CHAPTER 12

TELECOMMUNICATIONS NETWORK PLAN

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12.1 Network Structure

12.1.1 Network Structure in the Study Area

As described in Chapter 4, a three hierarchical level network structure is adopted in the BMA and a four hierarchical level network structure is adopted in the Surrounding Area. According to GAS 9 Case Study on transition of a mixed (analog / digital) national network moving to a digital national network, the existing three level network structure (upper levels from PC level are counted) is the most economical and in the case of the two level network structure, the cost will be 8.6% higher than the three level network structure.

In the era of analog telephone services by the use of metallic subscriber cables, an important point for the local network structure was how to reduce outside plant cost because the cost occupied large part of the total network cost. As a result, the number of telephone offices became rather large in multi-exchange cities because, if a telephone office covers a wide area, the cost of subscriber lines rapidly became high. Furthermore, the distance between a telephone office and a telephone terminal was limited by loss and loop-resistance permitted by the transmission engineering standard.

By the introduction of new technologies such as optical fiber cables and network digitization, transmission cost in both long distance network and local network has become cheaper and not affected by distance so much as before. It is said that for using digital switches, digital transmission and subscriber optical fiber cables, the optimal number of switching nodes become smaller than that of the existing network and the cost will be little affected by the change of the number of switching nodes. Besides, in the study of network optimization, the easiness for network function development, efficiency of operation and maintenance and network stability has become as important factors.

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 local network structure is still suitable. Figure 12.1.1 shows the basic network structure in this study. But in a detail study of the network structure plan in the BMA, circumstances peculiar to the city such as earth conditions and traffic conditions have to be considered in addition to issues related to the construction period. Because the most urgent target for the sector is to fulfill the telephone demand as early as possible especially in seventh expansion project.

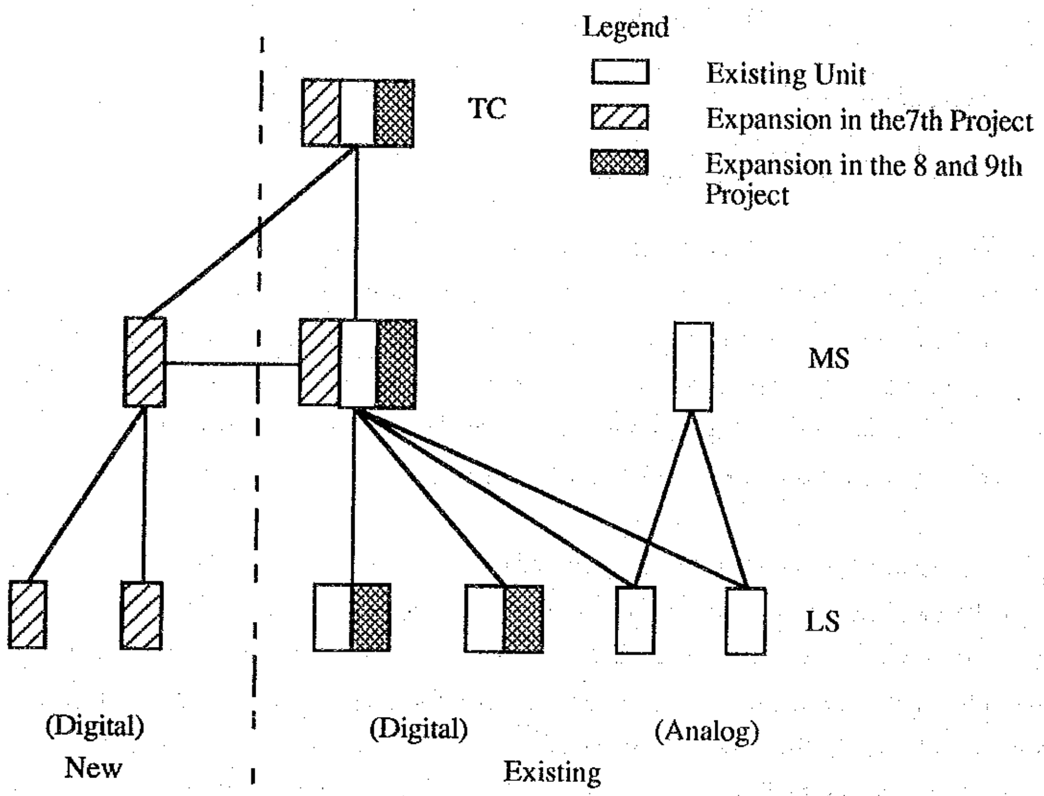


Figure 12.1.1 Basic Network Structure in the BMA

12.1.2 Case Study on the BMA Network

During the seventh expansion project, a new telephone network will be established under the BTO (Built, Transfer and Operation) scheme. In this case study, what effects will be imposed on the existing network by the new network, especially on traffic flows between the existing tandem switches and new tandem switches, will be studied for the end results of the 7th project.

