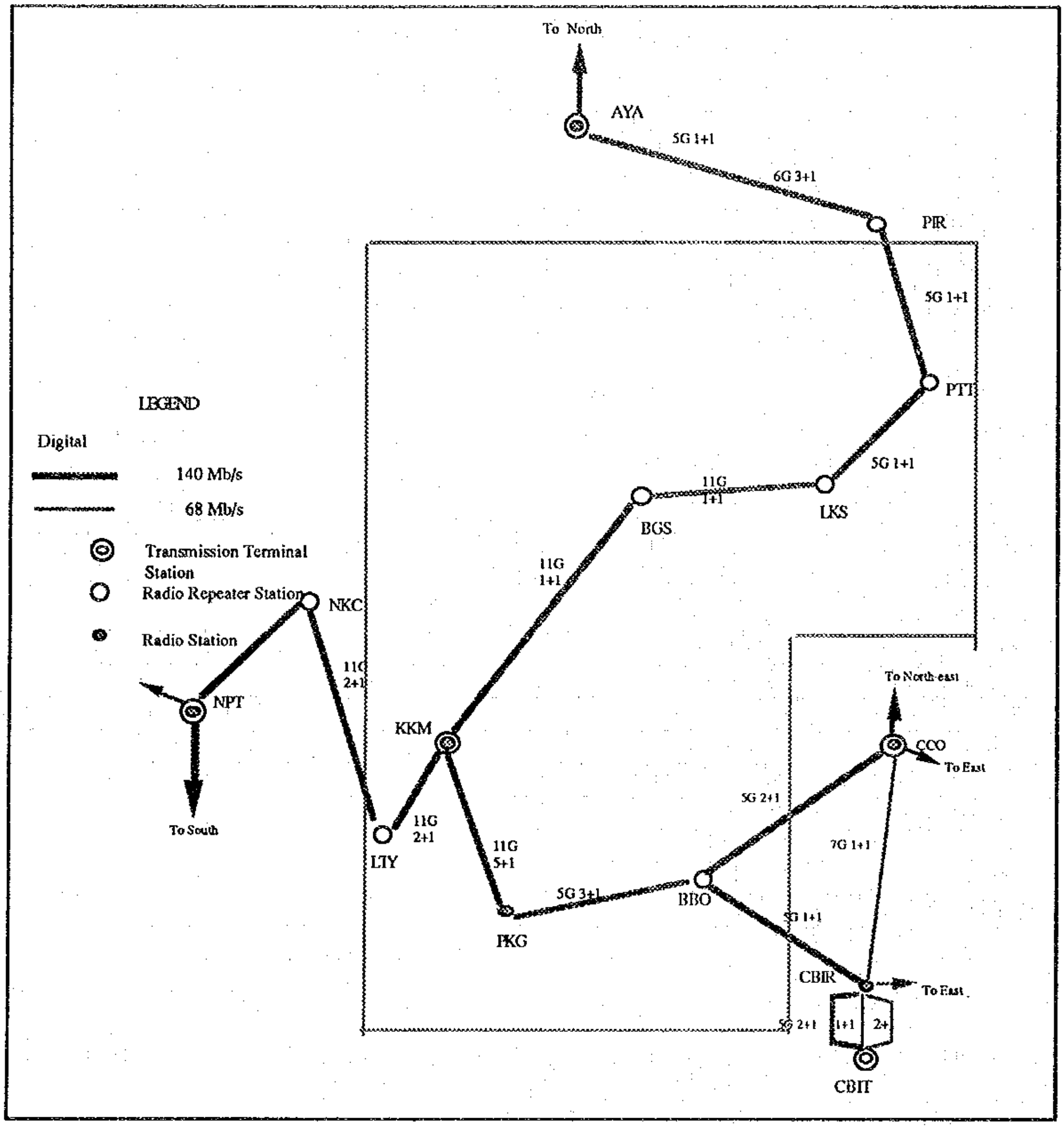


Figure 6.5.2-2 Long-distance Transmission System in the BMA after the Fifth and Sixth Expansion Projects

2) Analog Transmission System

a) The long-distance analog transmission system in the study area is shown in Figure 6.5.2-3. As shown in this figure, the long-distance analog transmission system consists of only microwave systems, which have been installed to connect analog crossbar switching facilities. They are installed in only along main routes such as the Ayutthaya and Nakhon Pathom route. TOT has already stopped to expand analog switching facilities.

b) Replacement of the analog transmission systems should be carried out in accordance with replacement of the analog crossbar switching facilities. Most analog facilities have been used more than ten years. The fault ratio of the analog facilities should be also analyzed from the viewpoint of service grade.

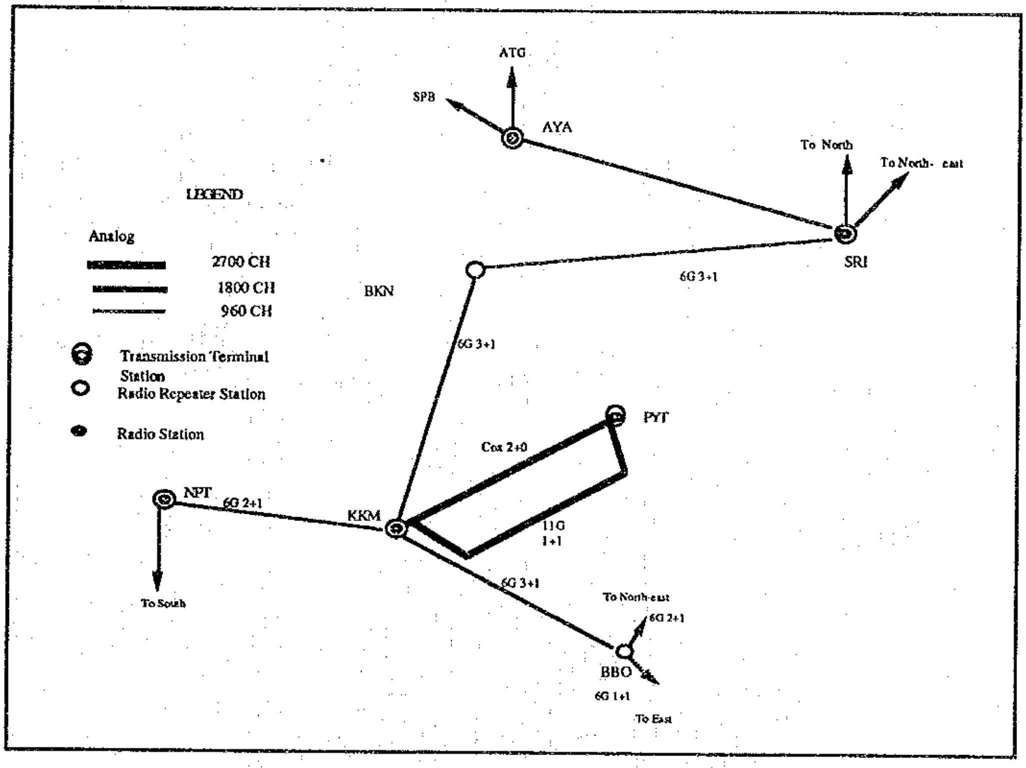


Figure 6.5.2-3 The Layout of Long-distance Analogue Transmission System after the Fifth and Sixth Expansion Projects

6.5.3 Junction Transmission System

1) Layout of the Transmission System

The layout of the junction transmission network in the BMA after the fifth and sixth expansion projects is shown in Figure 6.5.3-1, which consists of optical fiber transmission systems and metallic cable PCM-30 systems. The PCM-30 systems were originally installed to connect the analog switching facilities. The optical fiber transmission systems have been introduced during the TOT 5th expansion project for mainly connecting SPC switching facilities. Replacement of the PCM-30 systems should be carried out in considering transmission facility space in the future and replacement of old deteriorated metallic cables.

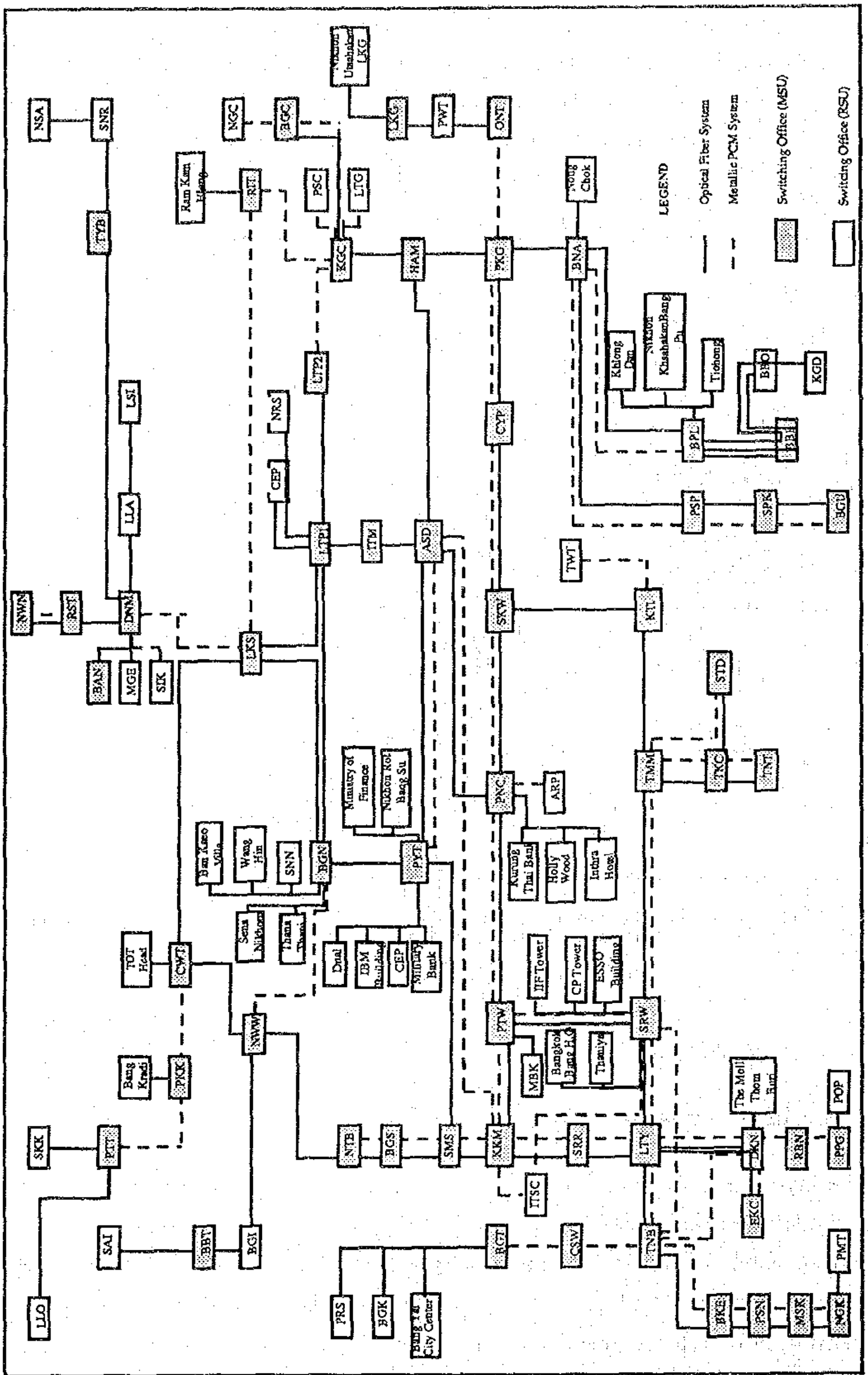


Figure 6.5.3-1   Junction Transmission Network in the BMA

2) Tandem Trunk Link Transmission System

TOT installed two optical fiber transmission systems separately for tandem trunk links and local trunk links. For connecting the tandem switches, the 565 Mb/s optical fiber transmission system is adopted in the BMA as shown in Figure 6.5.3-2. This system is effective for operation and maintenance, because these tandem trunk links can be immediately changed over to another transmission routes, when an optical fiber route is cut. The number of circuits between tandem offices at the end of the fifth and sixth expansion projects is shown in Table 6.5.3-1. As shown in the table, Surawong is a local exchange office in the digital network; however, it is classified as a tandem office in the transmission section because it has more than 40 thousand subscriber capacities. Figure 6.5.3-2 shows that all the circuits connecting the tandem offices are double routed. They are named as A and B routes.

Table 6.5.3-1 Number of Circuits between Tandems in the BMA after Fifth and Sixth Expansion Projects

Span	No. of DTI	System	Span	No. of DTI	System
LKS - LTY (B)	81	F-565 M	LKS - PKG (A)	162	F-565 M
KKM - LKS (B)	46	F- 140 M	LTY - PYT (A)	56	F- 140 M
LKS - PKG (B)	N.A.	F-565 M	LTY - SRW (A)	54	F- 140 M
LKS - PNC (B)	53	F- 140 M	PKG - PYT (B)	30	F- 140 M
LKS - PYT (B)	N.A.	F-565 M	KKM - PYT (A)	48	F- 140 M
LKS - PYT (A)	161	F-565 M	KKM - PNC (A)	91	F- 140 M
PNC - PYT (A)	164	F-565 M	PYT - SRW (B)	N.A.	F- 140 M
LTY - PYT (B)	11	F- 140 M	KKM - SRW (A)	39	F- 140 M
PYT - SRW (A)	123	F- 140 M	PKG - SRW (A)	40	F- 140 M
PKG - PYT (A)	40	F- 140 M	PNC - SRW (A)	81	F- 140 M
KKM - PYT (B)	N.A.	F- 140 M	LTY - PKG (B)	N.A.	F-565 M
KKM - PNC (B)	N.A.	F- 140 M	LTY - PKG (A)	129	F-565 M
KKM - LKS (A)	104	F- 140 M	PNC - PKG (A)	162	F- 140 M
LKS - LTY (A)	126	F-565 M	PNC - PKG (B)	56	F- 140 M
LKS - SRW (A)	43	F- 140 M	KKM - LTY (A)	204	F- 565 M
LKS - PNC (A)	50	F- 140 M	KKM - LTY (B)	N.A.	F - 565 M
PNC - PYT (B)	N.A.	F-565 M		N.A.	
Total	1,002		Total	1,152	
Ground Total	2,154				

Note: N.A. : Not Available

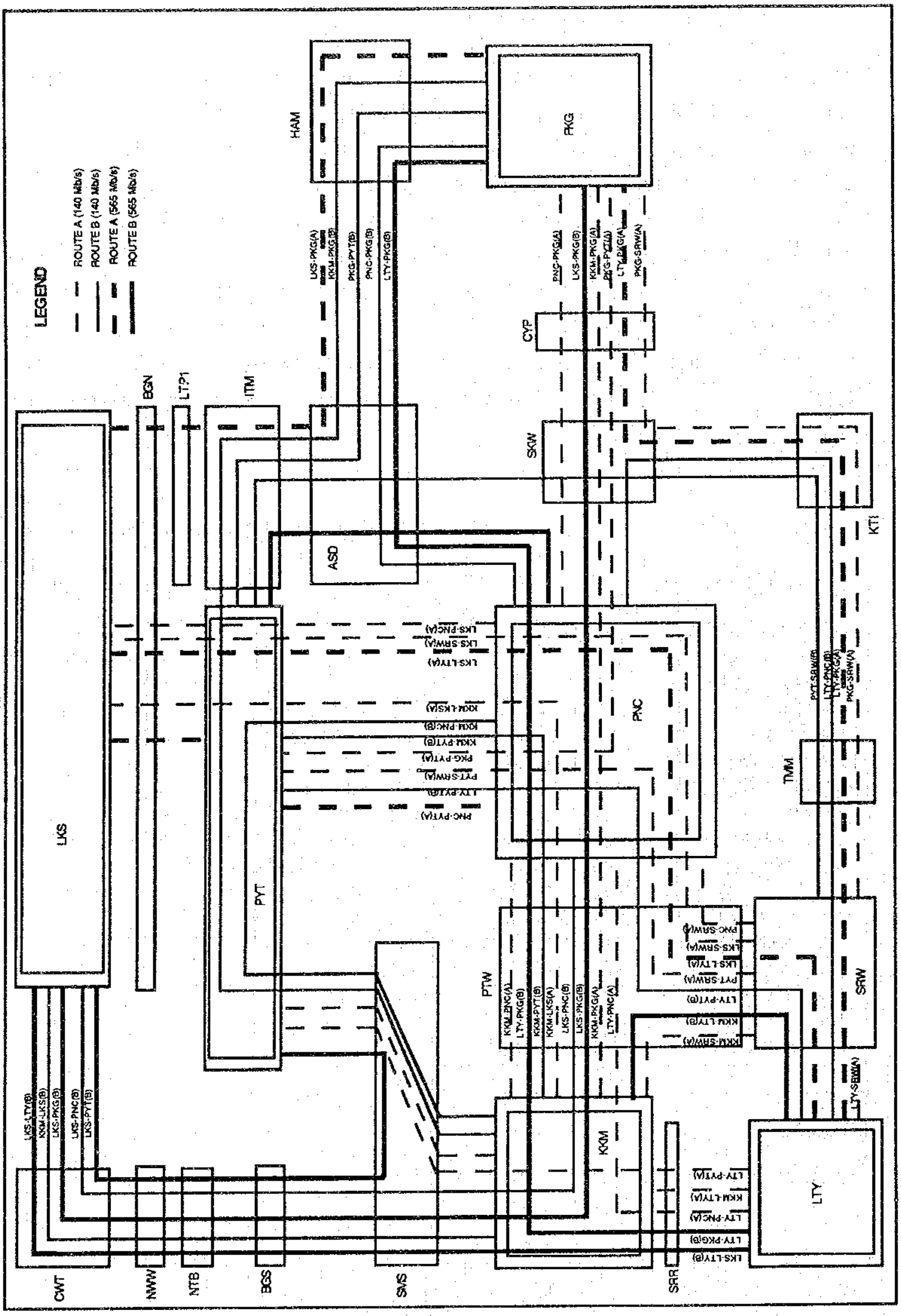


Figure 6.5.3-2 Tandem Trunk Transmission Network after the Fifth and Sixth Expansion Projects

3) Local Trunk Link Transmission System

To connect the local switches and the tandem switches, optimized optical fiber transmission systems such as 34 Mb/s, 140 Mb/s, and metallic cable PCM-30 systems are applied in the areas as shown in Figure 6.5.3-3. Main switches will be connected to each other with doubled or looped routes by the end of the sixth expansion project. Table 6.5.3-2 and Table 6.5.3-3 list the number of circuits between local switches as shown in Figure 6.5.3-3, which exclude junction routes between newly installed RSUs (Remote Switching Units) and MSUs (Main Switching Units).