1) Conditions in the Case Study

The following conditions are made for the study.

a) During the Phase 1, new switch units and a network are established separately from the existing network. The network has the same network hierarchy of the existing one.

b) During the Phase 1, new switch units are set up in each existing telephone area. They will be installed at the same offices where the existing switches are.

c) Increased subscriber lines during the Phase 2 and 3 will be accommodated by expanding the existing network capacity.

d) The main switch units having been constructed by the end of 1992 are regarded as traffic nodes in the existing network.

e) The trunk groups are sized on a one way base, 30 channel modularity and 0.01 loss probability (on basic route). High usage routes are established if the LTC (Last Trunk Capacity) method is economical on the case conditions.

f) Forecasted traffic in Chapter 10 is applied for traffic calculation.

2) Contents of Case Study

a) Estimation of the total number of trunk groups
b) Estimation of the total number of circuits
c) Estimation of the traffic volume and the number of circuits between the existing tandem switches and new tandem switches

Above items are studied in the following cases:

a) Case 1: Establish high usage routes between all switch nodes if the LTC method is economical (Figure 12.1.2-1),

b) Case 2: All traffic between the existing units and new units flow through gate way switches (tandem switches) of both networks (Figure 12.1.2-2),

c) Case 3: Nearly the same routing as the Case-2 but direct routing for intra-office traffic between two networks is allowed (Figure 12.1.2-3).

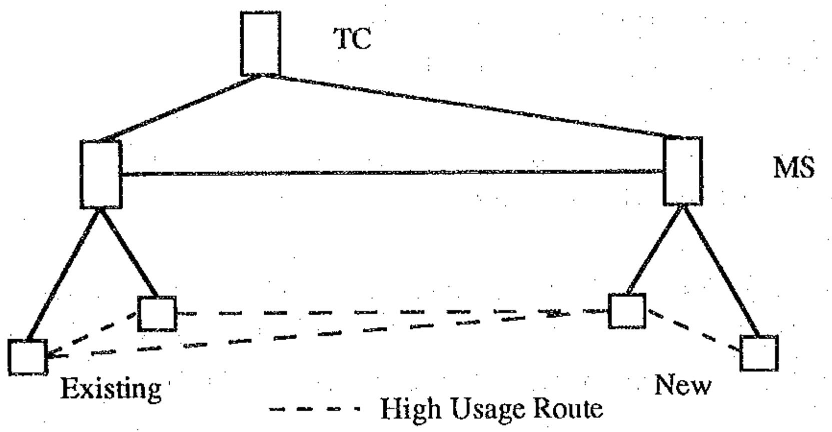


Figure 12.1.2-1 Establish high usage routes between existing LSs and new LSs if LTC method is economical (Case-1)

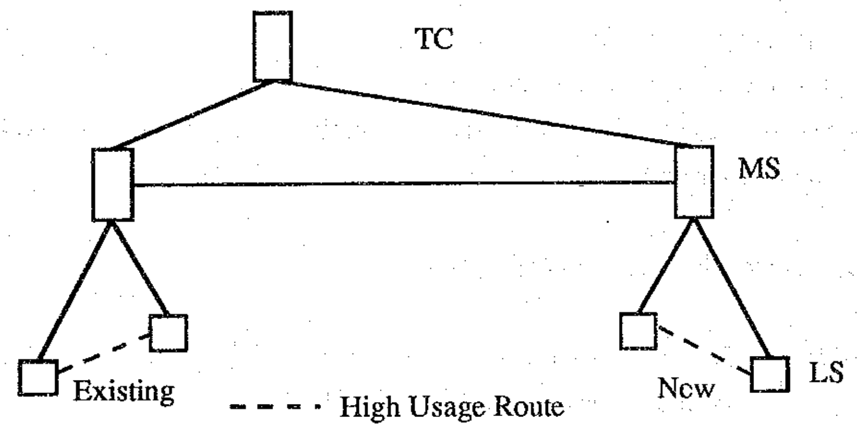


Figure 12.1.2-2 All Traffic between existing LSs and new LSs flows through gate way switches of both organizations (Case-2)

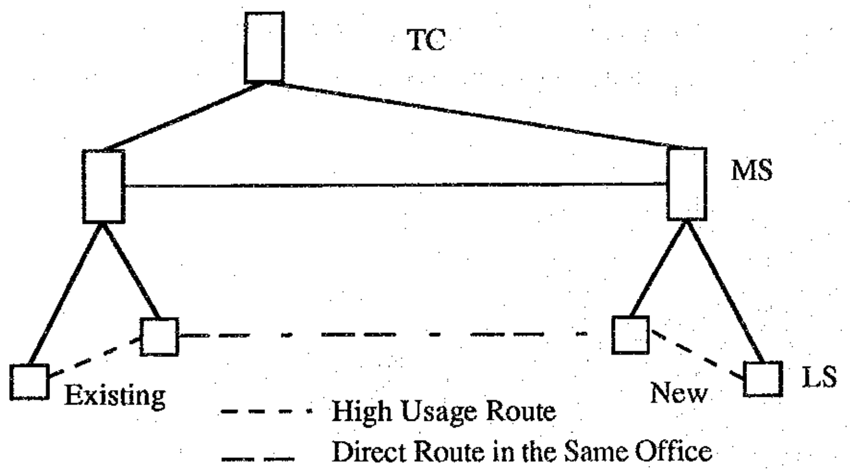


Figure 12.1.2-3 Establish direct routes between existing LSs and new LSs in the case of collocation (Case-3)

3) Results of Case Study

In the Case-1, the total number of junction circuits is smaller by 59,000 circuits (20%) compared with that of the Case-2. This corresponds to about 1.5 billion Baht in the transmission cost. Regarding the traffic between the existing tandems and the new tandems, the Case-1 is almost one ninth of the Case-2, although the number of circuits is one sixth.

In the Case-3, the number of circuits between the existing tandems and the new tandems is smaller by 7,700 circuits (13%) compared with that of the Case-2.

Other figures are shown in Table 12.1.2.

Table 12.1.2 Comparison in Each Case

	Case 1	Case 2	Case 3
Total Number of Circuits	237,000 cct (1.00)	296,000 cct (1.25)	286,000 cct (1.21)
Traffic Between Existing Tandems and New Tandems	5,900 erl. (1.00)	53,500 erl. (9.07)	46,000 erl. (8.00)
Circuits Between Existing Tandems and New Tandems	9,400 cct (1.00)	57,300 cct (6.10)	49,600 cct (5.28)

( ) : Ratio to Case-1

The circuit matrixes between exchanges in case 1, 2, and 3 are compiled in ANNEX.

12.2 Signalling System No.7

12.2.1 Features of the CCS No. 7

Common Channel Signalling System No. 7 (hereinafter referred to as "CCS No. 7") is a system in which a speech function and a signalling function are separated into different networks. The signals such as dialing information, supervisory signal are sent and received through a dedicated network which is commonly used by many speech trunks.

The main features of CCS No. 7 are as follows:

1) Signal information is expressed by combinations of bits. So, variety and capacity of signals which are required for providing enhanced network services, are greatly expanded.
2) Signal links are separated from speech trunks. So, signals can be transmitted while users are speaking.
3) Signals are transmitted through data links of 4.8 kb/s or 48 kb/s. So, a post dialing delay (time interval between the end of dialing by the user and reception of the tone such as ring-back tone, busy tone) will become shorter to about one third of the present delay time.
4) Applying both-way operation of speech trunks, the number of required trunks may become smaller than that of one-way operation.
5) On occasion of network emergencies, by transmitting information such as network control signals, information of terminal equipment, information of the results of trunk tests, automatic network control is possible.

From the features mentioned above, CCS No. 7 is the preferred signalling system between Integrated Digital Network (IDN) exchanges and within the Integrated Service Digital Network (ISDN).

With respect to both-way trunk operation refer to Appendix.

12.2.2 Basic Principle to Introduce the CCS No. 7

The basic policy to introduce "CCS No. 7" follows the Master Plan conducted by JICA in December, 1989.

In this study, the area to be studied is limited in the BMA and the Surrounding Area. However, in examining a signalling network configuration, the country wide network structure should be considered due to the traffic routing on this signalling network. Therefore, a nationwide introduction plan of CCS No. 7 was considered. Some data from the Master Plan were applied for examining the traffic and the number of circuits in the outside of the Study Area.

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 signalling 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 the R-2 signalling system.

2) Signalling Transfer Areas (a area in which a Signalling Transfer Point (STP) have responsibility for signal transfer, STA) are assigned to the same areas as the Tertiary Center Areas of the present PSTN.

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 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

12.2.3 Basic Principle of the Master Plan

Prior to examining the CCS No. 7 network, the following items are reviewed:

1) Regarding the signalling network configuration for STPs, an one-level network configuration is adopted because the reliability of STPs has been improved remarkably.

Besides, the number of signalling links per STP has become a large number to some hundreds. In case of Japan the number of signalling links per STP is approximately 700 and an one-level signalling network is being adopted. In this study, from these reasons mentioned above, large scale STPs having 700 signalling links are used to examine the signalling network.

2) The non-associated signalling mode will be adopted to economize the number of signalling links.

3) Regarding the network structure from the viewpoint of network reliability, i) each STP in a plane is linked by a mesh-structure, ii) the one-layer-network is composed of two planes, A-plane and B-plane, to secure network reliability,. iii) a SEP is connected to two STPs which belong to different planes. The concept is shown in Figure 12.2.3.