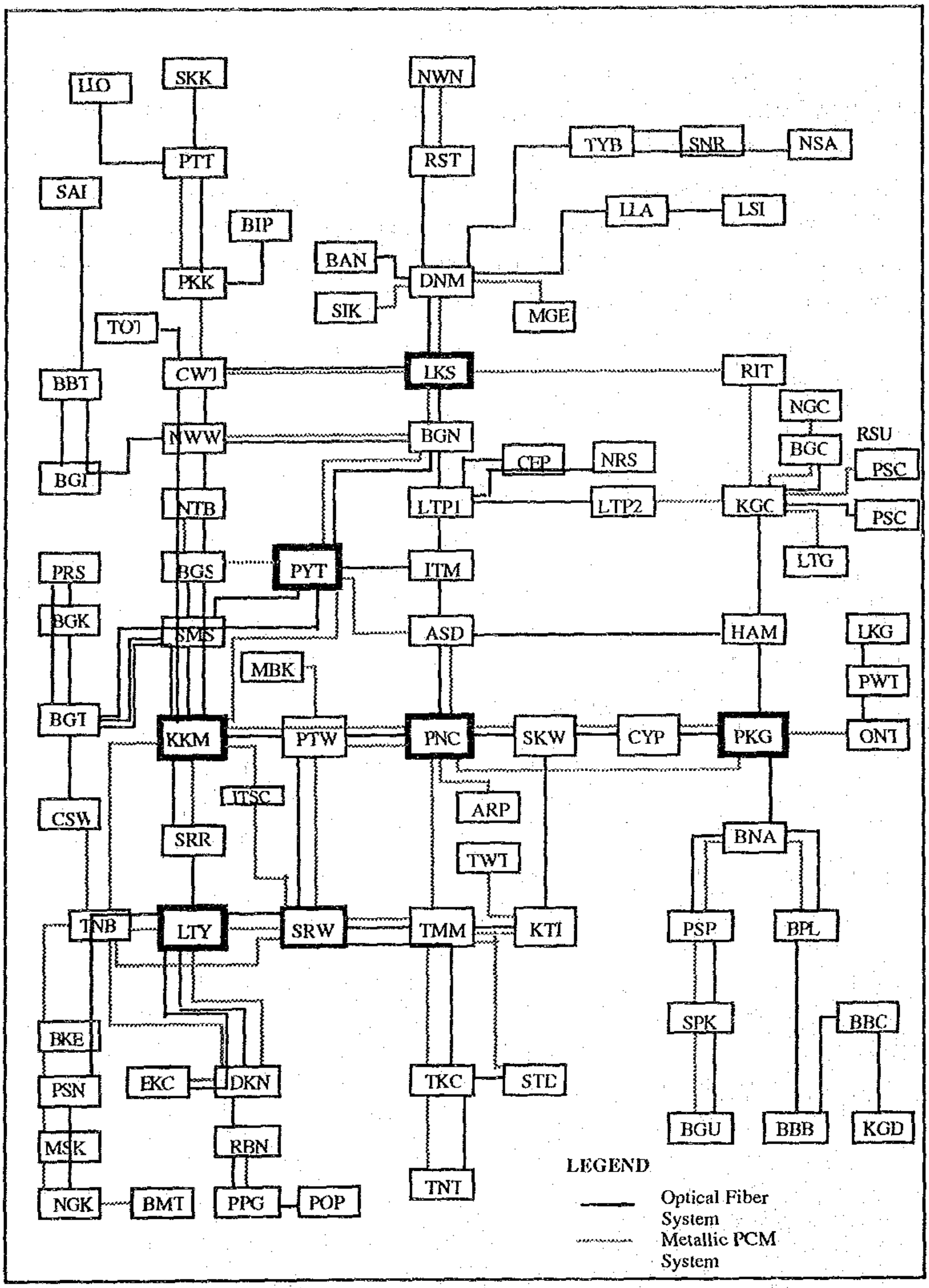


Figure 6.5.3-3 Local Trunk Transmission Network after the Fifth and Sixth Expansion Projects

Table 6.5.3-2 Number of Circuits between Local Offices (Fiber) after the Fifth and Sixth Expansion Projects

Span	No. of DTI	System	Span	No. of DTI	System
LLO - PTT	10	F-34 M	TYB - NSA	10	ditto
PTT - SKK	10	ditto	BGN - LTP1	26	F-140 M
PKK - BIP	16	F-140 M	BGN - PYT	91	ditto
TOT - CWT	35	ditto	PYT - LTP1		ditto
CWT - LKS	33	ditto	PYT - LTP1	108	ditto
CWT - KKM	22	ditto	PYT - LTP2	58	ditto
CWT - NWW	29	ditto	PYT - ASD	78	ditto
SAI - BBT	9	F-34 M	PYT - SMS	47	ditto
BBT - BGI	9	ditto	LTP-1 - ITM	38	ditto
BBT - NWW	38	F-140	LTP-1 - CEP	8	F-34 M
NWW - NTB	16	F-140 M	LPT-1 - NRS	24	F-140 M
NTB - BGS	95	ditto	LPT-1 - LPT-2	44	ditto
BGS - SMS	49	ditto	ITM - ASD	34	ditto
SMS - KKM	45	ditto	ASD - PNC	74	ditto
PRS - BGT	8	F-34 M	ASD - HAM	21	ditto
BGK - BGT	17	F-140 M	ASD - SKW	40	ditto
BGT - CSW	69	ditto	PNC - HAM	42	ditto
BGT - SMS	21	ditto	PNC - SKW	111	ditto
BGT - PYT	50	ditto	SKW - PKG	76	ditto
BGT - KKM	157	ditto	SKW - KTI	37	ditto
BGS - KKM	40	ditto	SKW - TKC	96	ditto
KKM - SRR	56	ditto	SKW - SRW	28	ditto
SRR - LTY	11	ditto	SRW - SID	11	ditto
KKM - PTW	12	ditto	SRW - TMM	52	ditto
KKM - SRR	62	ditto	TKC - TNT	36	ditto
LTY - PSN	11	ditto	TKC - STD	36	ditto
PSN - NGK	11	ditto	BGC - KGC	5	ditto
NGK - PMT	32	ditto	KGC - LPT-2	39	ditto
LTY - EKC	22	ditto	KGC - PSC	19	ditto
LTY - DKN	34	ditto	KGC - HAM	41	ditto
DKN - RBN	27	ditto	KGC - PKG	145	ditto
RBN - PPG	11	ditto	HAM - PKG	51	ditto
PPG - POP	35	ditto	PKG - CYP	69	ditto
NWW - DNM	49	ditto	PKG - BNA	145	F-565 M
RST - DNM	31	ditto	PKG - PSP	101	F-140
DNM - BAN	22	ditto	PKG - SPK	58	ditto
DNM - TYB	20	ditto	PKG - BPL	79	ditto
DNM - LKS	38	ditto	ONT - PWT	50	ditto
DNM - LLA	17	ditto	PWT - LKG	33	ditto
DNM - LSI	9	F-34 M	BPL - BBB	16	ditto
LKS - BGN	59	F-140 M	BPL - BBO	16	F-34 M
LKS - LTP-1	32	ditto	BPL - KGD	10	ditto
TYB - SNR	10	F-34 M			
Total	1,389		Total	2,103	
Ground Total	3,492				

Table 6.5.3-3 Number of Circuits between Local Offices (PCM-30) after the Fifth and Sixth Expansion Projects

Span	No. of System	Span	No. of System
PTT - PKK	34	ITSC - SRW	35
PKK - CWT	65	PTW - MBK	N.A.
CWT - LKS	117	PTW - SRW	127
SIK - DNM	2	SRW - LTY	40
LKS - RIT	92	SRW - TNB	85
RIT - KGC	72	SRW - TMM	122
NGC - BGC	2	LTY - TNB	115
BGC - KGC	34	TNB - CSW	81
KGC - LTG	10	TNB - BKE	88
KGC - LTP2	86	TNB - DKN	86
BGN - LKS	31	BKE - PSN	9
BGN - NWW	102	PSN - MSK	72
BGN - PYT	3	MSK - NGK	43
NTB - BGS	3	NGK - BMT	2
BGS - PYT	69	DKN - EKC	72
PYT - KKM	23	DKN - RBN	81
PYT - ASD	3	RBN - PPG	60
ASD - PNC	N.A.	TMM - TKC	113
PNC - KKM	62	TMM - KTI	24
PNC - PTW	104	TMM - STD	2
PNC - TMM	109	TKC - TNT	50
PNC - SKW	86	PKG - ONT	55
PNC - PKG	15	PSP - BNA	18
SKW - CYP	72	PSP - SPK	5
CYP - PKG	8	SPK - BGU	20
KKM - PTW	61	BNA - BPL	5
KKM - SRR	48	LTY - DKN	155
KKM - TNB	53	DNM - LKS	131
KKM - ITSC	40		
TOTAL	1,406	TOTAL	1,696
Grand Total	3,102		

Note: N.A.: Not Available

6.5.4 Spur Route Transmission System

1) Layout of Transmission System

The spur route transmission systems in the Study Area are shown in Figure 6.5.4-1 to Figure 6.5.4-3. All the spur route transmission systems consist of digital microwave systems except Nakhon Pathom, Ayutthaya, Bang Pa In and Wang Noi where optical fiber systems are applied. It means that the RSU has been adopted as a local exchange (LE) instead of the MSU in the provincial area because each switch has a small number of subscribers in the provincial area, and they are connected to the MSU facilities by digital microwave transmission systems.

2) Consideration of Future Expansion Plan

As discussed in Chapter 2, the BMR will expand into Samut Sakhon and Ayutthaya provinces. Therefore, it is expected that more RSUs are needed and expanded in the near future and more spur transmission routes are required to connect these RSUs. Because of the flatness of the land and comparatively low construction cost, microwave transmission systems are much more applicable than optical fiber systems in these areas. To meet the increasing demand in the near future, the sector must allocate more frequencies for expansion of radio transmission systems in these areas because 2 GHz band is almost fully accommodated in the areas, particularly in Ayutthaya.

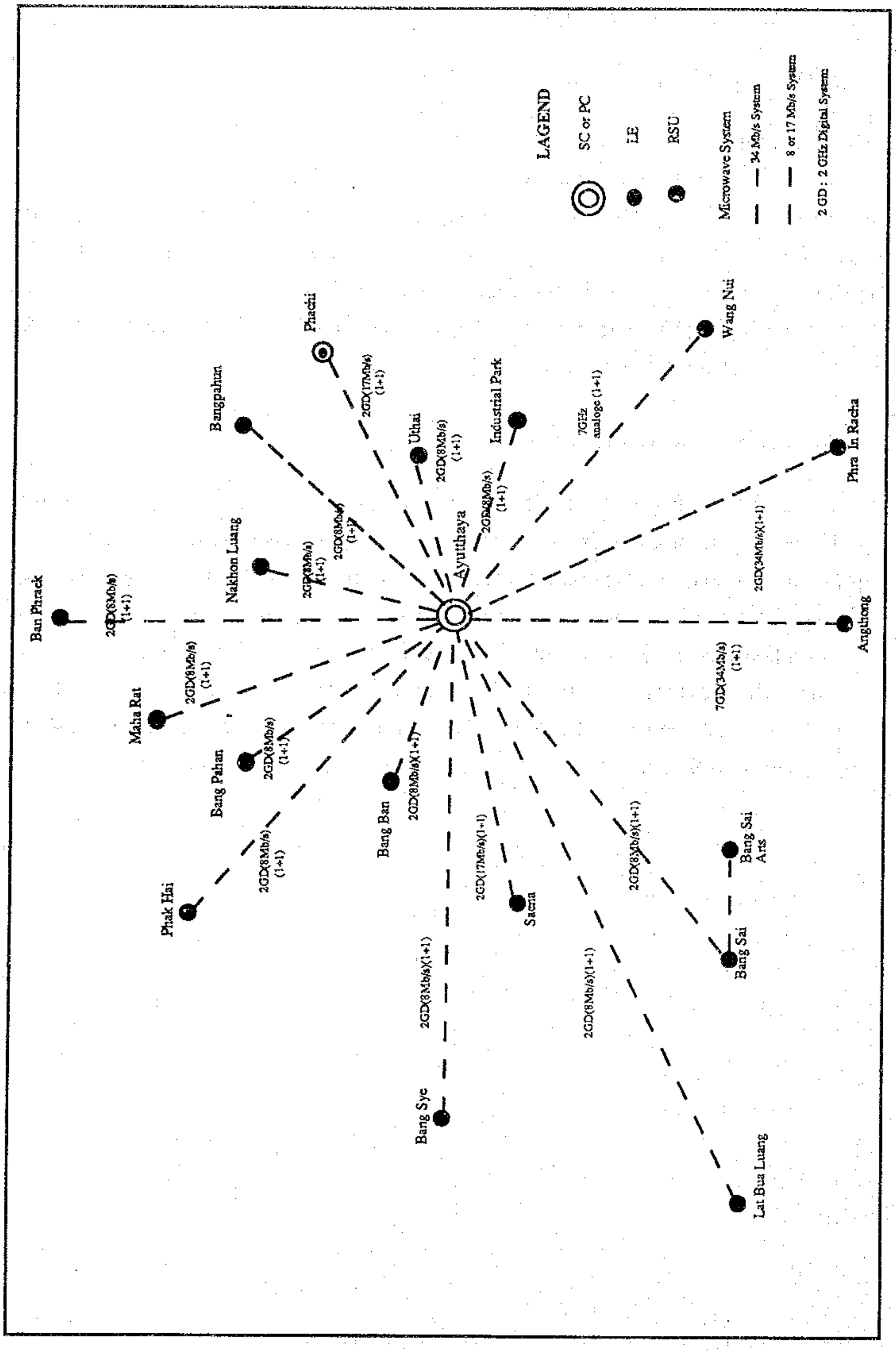


Figure 6.5.4-1 Layout of Spur Transmission System in Ayutthaya Area after the Fifth and Sixth Expansion Projects

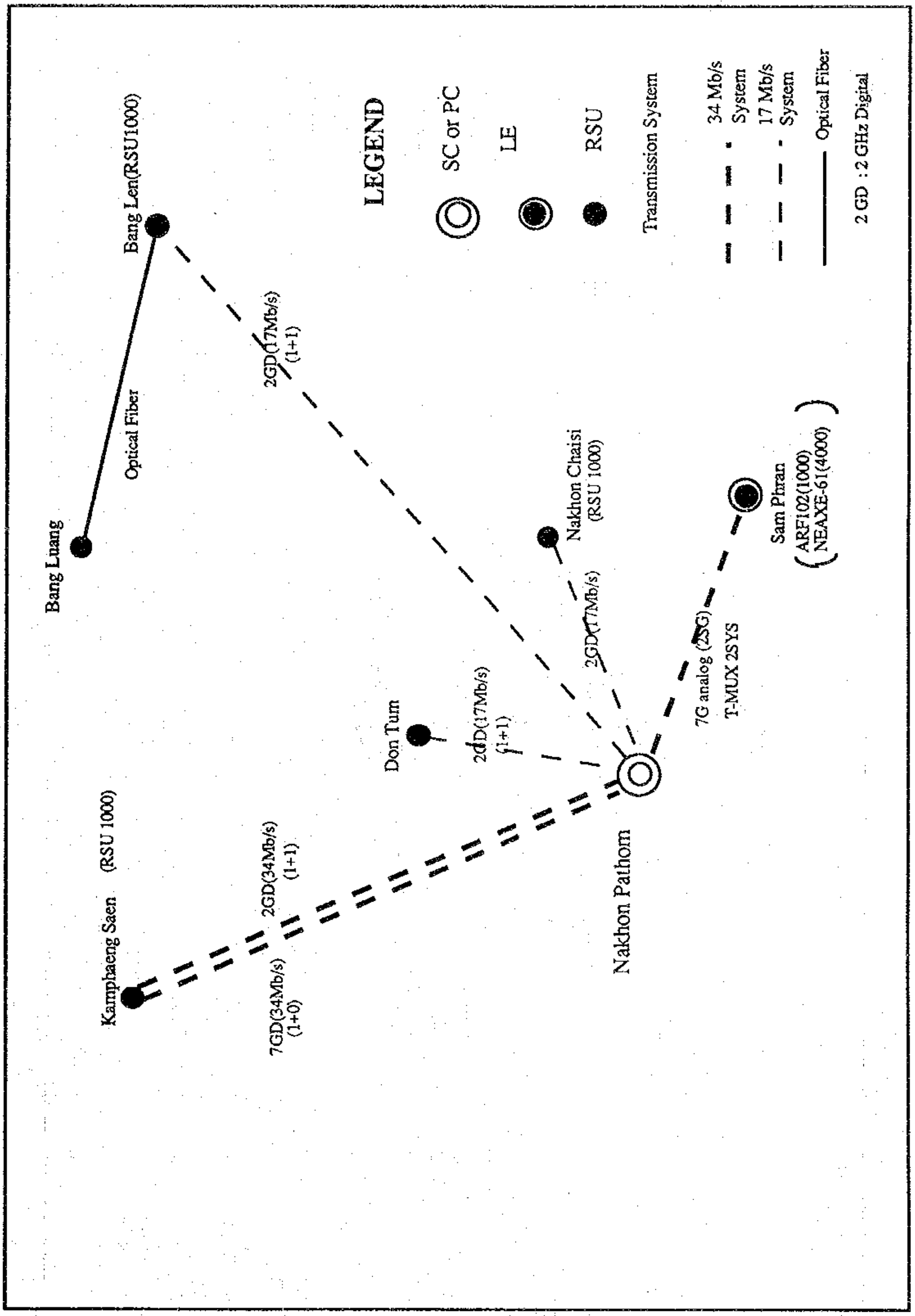


Figure 6.5.4-2 Layout of Spur Transmission in Nakhon Pathom Area after the Fifth and Sixth Expansion Projects