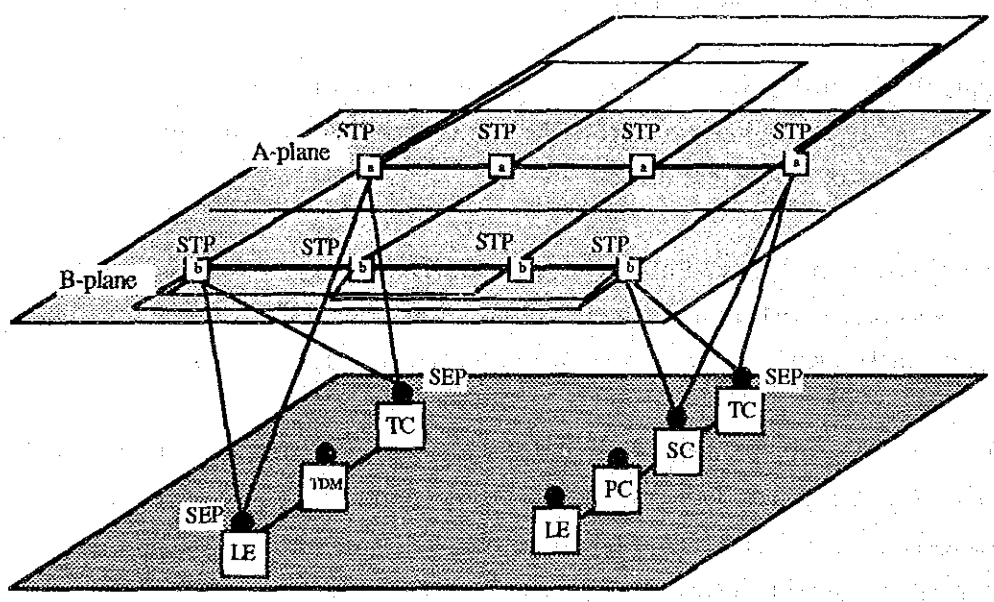


Figure 12.2.3 Concept of Network Configuration

12.2.4 Examination of Signalling Network Configuration

1) Rough Estimation

The signalling network configuration should be designed by taking account of processing capability of the STPs and the number of signal links of the STPs.

The principles of the CCS No. 7 introduction plan in the Master Plan are reviewed. The total number of circuits in the BMA is based on this study results. Regarding the total number of circuits of the provincial area, as the provincial area is out of scope in this study, it is calculated by using a ratio between the number of circuits in this study of the BMA to the Master Plan's number of circuits of the BMA. From the result concerning the total number of circuits of the BMA in this study, the total number of circuits in the BMA at 2007 is approximately 1.8 times larger then the Master Plan number. Therefore, the total number of circuits in the provincial area at 2007 in the Master Plan is multiplied by 1.8 as well as the BMA's.

Regarding the number of SEPs, the number of exchange offices is used as it number. 140 exchange offices used in this study is the number of SEPs in the BMA and 500 exchanges offices described in the Master Plan is the number of SEPs 9 in the Provincial area.

- BMA	:	334,860 channels	140 SEPs
- Provincial area	:	111,600 (62,000 X 1.8) channels	500 SEPs

334,860 channels represents the total number of required transit circuits at the end of 2007 in the BMA described in ANNEX of the Long-term Plan.

62,000 channels are for the Provincial Areas shown in ANNEX of the Master Plan.

The average number of circuits per SEP is:

- BMA	:	334,860 / 140 = 2,400 channels
- Provincial area	:	111,600 / 500 = 223 channels

Form the above calculation result, the number of channels per SEP is less than 16,000 . One 48 kb/s digital signal link can control up to approximately 16,000 voice channels. Therefore, one signal link will be sufficient for signal transmission between a SEP and a STP in both the BMA and the provincial area.

The number of STPs depends on how many signal links a STP can accommodate. The rough relationship between the number of STPs and signal links is shown in Table 12.2.4-1.

Regarding the signal traffic routing as shown in Figure 12.2.4-1, at normal time, the traffic can be equally carried on by A plane and B plane; however, at trouble time, in order to relieve the traffic on the troubled plane completely, another plane should carry double traffic volume at normal traffic. Therefore, both planes should be limited and managed to carry the traffic less than a half of the total normal time traffic.

Table 12.2.4-1 Examples of Relationship between Number of STPs and Capability

Case A: Capability of STP = 700 Signalling links per STP

	No. of SEPs (1)	No. of Signalling Links per SEP (2)	No. of STPs (1)*(2)links/700 links
BMA	140	1	1 (140<700)
Provincial Area	500	1	1 (500<700)

Case B: Capability of STP = 400 Signalling links per STP

	No. of SEPs (1)	No. of Signalling Links per SEP (2)	No. of STPs (1)*(2)links/400 links
BMA	140	1	1 (140<400)
Provincial Area	500	1	2 (500>400)

Case C: Capability of STP = 100 links per STP

	No. of SEPs (1)	No. of Signalling Links per SEP (2)	No. of STPs (1)*(2)links/100 links)
BMA	140	1	2 (140>100)
Provincial Area	500	1	5 (500>100)

Note: 1. One 48 kb/s digital signal link can control approximately 16,000 voice channels.
2. No. of STPs is for one side plane.