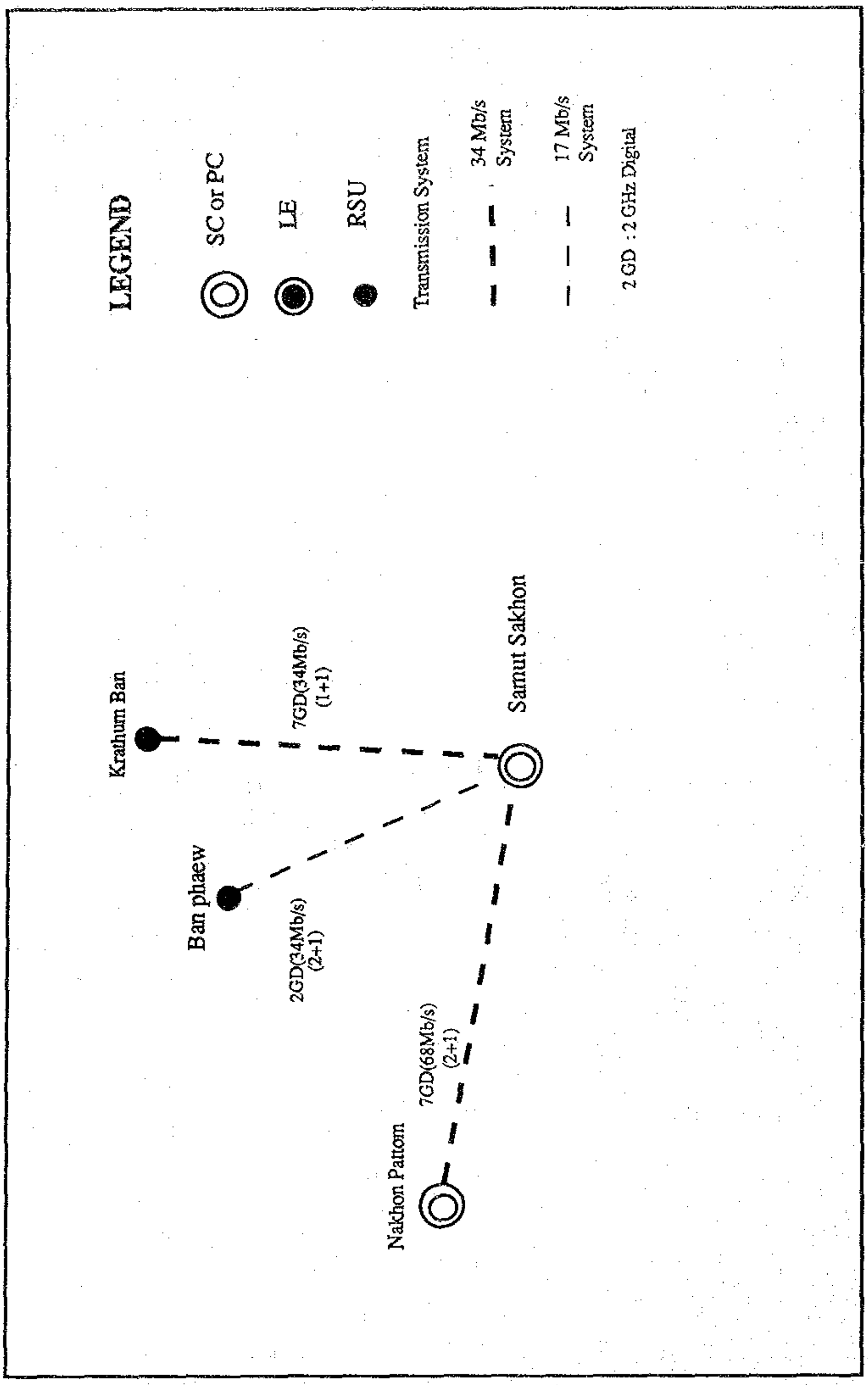


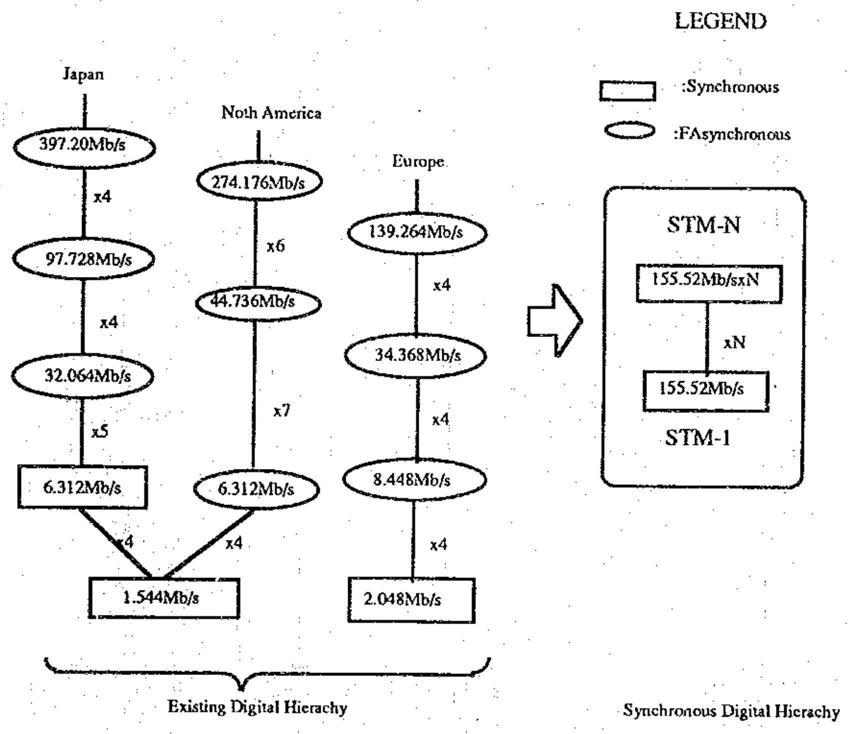
Figure 6.5.4-3 Layout of Spur Transmission System after the Fifth and Sixth Expansion Projects

6.5.5 Synchronous Digital Hierarchy (SDH)

1) Background of SDH

To make effective international connections by high speed digital streams, studies on how to connect different digital hierarchies such as CEPT (Conference of European Post and Telecommunication), North America, Japan, have started in many related countries and organizations.

In 1985, as a new hierarchy, SONET (Synchronous Optical Network) was proposed by USA. This can convert three different hierarchies into one integrated hierarchy. CCITT recommended a standardized synchronous digital hierarchy (SDH) in 1988 as G.707, 708 and 709. The concept of SDH is shown in Figure 6.5.5-1 and the multiplexing structure is shown in Figure 6.5.5-2.



STM-1: Synchronous Transport Mudule Level 1
STM-N: Synchronous Transport Mudule Level N

Figure 6.5.5-1 Standardized SDH

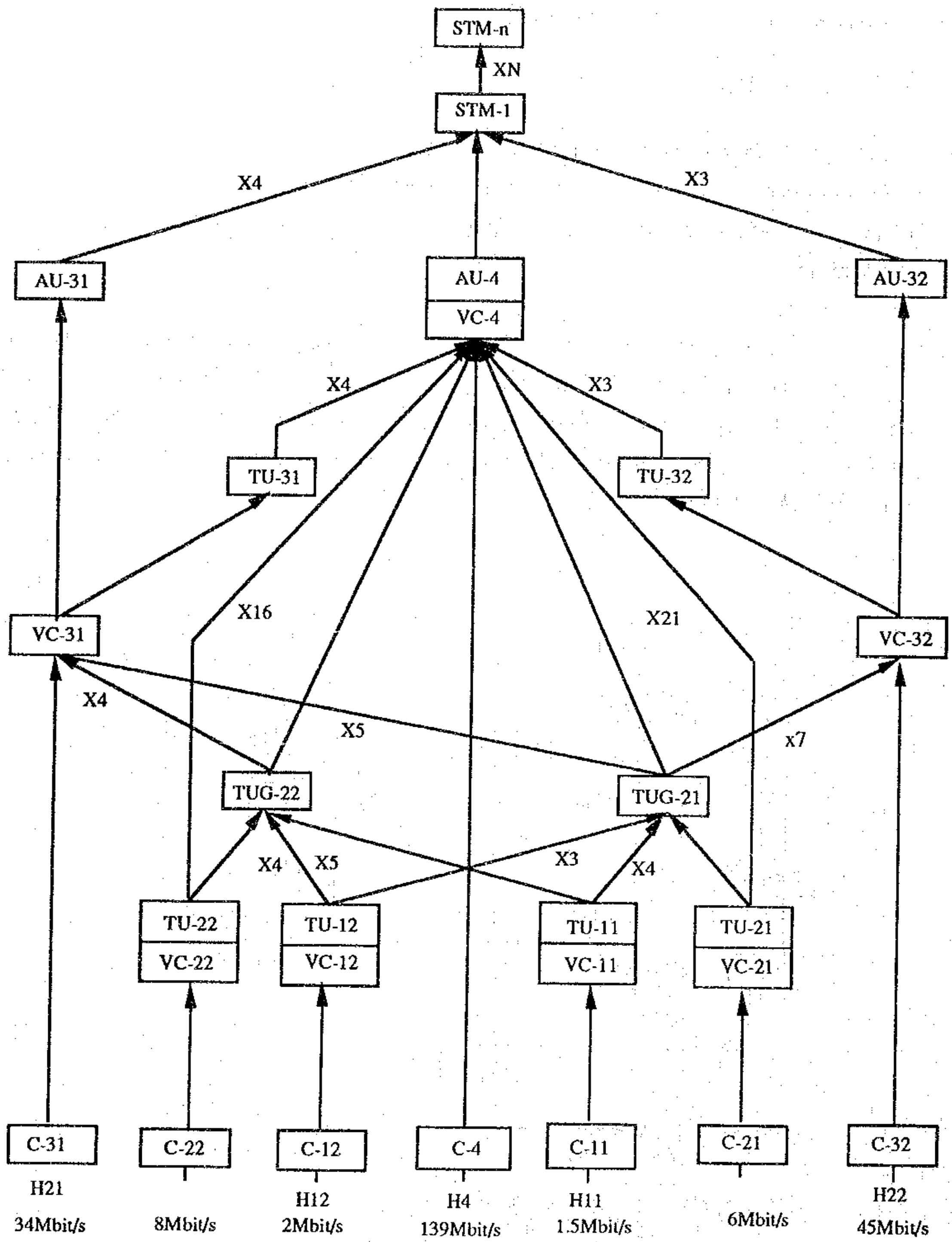


Figure 6.5.5-2 Multiplexing Structure of SDH

2) Merits of SDH

These synchronous digital multiplexing and a related synchronous digital hierarchy offer the following advantages.

- simplified multiplexing/demultiplexing techniques,

- direct access to lower speed tributaries, without need to multiplex/demultiplex the entire high speed signal,
- easy growth to higher bit rates in step with the evolution of transmission technology,
- enhanced operation, administration and maintenance (OAM) capability.

3) Introduction Plan of SDH in Thailand

Most Asian countries have not introduced the SDH system yet. However, Singapore has already embarked on a SDH trial arrangement with STM-1 (Synchronous Transport Module) to install on its national telephone network from mid-1992 to mid-1993. In Thailand too, TOT has a plan to introduce the SDH system to its data communication service; however, the plan is not fixed yet. The private firm, that will provide two million lines during the TOT's seventh ESDP project in the BMA, has a plan to introduce the SDH system.

CHAPTER 7

PRESENT ORGANIZATION AND MANAGEMENT

CHAPTER 7 PRESENT ORGANIZATION AND MANAGEMENT

7.1 Present TOT Organization Structure

Organization structure of TOT consist of three (3) bureaus and four (4) offices under the Board of Director and Managing Director as of May, 1991. The three bureaus are General Affairs, Operations and Engineering and Project. The four offices are Corporate Affairs, Internal Audit, Corporate Planning and ISDN promotion. Figure 7.1-1 to Figure 7.1-10 show the present organization structure of TOT. In this section, a primary focus will be on the organization structure of the Bureau of Operations in FY1991.

ORGANIZATIONAL STRUCTURE IN 1991

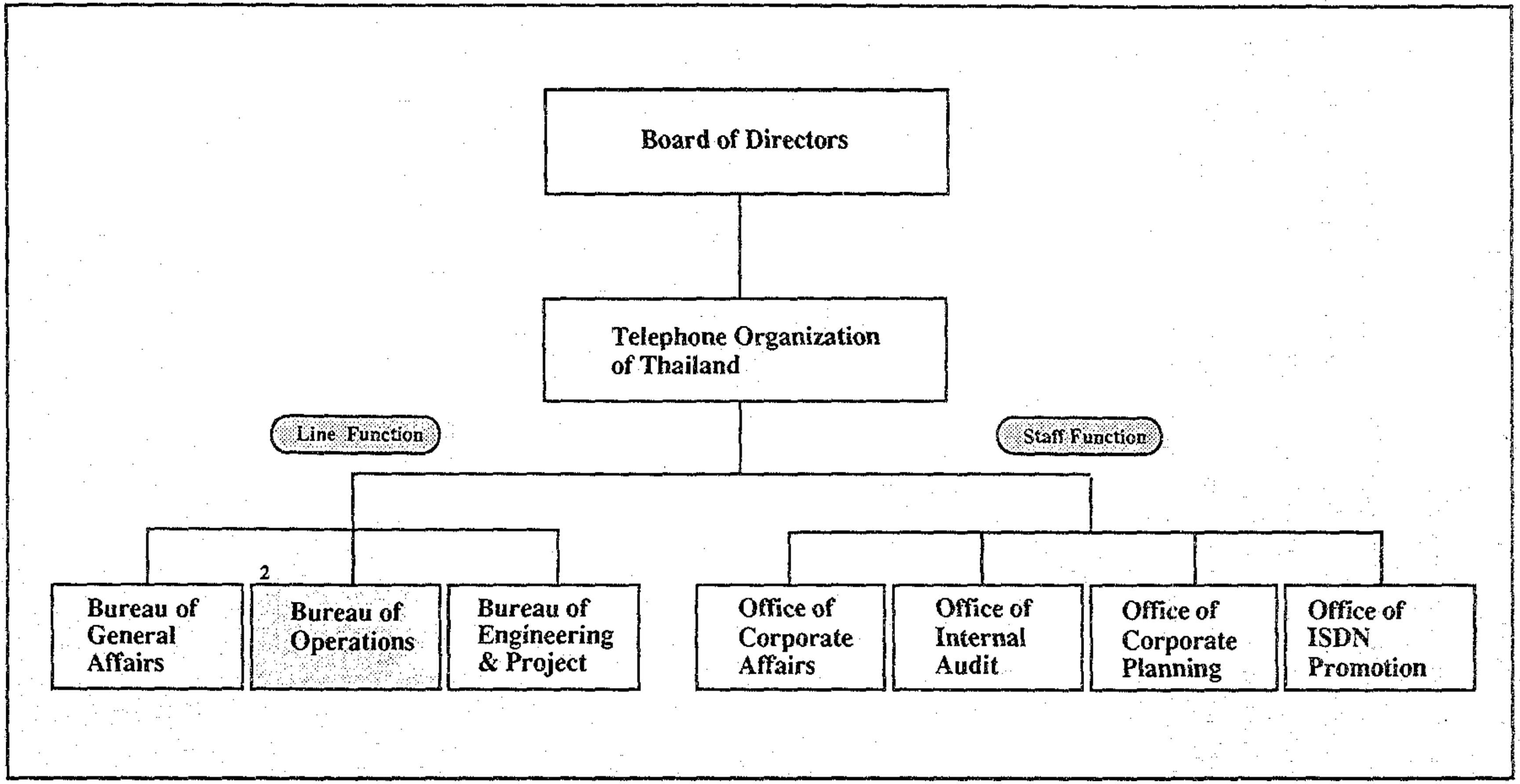


Figure 7.1-1 Organizational Chart (Bureau / Office) of Telephone Organization of Thailand

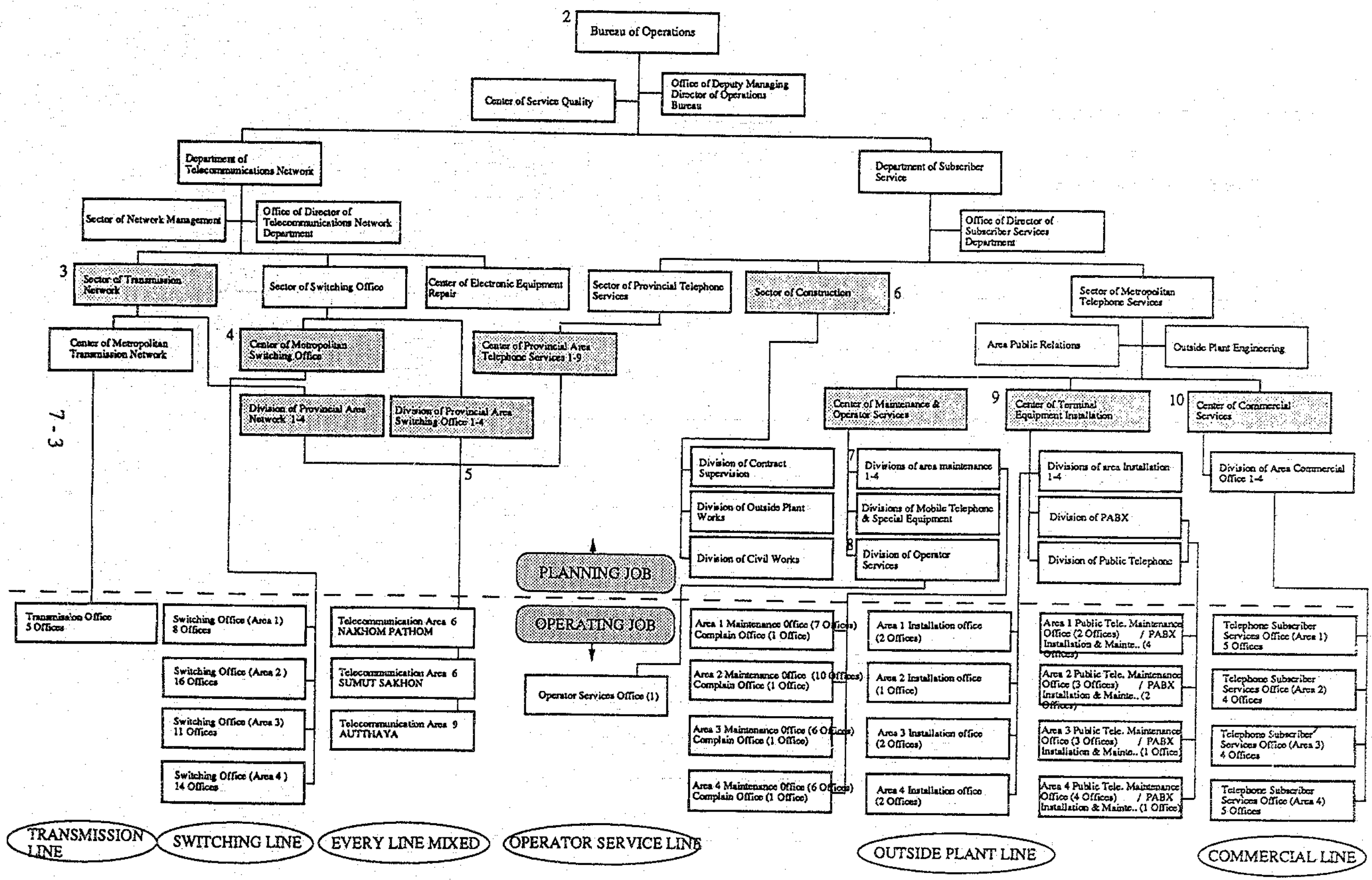


Figure 7.1-2 Organizational Chart of Operations Bureau

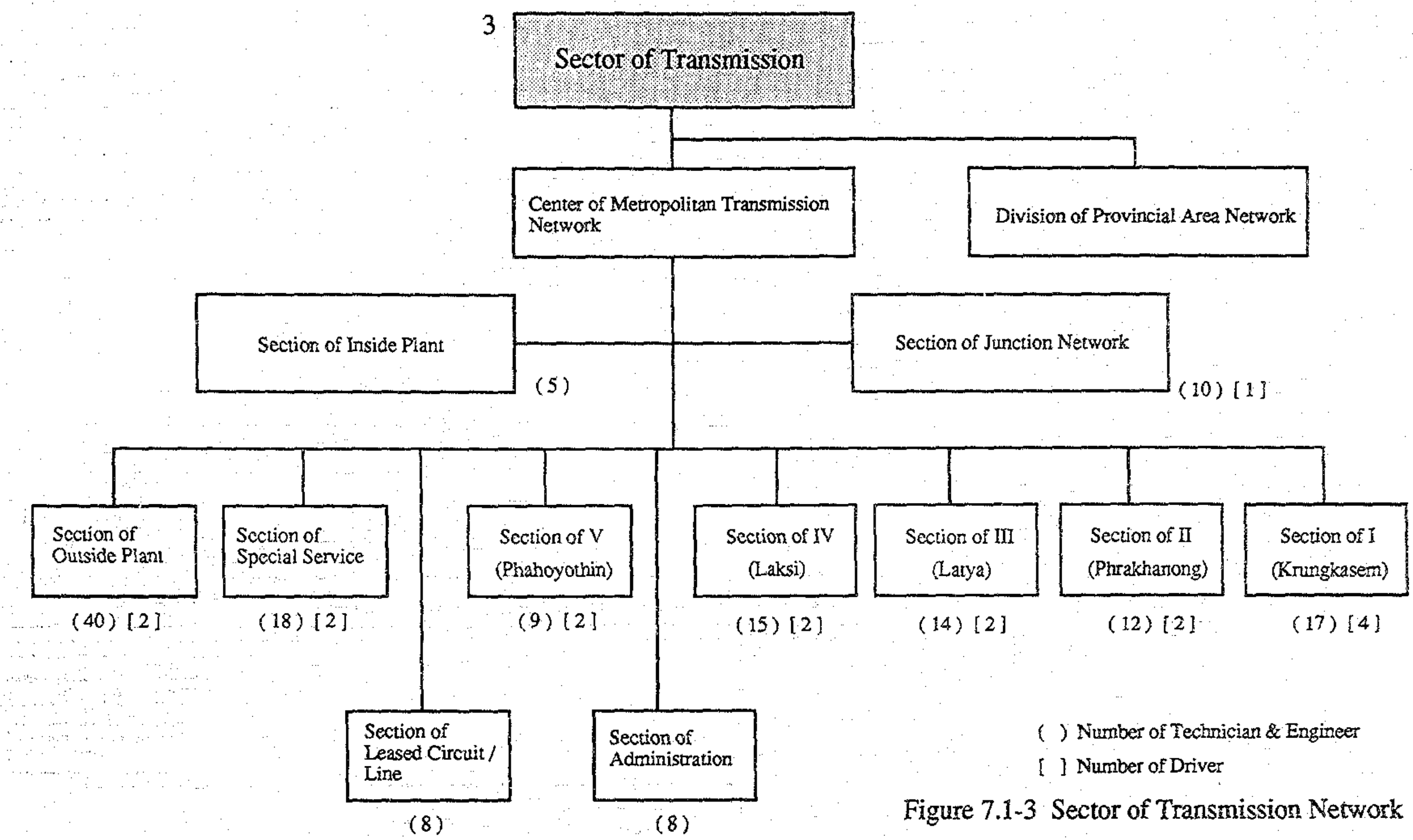


Figure 7.1-3 Sector of Transmission Network

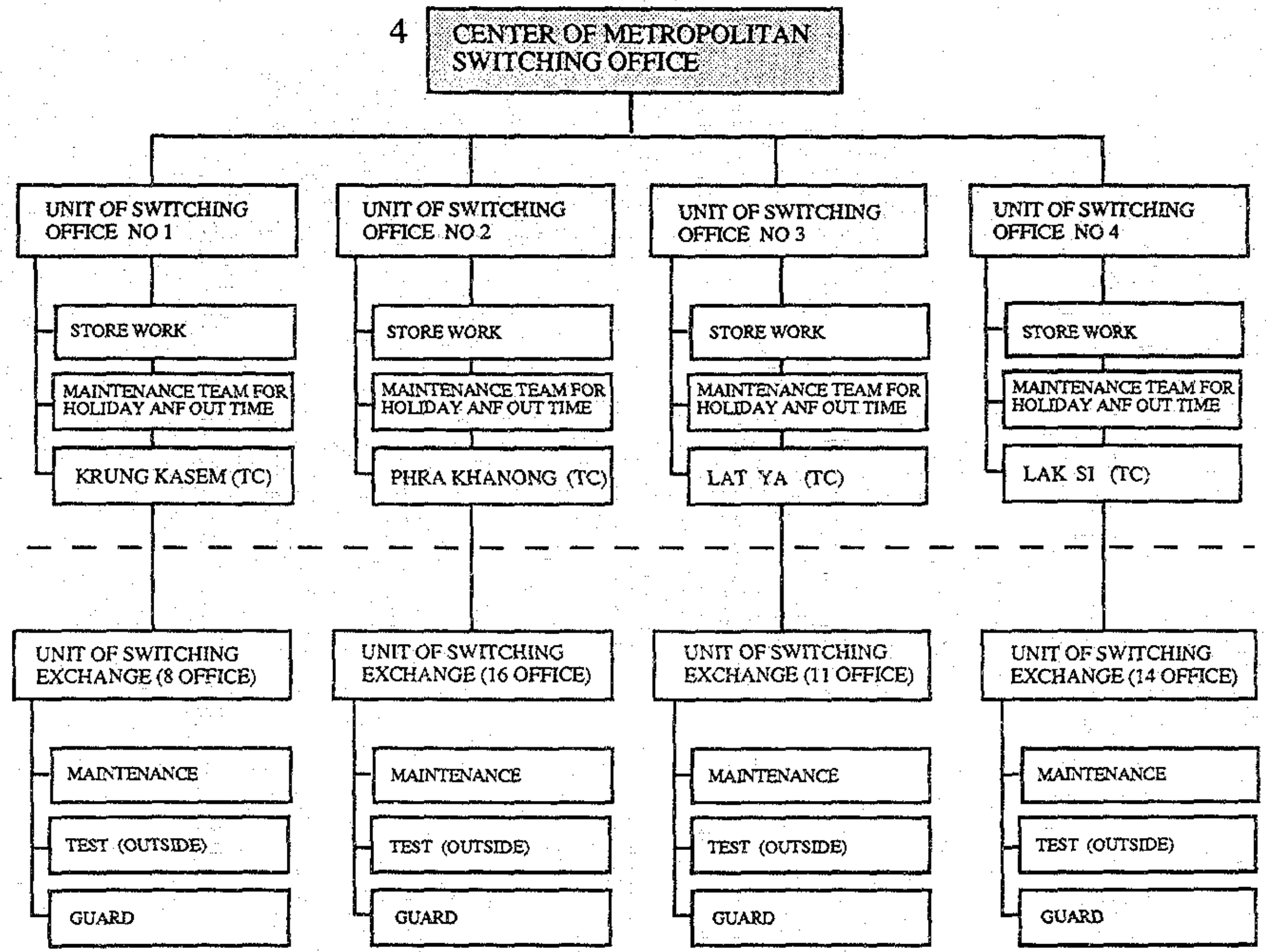


Figure 7.1-4 Center of Metropolitan Switching Office

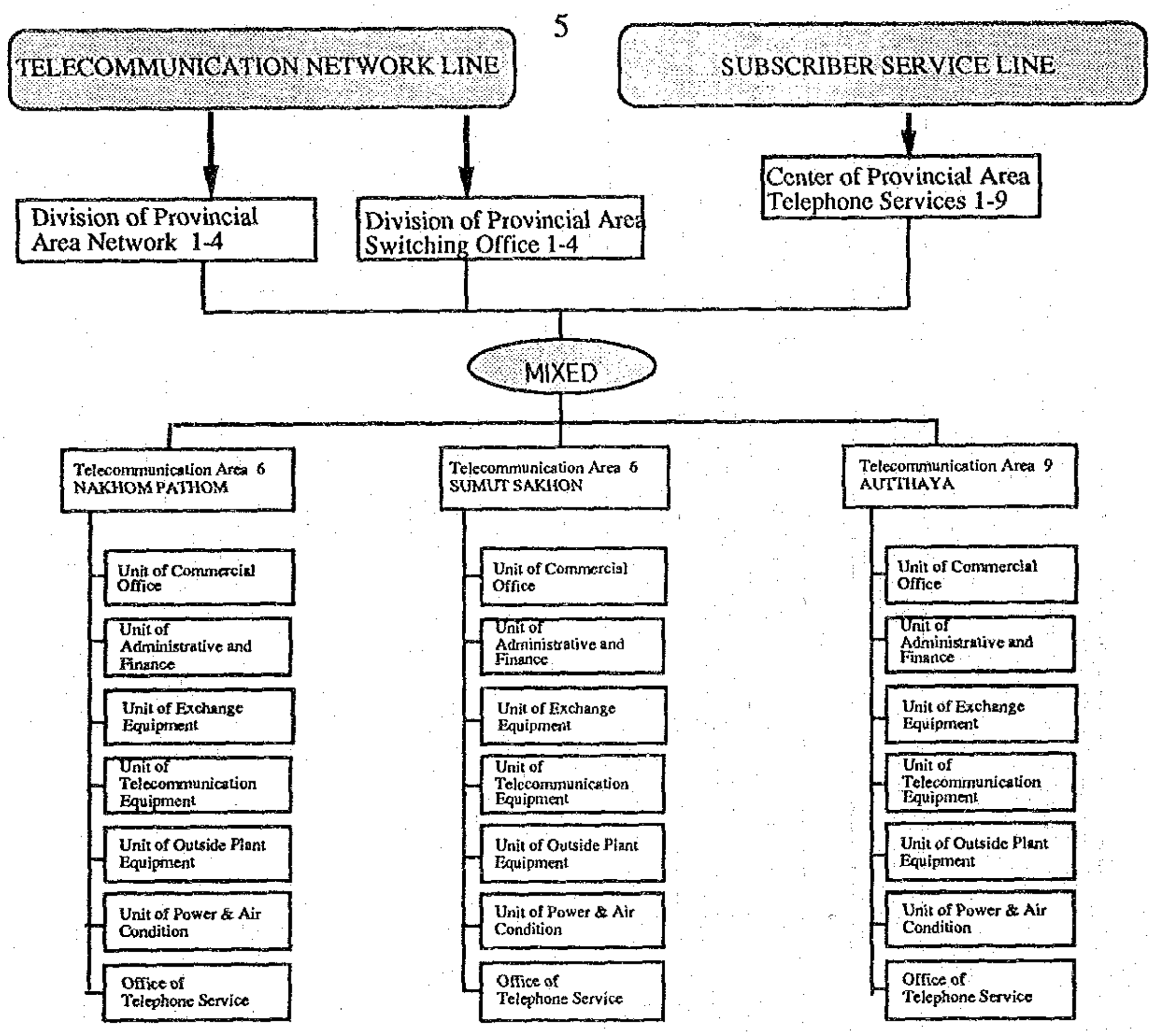


Figure 7.1-5 Organization Chart of Provincial Area

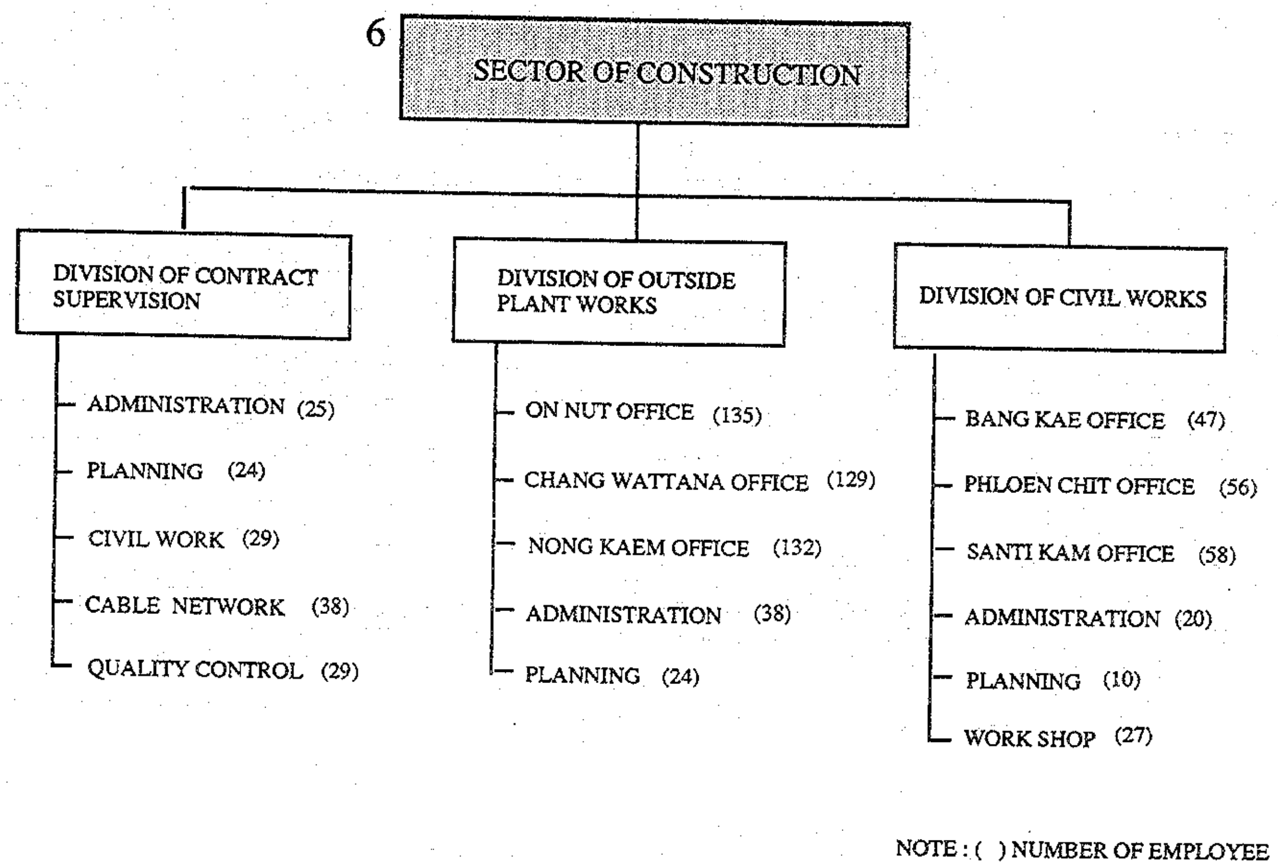


Figure 7.1 -6 Sector of Construction

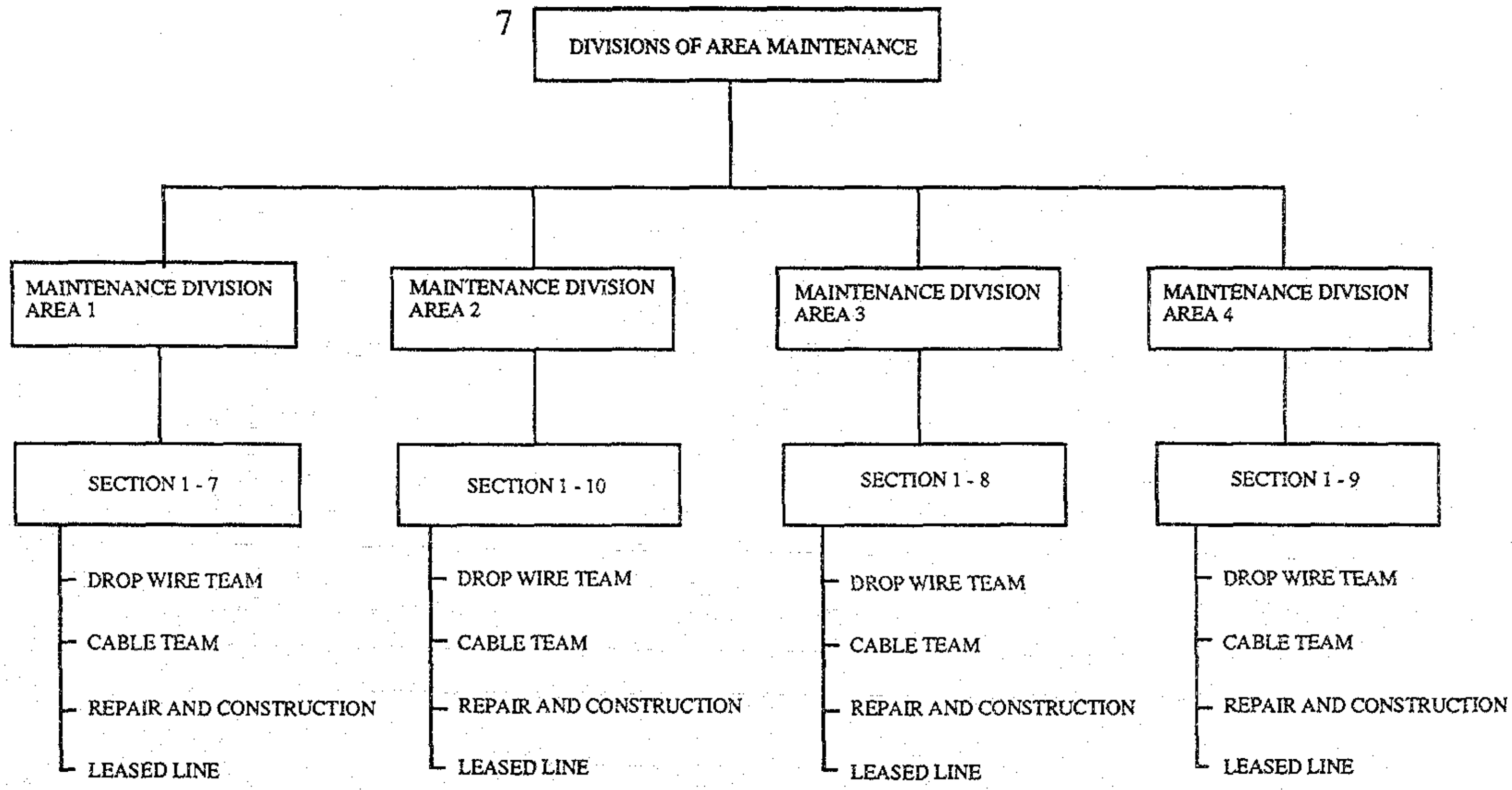


Figure 7.1-7 Divisions of Area Maintenance

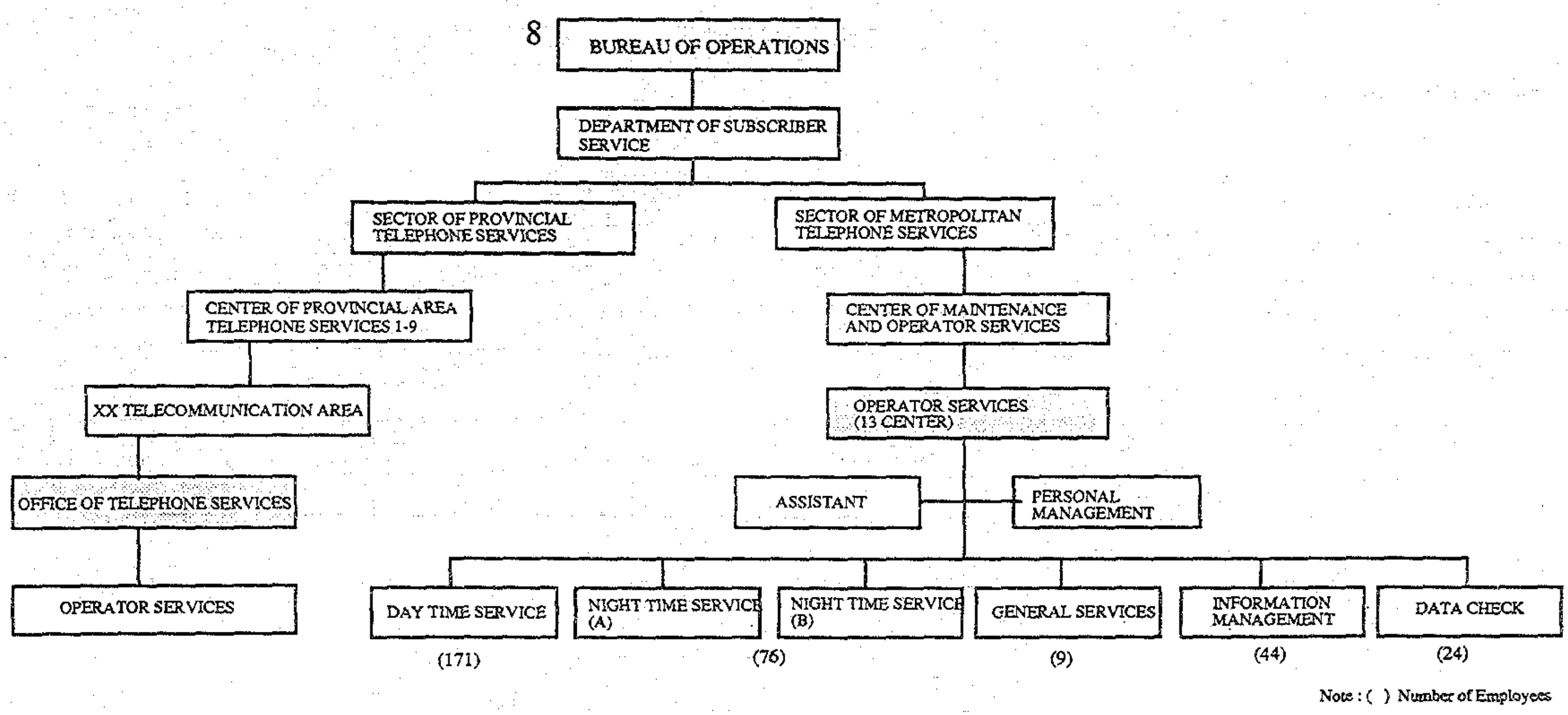


Figure 7.1-8 Operator Services

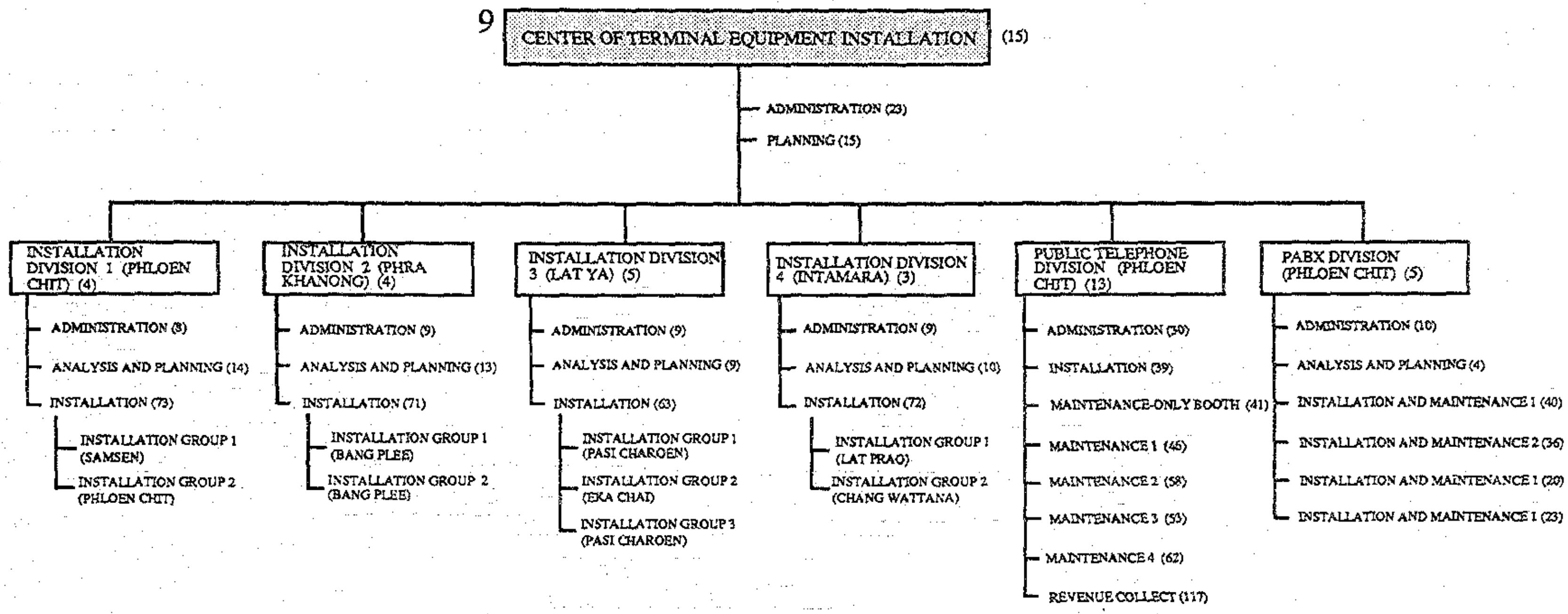


Figure 7.1-9 Center of Terminal Equipment Installation

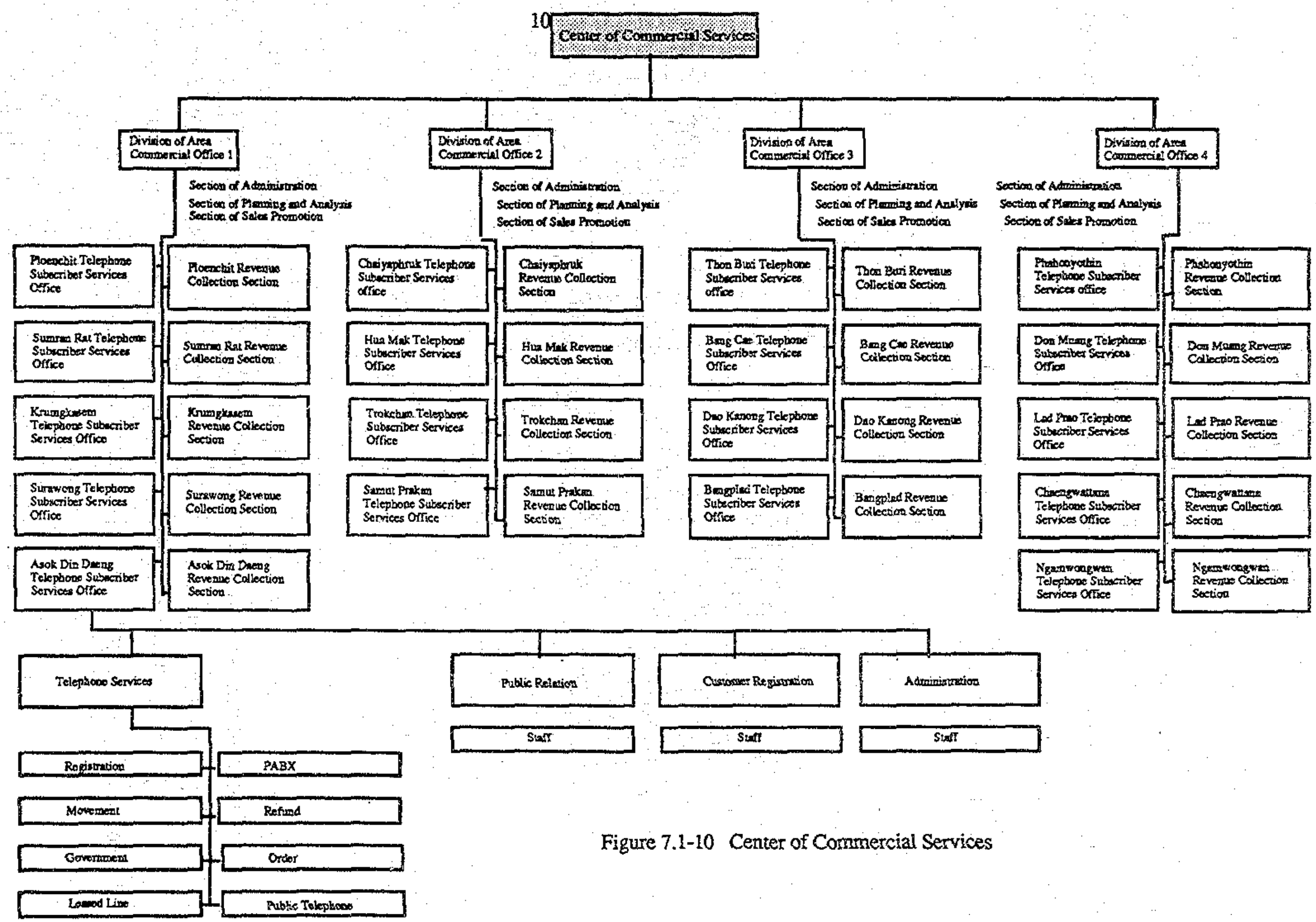


Figure 7.1-10 Center of Commercial Services

7.2 Actual Situation of Operation and Maintenance