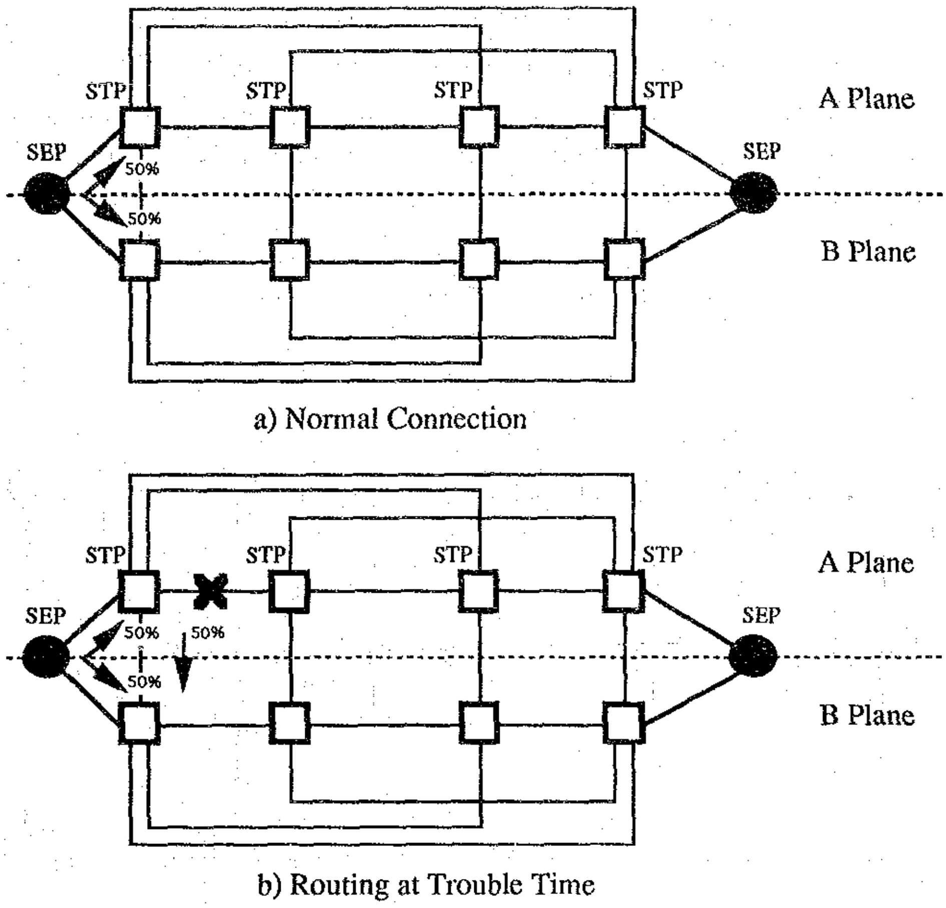


Figure 12.2.4-1 Traffic Routing

2) Signalling Network Configuration

From the rough estimation in Table 12.2.4-1, two STPs can cover all the country if a STP could accommodate 700 signalling links. In this study, the signalling network configuration is examined by using STPs which can accommodate a large number of the signalling links such as STPs mentioned above called large capacity STPs.

The large capacity STPs have become increasingly available nowadays economically due to technology advancement in the field. Consequently, one-layer signalling networks can be constructed economically using such STPs.

In order to secure the network reliability as mentioned before, the STPs shall be located on two planes of the signalling network respectively, A plane and B plane.

At present, four tertiary exchange offices, (Phisanulok, Nakhonratchasima, Surathani, Khrung Kasem) are located in the provincial area for carrying mainly the provincial telecommunication area traffic , and three tertiary exchange offices (Lat Ya, Lak Si, Phra Khanong) are located in the BMA for carrying mainly the Bangkok Metropolitan telecommunication area traffic.

Figure 12.2.4-2 shows the signalling network configuration.

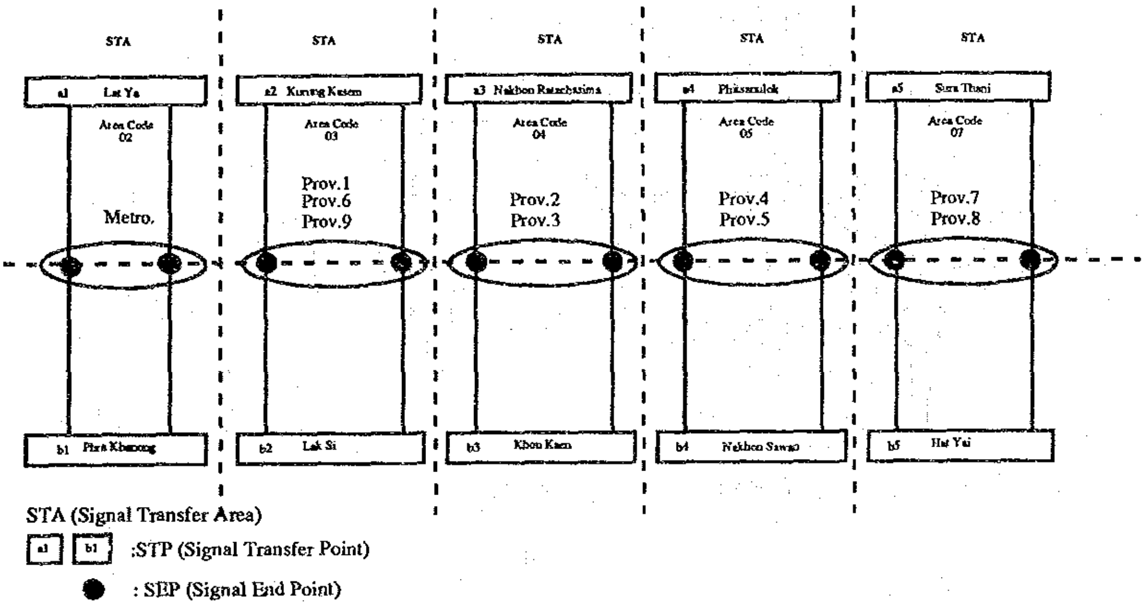


Figure 12.2.4-2 Signalling Network Configuration

STPs are connected by mesh-structure links. Each SEP is connected to STPs in A and B planes in the signal transfer area (STA). STPs in the same STA are linked each other. All SEPs in the Bangkok Metropolitan area accommodate two STPs at the territory centers, Lak Si and Phra Kanong. Two STPs at Kurung Kasem and Lak Si accommodate three provincial telecommunication area SEPs, Prov.1, Prov.6 and Prov.9. Two SEPs at Nakhon Ratchasima and Khon Kaen accommodate two provincial telecommunication area SEPs, Prov.2 and Prov.3. Provincial telecommunications areas 4 and 5 are controlled by two STPs at Phisanulok and Nakhon Sawan. Provincial telecommunications areas 7 and 8 are controlled by two STPs at Sura Thani and Hat Yai.