7.2.1 Labor Productivity

A suitable employee allocation for providing good customer services and cutting down operation costs is an important matter because operation and maintenance activities mostly depend on manpower. The establishment of a proper staffing system is indispensable for realizing successful business.

1) Switching Section

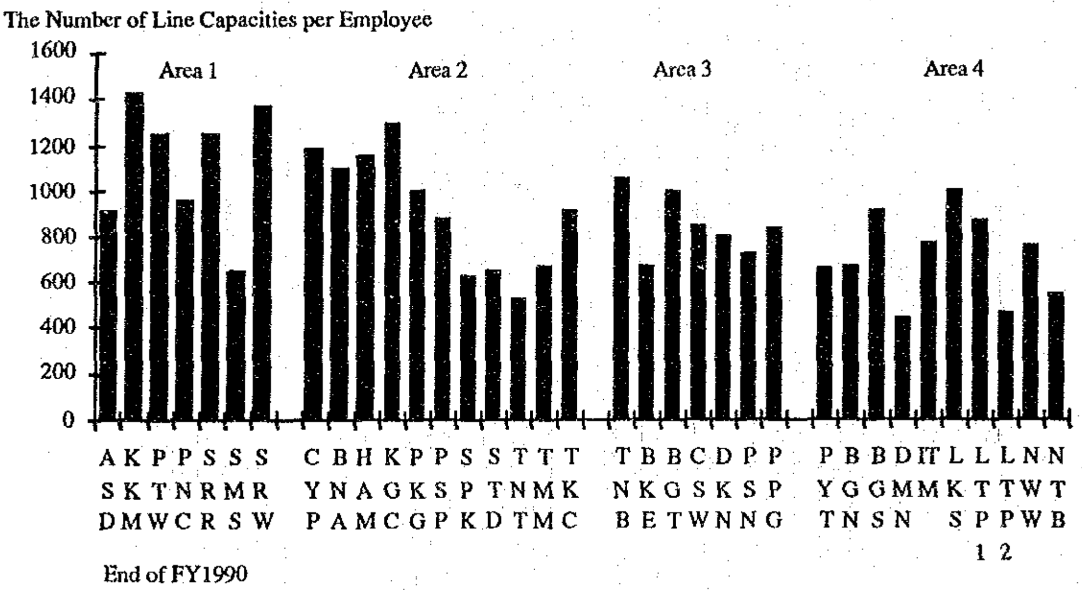


Figure 7.2.1-1 The Number of Line Capacities per Employee

Figure 7.2.1-1 and Table 7.2.1-1 show the number of line capacities per employee for the XB switches at the end of FY 1990. The average number of line capacities per employee is about 940 in the BMA. However, there exist quiet differences among exchange office. The maintenance area 1 and 2 have higher figures than other areas. The staffing imbalance may cause a decrease of customer service quality.