The call traffic through signalling network is handled by ten (10) STPs. In order to establish the network, the existing routing on the ordinary telephone network shall be reconsidered due to the different routing from the existing one At present, only overflowed traffic can be routed to alternative directions. The traffic through the CCS No. 7 network, however, shall be carried to two directions (STPs) even at normal time to secure the network reliability.

3) Estimation of Number of Signalling Links

In order to calculate the number of signalling links, the following formula is used:

$$S = \frac{\Sigma a}{P} \quad \cdots\cdots \quad (12.1)$$

where

S : Number of signalling links

Σa : Total volume of signals (bite/sec) between exchange offices

P : Capacity of a signalling link (bite/sec)
P in case of 48kb/s signalling link is 4,800 bite/sec, when the efficiency of circuit usage is 80%.

a) Signalling Links Between Exchanges and STPs

Prior to calculating the number of signalling links by using the above mentioned above formula, which signalling link is to be calculated shall be considered. In order to make a easy understanding, Figure 12.2.3-3 is used. This figure shows the case of Prov.7 and 8.

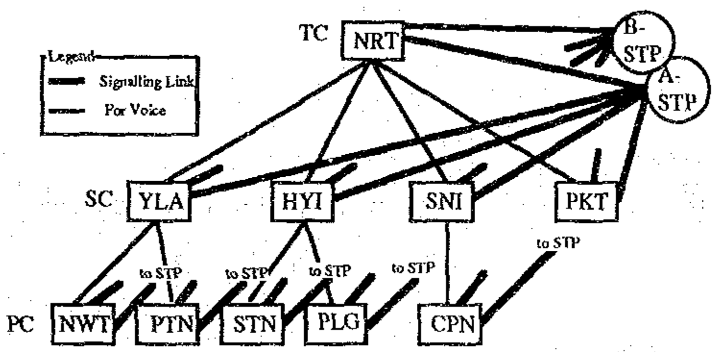


Figure 12.2.4-3 Example of Network Configuration

The number of circuits at the LEs and the PCs in the provincial telecommunication area seems small, after calculating the number of circuits at the TDMs, SCs and TCs, the number of circuits at LEs and PCs in the provincial telecommunication area will be calculated if necessary.

First of all, the largest exchange office among all exchange classes, LE, TDM, SC and TC, in 2007 is examined. LakSi T4 is the largest during this study term and the forecasted number of circuits will be approximately 36,000 in 2007.

Table 12.2.4-2 shows the volume of signals (bite /sec) between the largest exchange office, Lak Si T4 , and STP.

Table 12.2.4-2 Volume of Signals between Lak Si T4, and STP

Year		1997		2002		2007	
Services		a (bite/sec)	No. of channels	a (bite/sec)	No. of channels	a (bite/sec)	No. of channels
Total No. of circuits		-	* 20,900	-	* 32,380	-	* 36,000
Telephone	TUP	6,000	20,690	9,200	31,730	10,020	34,560
	ISUP	90	210	270	650	590	1,440
Non-Telephone		480	210	1,430	650	3,170	1,440

Note TUP : Telephone User Part
ISUP: ISDN User Part
1) Ratios for new services is 1% in Phase-1, 2% in Phase-2 and 4% in Phase-3, respectively
2) * mark's figure is referred from ANNEX
3) No. of circuits for non-telephone services is added at the same ratio as ISUP of telephone services

In 1997

Σa : 6,570 bite/sec

P : 4,800 bite/ sec

From the formula 12.1

$S = \frac{6570}{4800} = 1.37$------------ approximately 2 links for one plane

In 2002

Σa : 9,900 bite/sec

P : 4,800 bite/ sec

In the same sway

$S = \frac{10910}{4800} = 2.27$------------ approximately 3 links for one plane

In 2007

Σa : 13,780 bite/sec

P : 4,800 bite/ sec

In the same way

$S = \frac{13780}{4800} = 2.87$------------ approximately 3 links for one plane

b) Signalling Links Between STPs

The number of signalling link between the STPs are estimated by using the same formula 12.1 as mentioned above.

Table 12.2.4-3 Volume of Signals between STPs

Year		1997		2002		2007	
Services		a (bite/sec)	No. of channels	a (bite/sec)	No. of channels	a (bite/sec)	No. of channels
Total No. of	circuits	-	* 236,900	-	* 296,600	-	* 334,900
Telephone	TUP	68,000	234,500	84,300	290,670	93,240	321,500
	ISUP	980	2,400	2,430	5,930	5,500	13,400
Non-Telephone	ISUP	5,280	2,400	13,050	5,930	29,480	13,400

Note TUP : Telephone User Part

ISUP: ISDN User Part

1) Ratios for new services is 1% in Phase-1, 2% in Phase-2 and 4% in Phase-3, respectively

2) * mark's figure is referred from ANNEX

3) No. of circuits for non-telephone services is added at the same ratio as ISUP of telephone services

In order to estimate the number of signalling links between the STPs and SEPs in the Bangkok Metropolitan Telecommunication Area is taken to calculate the scale of number of signalling links.