Table 7.2.1-1 The Number of Line Capacities (XB) per Employee

End of FY1990

Area	Exchange Office Name		Unit	(1) XB [Line Capacity]	Mainte.	Test	(2) Total	(3) = (1) / (2)
1	ASOK DIN DAENG	ASD	1	10,000	6	5	11	909
1	KRUNG KASEM	KKM	1	10,000	7		7	1,429
1	PATHUM WAN	PTW	1	10,000	4	4	8	1,250
1	PHLOEN CHIT	PNC	2	22,000	14	9	23	957
1	SAMRAN RAT	SRR	3	30,000	18	6	24	1,250
1	SAMSEN	SMS	1	5,800	5	4	9	644
1	SURAWONG	SRW	3	30,000	17	5	22	1,364
	AREA1 TOTAL		12	117,800	71	33	104	1,133
							0	
2	CHAIYRPHRUK	CYP	1	13,000	6	5	11	1,182
2	BANG NA	BNA	1	12,000	7	4	11	1,091
2	HUA MAK	HAM	1	8,000	4	3	7	1,143
2	KHLONG CHAN	KGC	1	13,000	6	4	10	1,300
2	PHRA KHANONG	PKG	1	8,000	4	4	8	1,000
2	PU CHAO SAMING PHRAI	PSP	1	7,000	4	4	8	875
2	SAMUT PRAKAN	SPK	1	5,000	6	2	8	625
2	SATHUPRADIT	STD	1	3,250	3	2	5	650
2	THANON TOK	TNT	1	5,250	6	4	10	525
2	THUNG MAHAMEK	TMM	1	10,000	10	5	15	667
2	TROK CHAN	TKC	1	10,000	6	5	11	909
	AREA2 TOTAL		11	94,500	62	42	104	909
3	THON BURI	TNB	1	20,000	14	5	19	1,053
3	BANG KHAE	BKE	1	6,000	4	5	9	667
3	BANG PHLAT	BGT	1	11,000	7	4	11	1,000
3	CHARAN SANITWONG	CSW	1	5,100	4	2	6	850
3	DAO KHANONG	DKN	1	12,000	8	7	15	800
3	PHASI CHAROEN	PSN	1	5,000	3	4	7	714
3	PHRA PRADAENG	PPG	1	3,310	3	1	4	828
	AREA3 TOTAL		7	62,410	43	28	71	879
4	PHAHONYOTHIN	PYT	2	17,800	22	5	27	659
4	BANG KHEN	BGN	1	10,000	10	5	15	667
4	BANG SU	BGS	1	10,000	8	3	11	909
4	DON MUANG	DMN	1	3,480	5	3	8	435
4	INTHAMARA	ITM	1	10,000	9	4	13	769
4	LAK SI	LKS	1	6,000	5	1	6	1,000
4	LAD PHRAO-1	LTP1	1	5,200	4	2	6	867
4	LAD PHRAO-2	LTP2	1	3,200	3	4	7	457
4	NGAN WONG WAN	NWW	1	5,300	4	3	7	757
4	NONTHABURI	NTB	1	3,300	3	3	6	550
	AREA 4 TOTAL		11	74,280	73	33	106	701

Source: Operations Department
Note: It was excluded deficient data

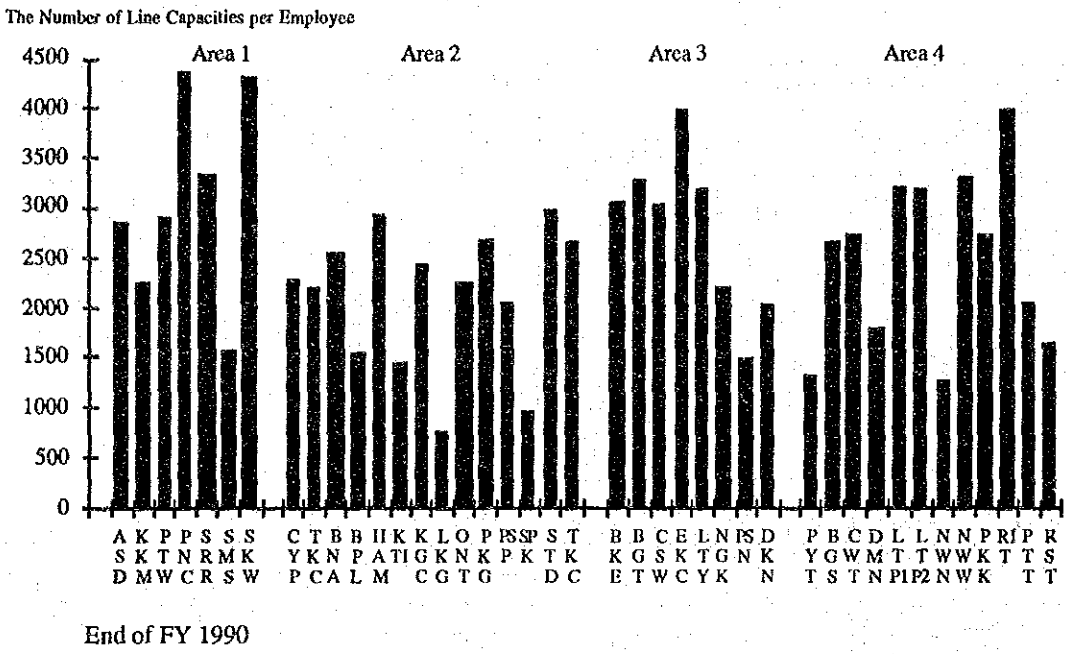


Figure 7.2.1-2 The Number of Line Capacities (SPC) per Employee

Figure 7.2.1-2 and Table 7.2.1-2 show the number of line capacities per employee for the SPC switches at the end of FY 1990. The average number of line capacities per employee is about 2,600 in the BMA. There are significant differences among areas and exchange offices. Especially, the maintenance area 2 has a lower figure than other areas.

Table 7.2.1-2 The Number of Line Capacities (SPC) per Employee

End of FY 1990

Area	Exchange Office		Unit	(4) SPC [Line Capacity]	Mainte.	Test	(5) Total	(6) = (4) / (5)	RSU Unit	Line Capacity
1	ASOK DIN DAENG	ASD	1	28,480	3	7	10	2,848		
1	KRUNG KASEM	KKM	2	60,384	21	6	27	2,236		
1	PATHUM WAN	PTW	1	20,240	3	4	7	2,891	1	1,000
1	PHLOEN CHIT	PNC	1	30,480	3	4	7	4,354	6	5,920
1	SAMRAN RAT	SRR	1	26,640	4	4	8	3,330		
1	SAMSEN	SMS	1	6,242	2	2	4	1,561		
1	SUKHUMWIT	SKW	2	68,912	6	10	16	4,307	6	6,144
	AREA1 TOTAL (1990)		9	241,378	42	37	79	3,055	13	13,064
2	CHAIYRPHRUK	CYP	1	20,480	6	3	9	2,276		
2	BANK CHAN	TKC	1	13,192	2	4	6	2,199	4	4,096
2	BANG NA	BNA	1	15,240	5	1	6	2,540		
2	BANG PHLI	BPL	1	12,192	7	1	8	1,524	13	12,816
2	HUA MAK	HAM	1	20,384	2	5	7	2,912		
2	KHLONG TOEI	KTI	1	10,000	2	5	7	1,429	1	512
2	KHLONG CHAN	KGC	1	19,240	3	5	8	2,405	7	8,096
2	LAT KRABANG	LKG	1	3,820	4	1	5	764	1	1,024
2	ON NUT	ONT	1	20,312	4	5	9	2,257	1	1,000
2	PHRA KHANONG	PKG	1	21,360	6	2	8	2,670		
2	PU CHAO SAMING PHRAI	PSP	1	8,120	2	2	4	2,030	10	10,240
2	SAMUT PRAKAN	SPK	1	2,870	3		3	957		
2	SATHUPRADIT	STD	1	14,862	3	2	5	2,972		
2	TROK CHAN	TKC	1	13,192	4	1	5	2,638		
	AREA2 TOTAL (1990)		14	195,264	53	37	90	2,170	37	37,784
							0			
3	BANG KHAE	BKE	1	12,192	3	1	4	3,048		
3	BANG PHLAT	BGT	1	29,540	3	6	9	3,282	9	9,216
3	CHARAN SANITWONG	CSW	1	15,192	3	2	5	3,038		
3	EKKACHAI	EKC	1	19,970	1	4	5	3,994		
3	LAT YA	LTY	1	25,360	5	3	8	3,170	3	3,072
3	NONG KHAEM	NGK	1	13,192	3	3	6	2,199	5	5,096
3	PHASI CHAROEN	PSN	1	5,942	2	2	4	1,486		
3	PHRA PRADAENG	DKN	1	14,144	1	6	7	2,021		
	AREA3 TOTAL (1990)		8	135,532	21	27	48	2,824	17	17,384
4	PHAHONYOTHIN	PYT	1	9,300	5	2	7	1,329	4	4,072
4	BANG SU	BGS	1	13,192	3	2	5	2,638	2	8,144
4	CHAENG WATTHRNA	CWT	1	16,192	2	4	6	2,699	4	4,096
4	DON MUANG	DMN	1	14,240	7	1	8	1,780	14	13,680
4	LAD PHRAO-1	LTP1	1	15,960	4	1	5	3,192	2	2,048
4	LAD PHRAO-2	LTP2	1	22,240	3	4	7	3,177	2	2,000
4	NAWA NAKHON	NWN	1	5,000	2	2	4	1,250		
4	NGAN WONG WAN	NWW	1	26,591	4	4	8	3,324		
4	PAK KRET	PKK	1	16,288	3	3	6	2,715	2	2,048
4	RAM INTHRA	RIT	1	23,925	4	2	6	3,988	2	2,048
4	PHAHUM THANI	PTT	1	8,192	3	1	4	2,048	2	2,048
4	RANG SIT	RST	1	8,192	4	1	5	1,638		
	AREA4 TOTAL (1990)		12	179,312	44	27	71	2,526	34	40,184

Source: Operations Department
Note: It was excluded about deficient data

2) Outside Plant Section

a) Maintenance Section

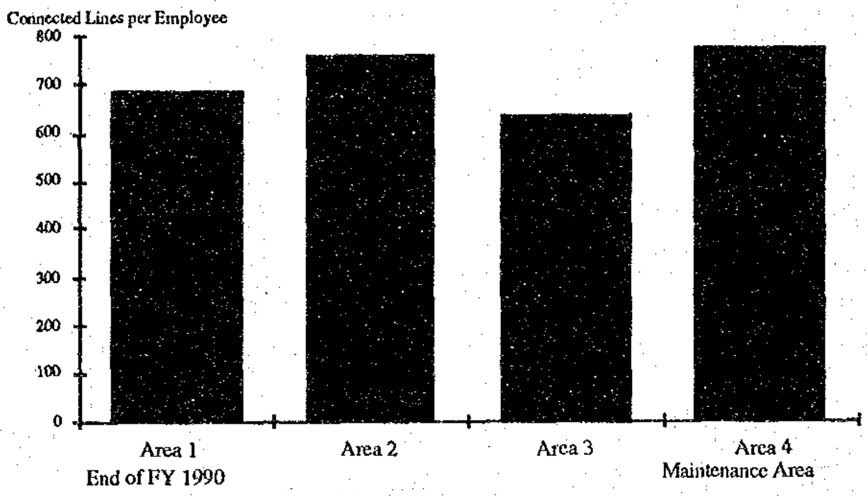


Figure 7.2.1-3 Connected Lines per Employee

Figure 7.2.1-3 and Table 7.2.1-3 show the number of connected lines per employee of the maintenance section in the outside plant field at the end of FY1990. The average number is about seven hundred and ten (710) connected lines in the BMA. There is no significant difference among the areas.

Table 7.2.1-3 Connected Lines per Employee

End of FY1990

	E	Cr	W	(1) Sub Total	Used Line	(3) = (2) / (1)	A	Cl	S	(4) Sub Total	(5) = (4) / (1)
Area 1	56	306	21	383	262,976	687	17	98	16	131	0.34
Area 2	45	287	15	347	263,198	758	21	73	15	109	0.31
Area3	46	237	28	311	197,032	634	20	89	12	121	0.39
Area4	55	270	11	336	259,822	773	16	97	14	127	0.38
TOTAL	202	1,100	75	1,377	983,028	714	74	357	57	488	0.35

Note:
E (Engineer)
Cr (Craftsman)
W (Worker)
A (Administrator)
Cl (Clerical)
S (Special Officials)

b) Installation Section

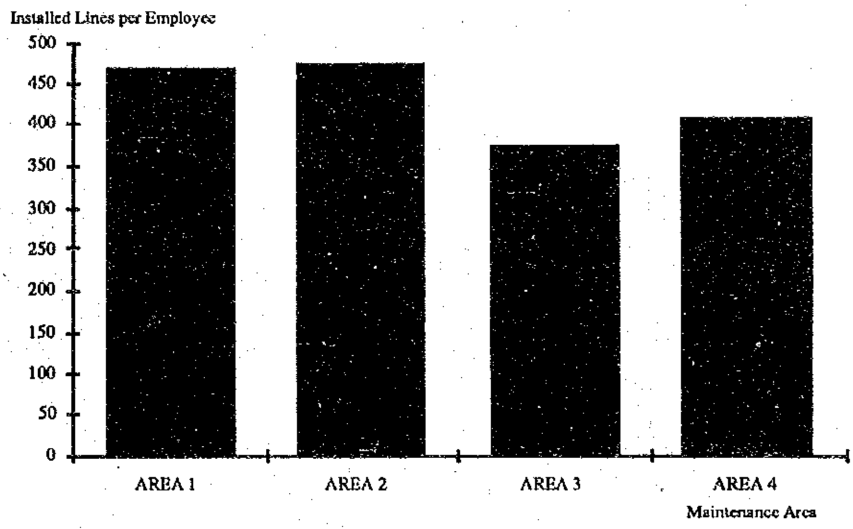


Figure 7.2.1-4 Number of Installed Lines for FY1990 per Employee

Figure 7.2.1-4 and Table 7.2.1-4 show the number of newly installed lines per employee of the installation section in the outside plant field. The average number is about four hundred and thirty (430) in the BMA. The installation area 3 has a lower figure than other areas.

Table 7.2.1-4 Number of Newly Installed Lines for FY1990 per Employee

	TECHNICIAN	ENGINEER	(1) TOTAL	(2) NO. OF INSTALL	(2) / (1)
AREA 1 (SAMSEN)	55	3	58	27,218	469
AREA 2 (PHRAKANONG)	65	3	68	32,272	475
AREA 3 (LAT YA)	59	4	63	23,636	375
AREA 4 (INTHAMARA)	72	3	75	30,606	408
TOTAL	251	13	264	113,732	431

c) Commercial Section

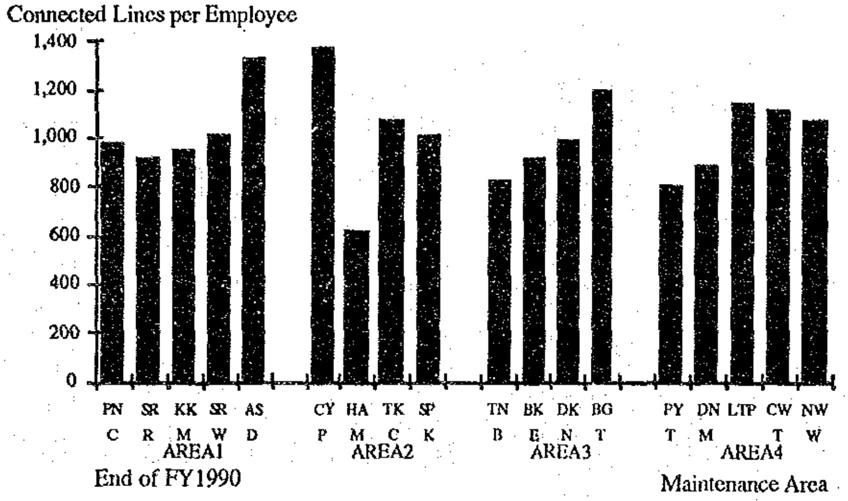


Figure 7.2.1-5 Connected Lines per Employee in the Commercial Section

Figure 7.2.1-5 and Table 7.2.1-5 show the number of connected lines per employee in the commercial section at the end of FY1990. The average number is about one thousand (1,000) in the BMA. It seems that staff allocation in the section is adequate except the Hua Mak office in the commercial area 2.

Table 7.2.1-5 The number of Connected Lines per Employee

End of FY1990

Office Name	(1) U.L	(2) Employee (S.S.O)	(3) Employee (R.S.)	(4) = (2)+(3)	(5) Employee (A.C.O.)	(6) = (4)+(5)	(1) / (4)
Phloen Chit	52,718	26	28	54			976
Samran Rat	48,961	29	24	53			924
Krung Kasem	54,796	25	33	58			945
Surawong	49,450	30	19	49			1,009
Asok Din Daeng	57,051	27	16	43			1,327
AREA 1 TOTAL	262,976	137	120	257	51	308	1,023
Chaiyaphruk	97,036	39	32	71			1,367
Hua Mak	41,969	39	29	68			617
Trok Chan	68,866	36	28	64			1,076
Samut Prakan	54,737	29	25	54			1,014
AREA 2 TOTAL	262,608	143	114	257	43	300	1,022
Thon Buri	43,823	31	22	53			827
Bang Khae	39,777	26	17	43			925
Dao Khanong	54,796	31	24	55			996
Bang Phlad	58,636	30	19	49			1,197
AREA 3 TOTAL	197,032	118	82	200	40	240	985
Phahonyotin	43,284	29	25	54			802
Don Muang	30,880	24	11	35			882
Lad Prao	63,841	32	24	56			1,140
Chaeng Wattana	58,159	31	21	52			1,118
Ngam Wong Wan	59,079	31	24	55			1,074
AREA 4 TOTAL	255,243	147	105	252	46	298	1,013
TOTAL	977,859	545	421	966	180		1,012

Note U.L.is the abbreviation for Used Lines. S.S.O is the abbreviation for Subscriber. Service Office
R.S.is the abbreviation for Revenue Section A.C.O.is the abbreviation for Area Commercial Office

7.2.2 Current Situation of Operation and Maintenance

1) Switching Section

a) Job Description

Table 7 2.2-1 shows the job description in the switching section.

b) Fault Repair Work

Figure 7.2.2-1 shows a flow of fault repair works in the switching section.

c) Current Situation in Exchange Office

The followings are the examples of an current work situation in an exchange offices in the BMA.

i) Asok Din Daeng Exchange Office

- Organization Form   End Office

    See Figure 7.1-4

- Line Capacity

XB Switch	10,000
SPC Switch	30,000

- Fault Repair Work

Number of abnormal fault repairs per day	1 to 2
Number of ordinary fault repairs per day	10 to 20

- Number of Employees

Cross Bar	Maintenance	5 Persons
	MDF (Test)	5 Persons
SPC	Maintenance	5 Persons
	MDF (Test)	3 Persons

- Duty Work Hour

    - 8:00 - 16:00

    The maintenance work except the duty work hours in the exchange offices is covered by the Krung Kasem switching office.

Table 7.2.2-1 Job Item in Switcing Section

Classification	*Job Category*	*Work Item*	Exchange Center	Maintenance Center	National OMC	Others
Maintenance Work	**Alarm Supervision**	*ALDP / AALP Supervision*	0	0	0	
		Autonomous Message Supervision			0	
	Routine Fault Supervosion	*Autonomous Message Supervision*			0	
		Preventive Routine Test	0			
	Subscribers Compaints Treatment	*Reception of Complaint Calls and Test*	*	*	*	17 ABC
	Routine Maintenance	*Routine Inspection of Equipment*	0			
	Trouble Repair	*Trouble Shooting*	0			
		Various Replacement Work	0	0		
	Emergency Processing	*Action of System Emergency*	0			
	Management	*File Management*	0			
		Spare Part Stock Control	0	0		
		Maintenance Statictics	0			
Operation Work	**Routine Work**	*Charging Data Collection*	0			
		Traffic Measurement				
		Service Observation				
	Demand Work	*Service Order*	0			
		Traffic Control	*	*	*	
		Change Observation	0			
		Office Data Change	0			
		Malicious Call Trace	0			
	Management	*Subscriber Data Management*	*	*	*	
		Office Data Management	*	*	*	
		Operational Job Statistics	*	*	*	

Note: O means under operations, and * means under preparations

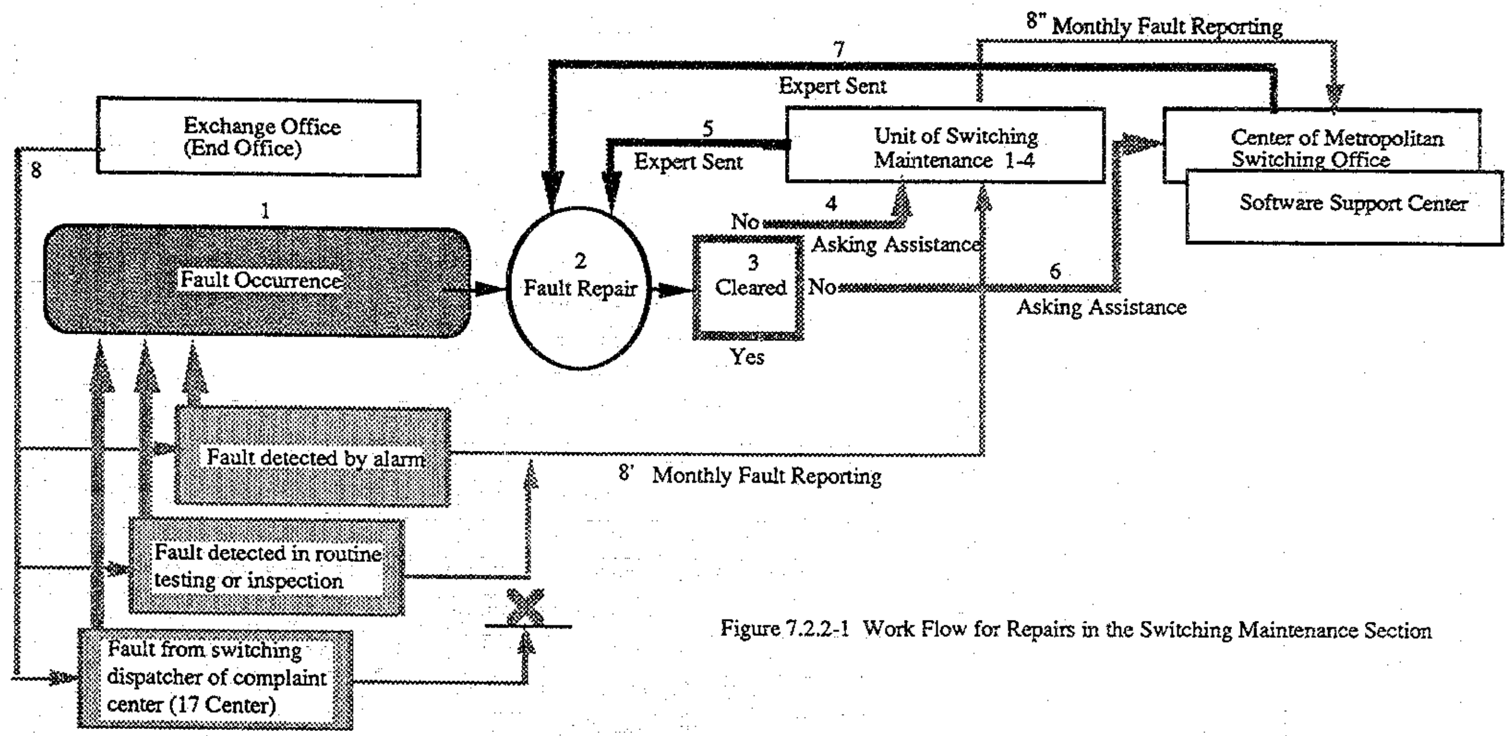


Figure 7.2.2-1 Work Flow for Repairs in the Switching Maintenance Section

2) Outside Plant Section

a) Work Volume and Staffing

Table 7.2.2-2 shows the staff allocation and the work volume of the outside plant section in the Study Area. Figure 7.2.2-2 shows a work flow for repairing faults.

The followings are examples of an actual works for the outside plant section in the BMA.

i) Divisions of Area Maintenance 1

- Organization Form — See Figure 7.1 (7 / 10)

- Standard Teams and Employees

Drop Wire	4,700 Connected Lines per Team
Cable	8,300 Connected Lines per Team
Repair and Construction	1 Team (5 Persons) per section
Leased Line	1 Team (3 Persons) per section

ii) Divisions of Area Maintenance 1 Section 6

- Organization Form — See Figure 7.1-1 (7 / 10)

- Number of Line Capacitis 38,481
- Number of Connected Lines 32,291
- Line Spares 30
- Number of Teams

Drop Wire Team	6 teams
Cable Team	3 teams

Table 7.2.2-2 System and Situation of Outside Plant

Organization	Function	Number of Sector (Location of maintenance)	Number of Employee	Number of Used line (1991.5)	Number of Repair (1990)	Persentage of Fault cleared within 1 day
Division of Metro Area Maintenance Center	Management & Planning		about 40		including about 20% of switching line repair	
Maintenance division Area 1	Maintenance	10	286	262,976	98,139	89.11%
Maintenance division Area 2	Maintenance	7	252	263,198	104,102	91.43%
Maintenance division Area 3	Maintenance	8	210	197,032	81,171	93.58%
Maintenance division Area 4	Maintenance	9	227	259,822	109,742	87.07%
Sub Total		34	1,015	983,028	393,155	90.08%
Provincial Tele. Area 6 Samut Sakhon	Installation & Maintenance	1	12	10,037	*32282 is total number of Provincial area 6	76.68%
Provincial Tele. Area 6 Nakhon Pathom	Installation & Maintenance	1	24	15,546	*32282 is total number of Provincial area 6	76.68%
Provincial Tele. Area 9 Autthaya	Installation & Maintenance	1	29	12,824	*32098 is total number of Provincial area 9	64.84%

Organization	Organization	kind of Team	Standard of Employee	Work Time		
Maintenance division Area 1	Sector	Drop Wire	4,700 line connect / 2 persons	8.00 - 16.00		
ditto	ditto	Cable	8,300 line connect / 3 persons	ditto		
ditto	ditto	Repair and Construction	1 team / 1 sector	ditto		
ditto	ditto	Leased Line	1 team / 1 sector	ditto		
Maintenance division Area 2	ditto	ditto	ditto	ditto		
Maintenance division Area 3	ditto	ditto	ditto	ditto		
Maintenance division Area 4	ditto	ditto	ditto	ditto		

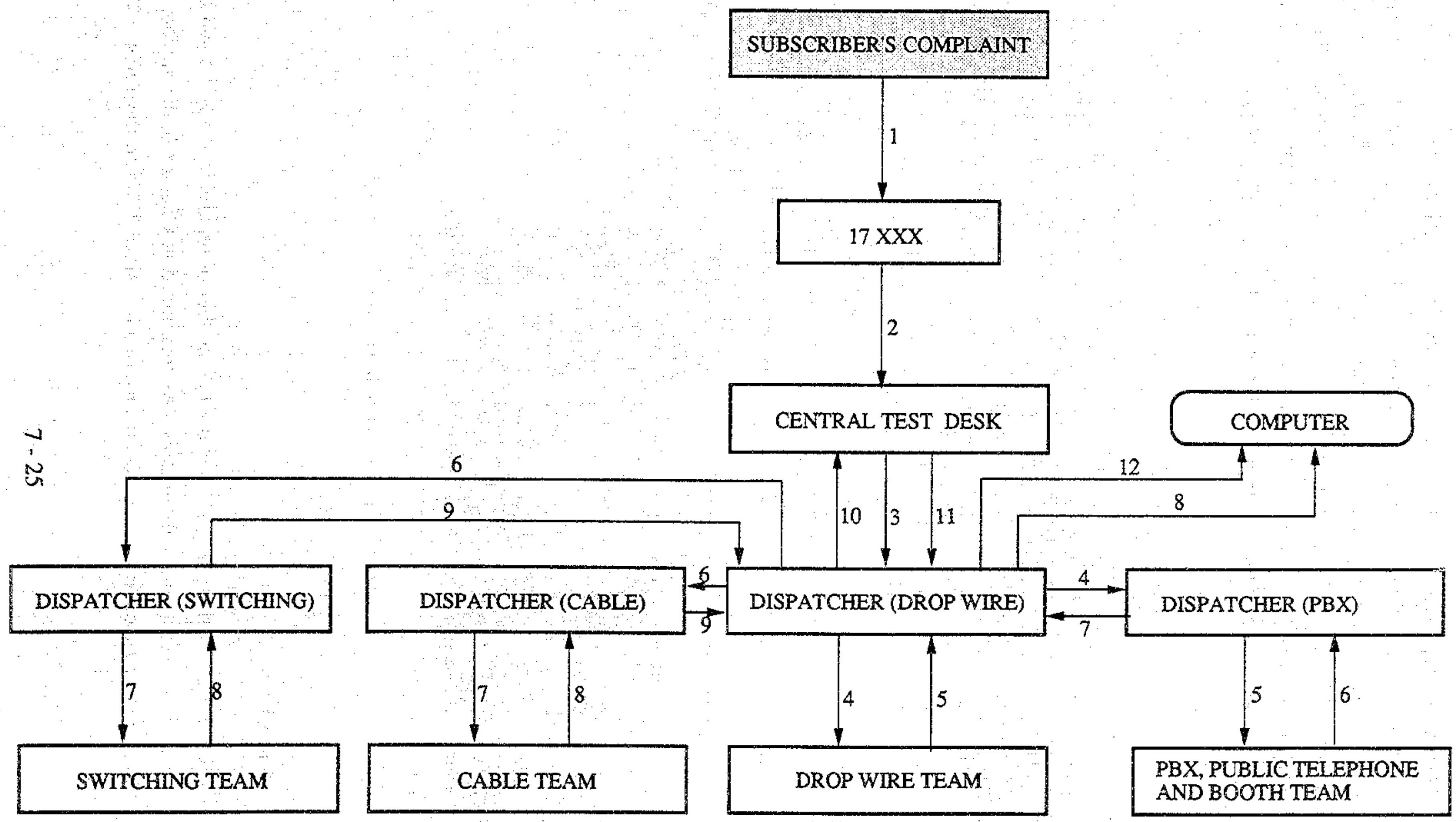


Figure 7. 2. 2 - 2 Complaint Flow

b) Installation Volume

TOT does not provide any telecommunication terminal such as a telephone sets for customers. Therefore, installation works are mainly on jumpering at MDFs.and drop wires and protector installations. Table 7.2.2-3 and Figure 7.2.2-3 show the number of installations. Since FY 1985, TOT has given private firms contracts for a part of the installation works. In FY1986, the number of installations done by the contractors amounted to approximately forty three thousand (43,000) lines.

Table 7.2.2-3 Number of Installed Lines

	1984	1985	1986	1987	1988	1989	1990
BMA (TOT)	25,458	60,018	79,052	51,406	56,693	109,371	104,294
BMA(Contractor)	0	18,158	43,042	23,188	17,814	7,463	9,438
NPT,SKN & AYA	4,098	3,148	2,560	2,695	1,636	5,136	8,331
Study Area Total	29,556	63,166	81,612	54,101	58,329	114,507	112,625

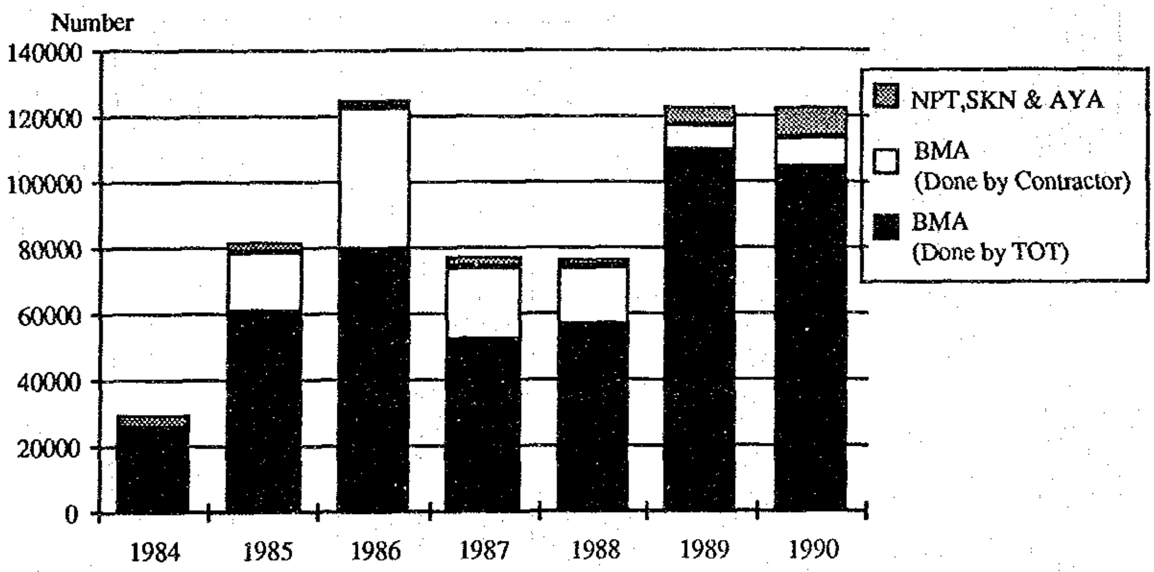


Figure 7.2.2-3 Number of Installed Lines

c) Maintenance

Table 7.2.2-4 and Table 7.2.2-5 show the number of repairs in the BMA and the provincial telecommunication areas. As mentioned in Chapter 6, the number of faults per connected line has decreasing steadily since 1985 in the BMA. The number of repairs has not been increasing in spite of the facility expansion. However, in the provincial areas, the number of faults per connected line has not been improved since 1984 because the number of repairs has been increasing with the facility expansion.