In 1997

Σa : 74,260 bite/sec

P : 4,800 bite/ sec

From the formula 12.1

$S = \frac{74260}{4800} = 15.5$------------ approximately 16 links for one plane

In 2002

Σa : 99,780 bite/sec

P : 4,800 bite/ sec

In the same way

$S = \frac{99780}{4800} = 20.8$------------ approximately 21 links for one plane

In 2007

Σa : 128,220 bite/sec

P : 4,800 bite/ sec

In the same way

$S = \frac{128220}{4800} = 26.7$------------ approximately 27 links for one plane

c) Conclusion

From the above results, even though all local exchange offices in the BMA have three (3) links to each STP and the STPs in the BMA have 27 links to other STPs in 2007, the total number of signal links is 528 as calculated below.

3 links x 140 (No. of SEP) + 27 links x 4 (to other STPs)

= 528 links

Figure 12.2.4-4 shows the network configuration.

The above example is for the BMA. The SEPs in the provincial area do not require so many signal links as compared with the BMA. From this point, there may be no need to put four (4) STPs for one plane. But to simplify the control of the signalling network, it is better to adjust the signal transfer areas (STAs) to the A code areas in the telephone numbering system. Consequently, the number of SEPs is five (5) for one plane in the whole country.

The STPs for A and B planes are installed at the exchange offices in each STA, which are on the final trunk routes to secure the reliability of the network.

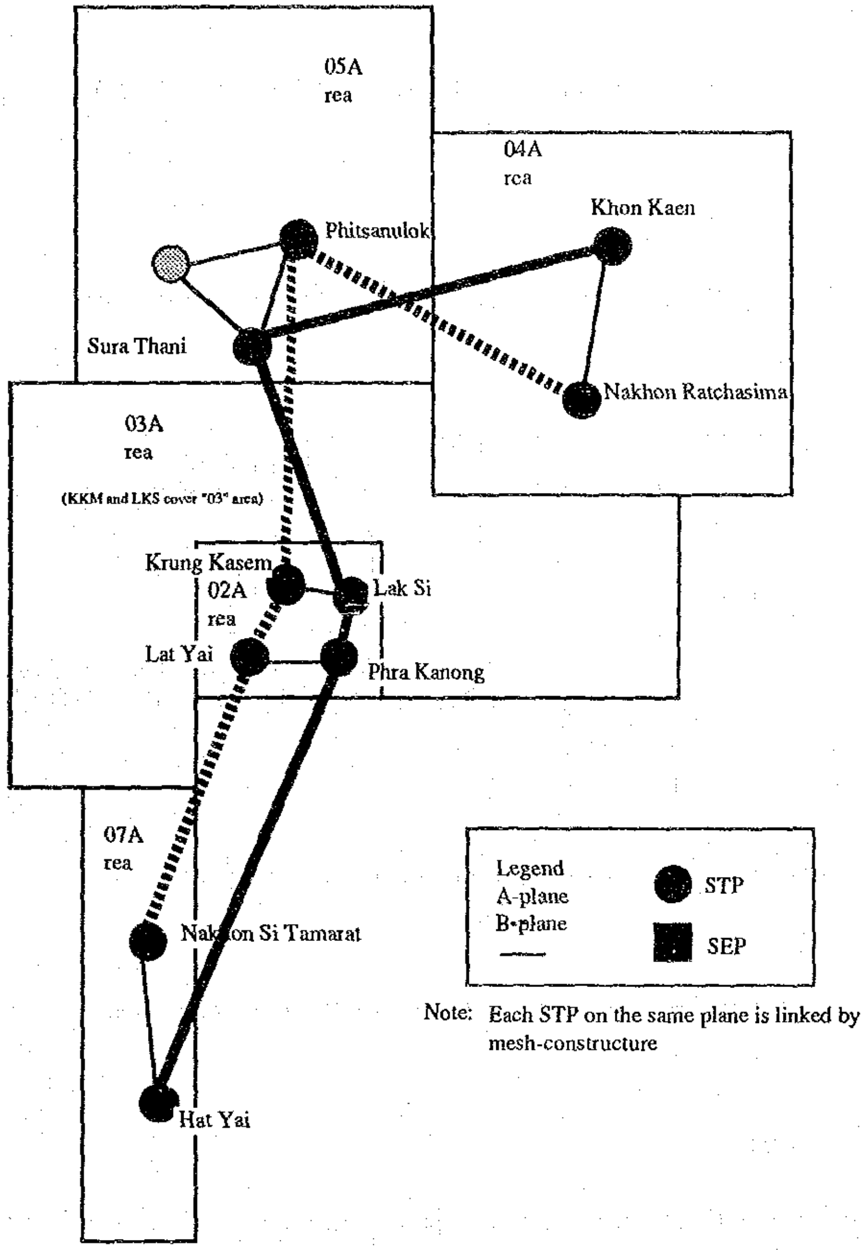


Figure 12.2.4-4 Signalling Network Configuration

12.2.5 Numbering Plan

Every signalling point (signalling end point and signalling transfer point) will be allocated in its own unique point code.