Table 7.2.2-4 Number of Repairs and Percent of Faults per Connected Line per Month in the BMA

	1981	1982	1983	1984	1985
Line Connected	287,090	312,062	339,510	361,924	433,517
Number of Repair	238,248	256,127	318,383	329,035	381,937
% Fault/Month				9.37	9.49

	1986	1987	1988	1989	1990
Line Connected	548,080	614,707	686,151	792,203	900,941
Number of Repair	352,829	344,397	380,693	354,939	353,824
% Fault/Month	7.04	4.68	6.01	5.59	4.81

Table 7.2.2-5 Number of Repairs and per cent of Faults per Connected Line per Month in the Provincial Areas

	1981	1982	1983	1984	1985
Line Connected	102,148	113,617	123,721	157,567	192,981
Number of Repair	69,231	72,340	79,596	98,447	113,777
% Fault/Month				5.85	5.43

	1986	1987	1988	1989	1990
Line Connected	250,832	286,915	319,721	365,811	423,581
Number of Repair	142,516	143,833	223,653	241,890	264,865
% Fault/Month	5.5	4.51	6.34	6.08	5.69

Note: The provincial areas mean the provincial telecommunication area 1 to 9.

Figure 7.2.2-4 and Figure 7.2.2-5 show the number of faults categorized by facilities. Most of faults have occurred on outside plants such as telephone sets, drop wires and cables both in the BMA and the Provincial Areas.

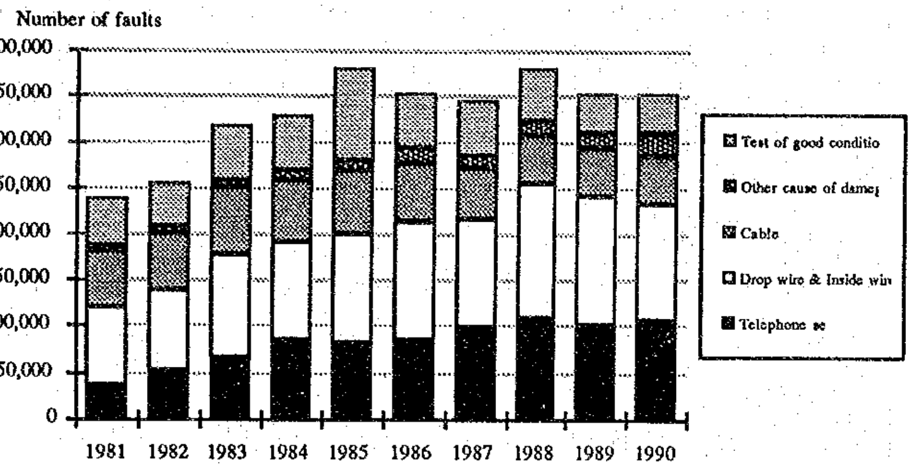


Figure 7.2.2-4 Number of Repaired Faults in the BMA

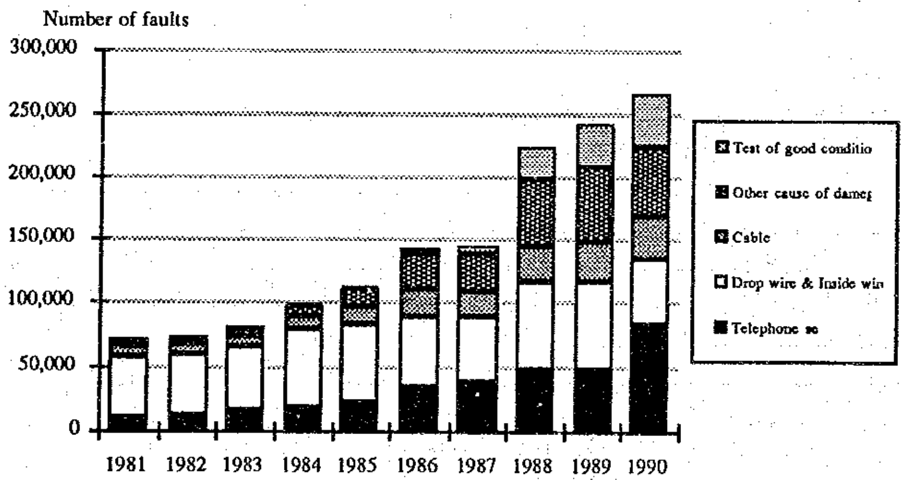


Figure 7.2.2-5 Number of Repaired Faults in the Provincial Areas

Figure 7.2.2-6 and Figure 7.2.2-7 show the required length of period of repairing in the BMA and the Provincial Areas. The required length in the BMA has been decreasing year by year; however, in the Provincial Areas it has been increasing since FY 1988.

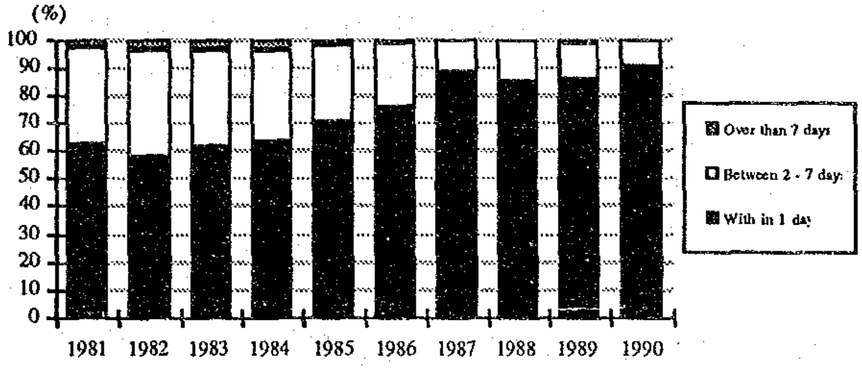


Figure 7.2.2-6 Repairing Period in the BMA

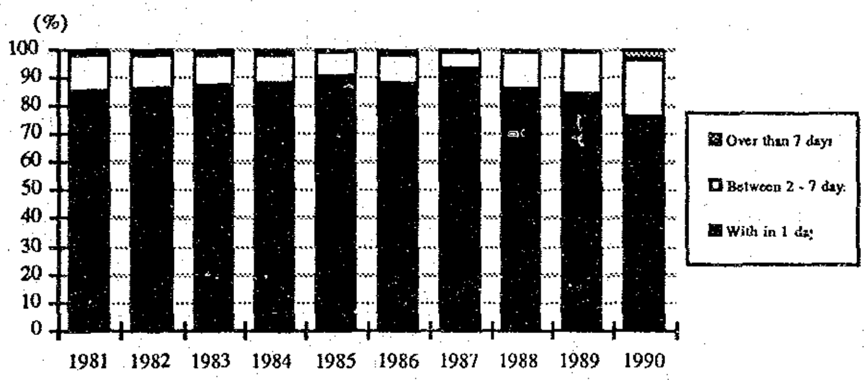


Figure 7.2.2-7 Repairing Period in the Provincial Area

3) Commercial Section

a) Ploenchit Telephone Subscriber Services Office

i) Organization Form : End Office
See Figure 7.1 (10 / 10)

ii) Range of Work Application Service Work

iii) Flow of service order work is shown in Figure 7.2.2-8

iv) Standard Employee

The standard number of employees for a commercial office is decided on the basis of the number of line units.

WORK FLOW FOR SERVICE ORDER

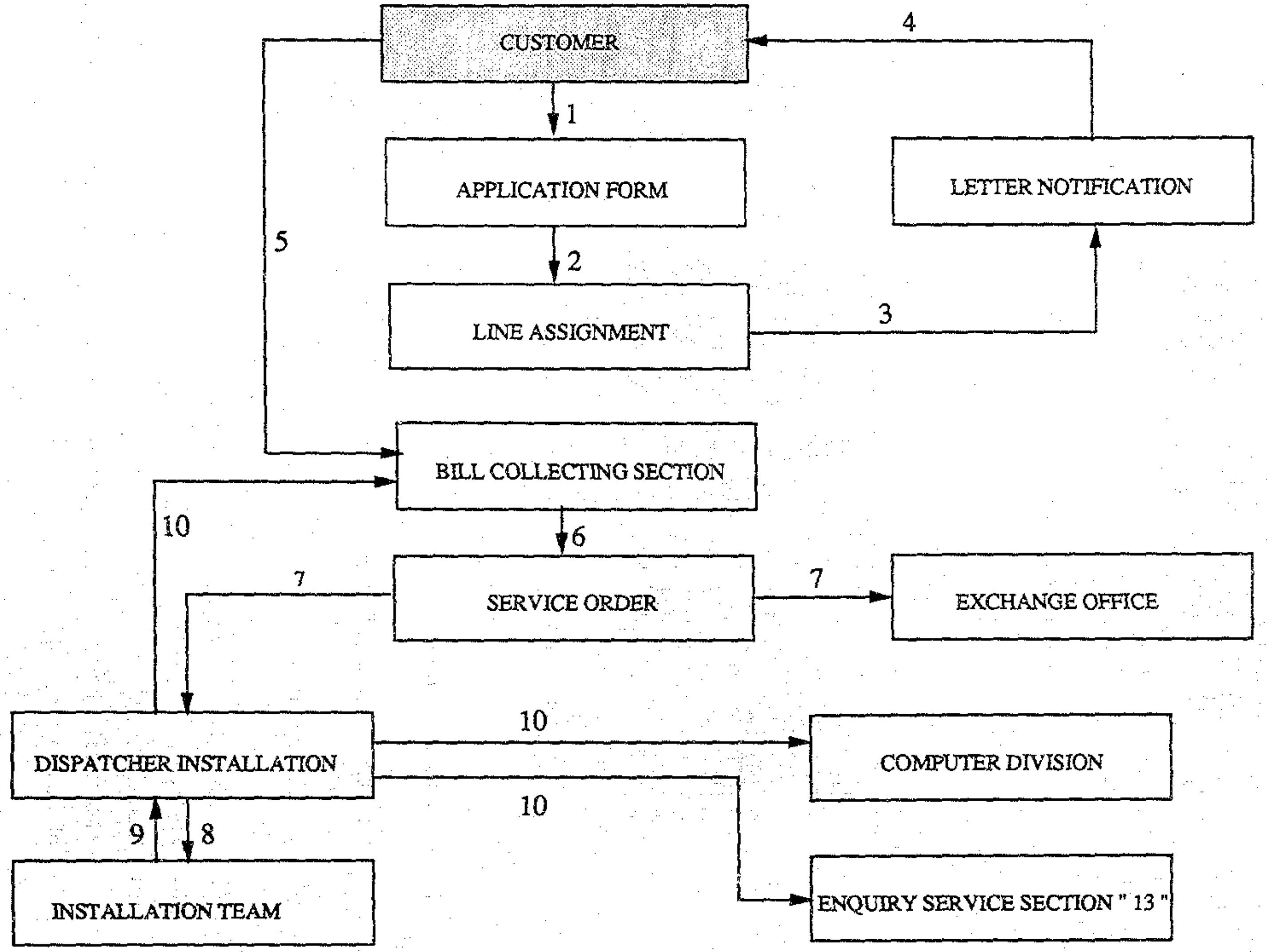


Figure 7.2.2-8 Service Order Flow

7.3 Manpower Planning and Training

As the number of subscribers, the varieties of telecommunications service offerings, and telecommunications networks and facilities expand, human resources will play greater roles for realizing successful services provision. Advanced telecommunications networks the operation and maintenance systems can not function at all without adequate human resources and a management system.

Work volume in the telecommunications field is getting bigger. However, there is a limitation of human resources. How to operate and maintain large scale telecommunications networks in a good condition without causing any service grade-down becomes an important issue.

7.3.1 Manpower Planning

1) Situation of Employees in TOT

a) Situation of Employees

Table 7.3.1-1 shows the number and classification of employees in each department of TOT in FY1991.

Table 7.3.1-1 Actual 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						1019	1019
			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	2922	2922
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	1198
	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 TEL. SERVICES	MAINTENANCE	Engineer	56	45	46	55			17	219
			Administrator	17	21	20	16			18	92
			Craftsman	306	287	237	270			7	1107
			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	1923
		OPERATOR SERVICES	Engineer	0						4	4
			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 TEL. SPECIAL EQUI.	Engineer	0						15	15
			Administrator	0						0	0
			Craftsman	0						24	24
			Clerical	0						7	7
			Special Official	0						0	0
			Worker	0						9	9
		SUB TOTAL		0	0	0	0	0	0	55	55
		TERMINAL EQUIPMENT INSTALLATION	Engineer	28	25	15	17			37	122
			Administrator	10	6	8	2			22	48
			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 7.3.1-1 Actual Number of Employees in TOT (2/2)

DEPARTMENT	SECTOR	CENTER	TYPE	BMA1	BMA2	BMA3	BMA4	SUR	OTHER	HQ	TOTAL
		COMMERCIAL SERVICES	Engineer	9	7	4	7			6	33
			Administrator	78	59	49	52			30	268
			Craftsman	20	16	22	19			9	86
			Clerical	184	204	156	198			16	758
			Special Official	1	2					1	4
			Worker	10	6	7	12			3	38
		SUB TOTAL		302	294	238	288	0	0	65	1187
	OTHERS		Engineer	0						80	80
			Administrator	0						258	258
			Craftsman	0						0	0
			Clerical	0						168	168
			Special Official	0						4	4
			Worker	0						30	30
	SUB TOTAL			0	0	0	0	0	0	540	540
	PROVINCIAL TEL. SERVICES		Engineer	0				46	852	0	898
			Administrator	0				22	419	0	441
			Craftsman	0				97	1807	0	1904
			Clerical	0				99	1837	0	1936
			Special Official	0				4	80	0	84
			Worker	0				63	1198	0	1261
	SUB TOTAL			0	0	0	0	331	6193	0	6524
SUB TOTAL				1321	1223	1030	1219	331	6193	2714	14031
ENGINEER & PROJECT			Engineer	0						722	722
			Administrator	0						181	181
			Craftsman	0						315	315
			Clerical	0						148	148
			Special Official	0						2	2
			Worker	0						147	147
SUB TOTAL				0	0	0	0	0	0	1515	1515
CORPORATE AFFAIRS			Engineer	0						118	118
			Administrator	0						20	20
			Craftsman	0						65	65
			Clerical	0						7	7
			Special Official	0						1	1
			Worker	0						11	11
SUB TOTAL				0	0	0	0	0	0	222	222
OFFICE OF INTERNAL AUDIT			Engineer	0						1	1
			Administrator	0						93	93
			Craftsman	0						0	0
			Clerical	0						14	14
			Special Official	0						0	0
			Worker	0						3	3
SUB TOTAL				0	0	0	0	0	0	111	111
OFFICE OF CORPOLATE PLANNING			Engineer	0						18	18
			Administrator	0						57	57
			Craftsman	0						0	0
			Clerical	0						7	7
			Special Official	0						0	0
			Worker	0						2	2
SUB TOTAL				0	0	0	0	0	0	84	84
TOTAL				1321	1223	1030	1219	331	6193	7568	18885

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

b) Status of Employees for Each Classification and Area

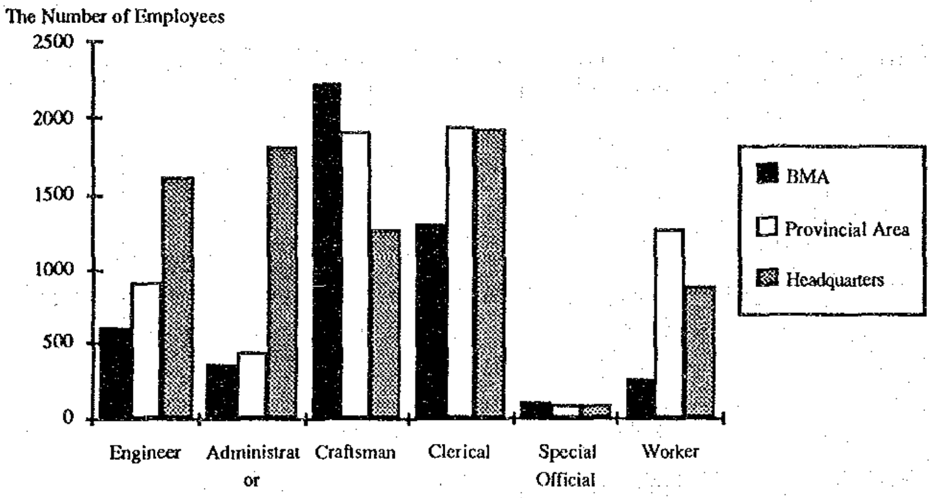


Figure 7.3.1-1 Number of Employees for Each Job Classification and Area

Figure 7.3.1-1, Figure 7.3.1-2, Figure 7.3.1-3, Figure 7.3.1-4, and Table 7.3.1-2 show how employees are distributed over job classifications and areas in 1991. Key findings are as follows:

i) there are a smaller number of engineers and a larger number of craftsmen in the BMA compared with the Provincial areas,

ii) the headquarters occupies about 50% of all engineers.

Table 7.3.1-2 Number of Employees of Each Job Classification and Area in FY1991

	BMA	Rate	Provincial	Rate	Headquarters	Rate
Engineer	590	0.12	898	0.14	1609	0.21
Administrator	343	0.07	441	0.07	1821	0.24
Craftsman	2221	0.46	1904	0.29	1263	0.17
Clerical	1292	0.27	1936	0.30	1916	0.25
Special Official	90	0.02	84	0.01	82	0.01
Workers	257	0.05	1261	0.19	877	0.12
Total	4793	1	6524	1	7568	1