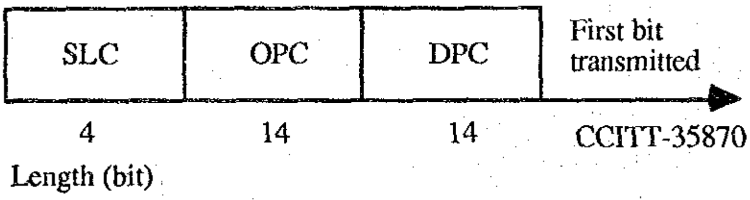
The numbering plan should be determined to have the sufficient number of SPs at the final stage of the network and to make easy routing.

1) Point code

A point code is assigned by a single number (universal access number) to a signalling point.

2) Bits

The CCITT Rec. Q704 assigns 14 bits for a signalling point code as shown in Figure 12.2.5-1.



SLC (Signalling Link Code) indicates the signalling link, connecting the destination and originating points, to which the message is related.

OPC .... Originating Point Code

DPC .... Destination Point Code

Figure 12.2.5-1 Standard Level Structure (Figure 14/Q. 704, CCITT)

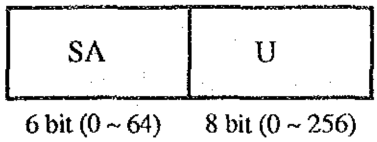
Since 14 bits allow the maximum of 16,384 (2^{14}) point code combinations, it is sufficient for the TOT network.

3) Format of Point Code

Considering to simplify the translation from point codes to routes, it is recommended that the codes of 14 bits are subdivided into 2 or 3 subdivisions.

This allows to divide the signalling network into a few geographical areas (and networks).

Figure 12.2.5-2 shows code format example and Figure 12.2.5-3 shows a structure of signalling areas corresponding to the code format example.



SA .... Signalling Area

U .... Unit code of SPs

Figure 12.2.5-2 Code Format Example

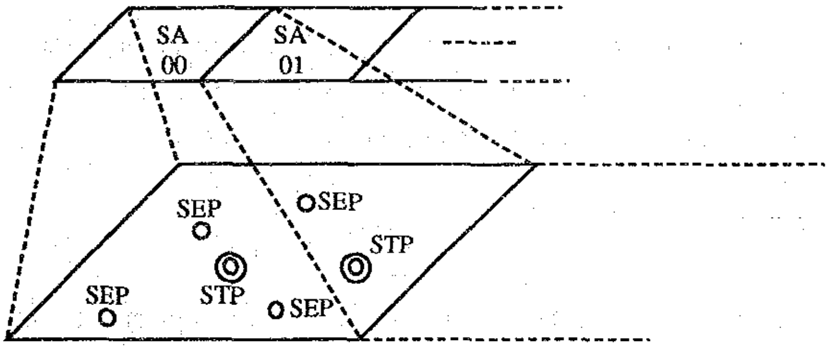


Figure 12.2.5-3 Signalling Area

12.3 Numbering Plan

12.3.1 Numbering Plan for Ordinary Telephone Service

1) General

The purpose of a numbering plan is to assign a telephone number to each subscriber without any conflict. A numbering structure should be designed to be simple for subscribers, to enable an economical telephone network expansion, and to cope with the future demand by taking international connection into consideration.

The telephone numbers are used not only to control connections between subscribers through the network but also identify the destinations for charging. In the numbering plan, the following matters should be taken into consideration.

- It should be unchanged as long as possible.

- A telephone call to a subscriber can be made from anywhere by dialing the same subscriber telephone number.

- The numbering style should be simple and easy to be understood and dialed by subscribers.

- For switching functions, the numbers should be easy to be translated for routing and charging.

- The maximum digits of a subscriber telephone number should be fixed. According to CCITT recommendation, domestic telephone number digits should not exceed twelve minus N (the digits ≤ 12 - N), where N stands for the country code digits. In the TOT case, it is allowed to have up to ten digits since Thailand country code is two, i.e., "66".

a) Examination of the Existing Numbering Capacity

Table 12.3.1-1 shows the required numbering capacity until FY 2022 calculated on the basis of the existing 7-digit numbering style. The necessary numbering capacity was estimated with a linear extrapolation based on the telephone demand at FY 2007.

Table 12.3.1-1 Estimated Necessary Numbering Capacity

	Telecom Area	Code	Y 2012	Y 2017	Y 2022	Numbering Capacity
BMA TOTAL	Area 1~4	2	7,069,161	8,083,619	9,098,077	8,000,000
Nakhon Pathom	Prov 6	34	266,155	330,042	393,929	800,000
Samut Sakhon	Prov 6	34	190,203	224,394	258,585	800,000
Ayutthaya	Prov 9	35	124,404	148,297	172,190	800,000

The present numbering style can provide sufficient telephone numbers until FY 2022 in the Surrounding Area. However, in the BMA, the shortage of numbers will occur in about FY 2017. TOT is examining to recover this issue by chaining the digit-number from 7 to 8.

This study has examined when the shortage of number will occur and what should be considered for changing the digits.

In order to estimate the necessary numbering capacity in the BMA, the following subscriber types and service categories are considered.

i) Ordinary Telephone Subscriber

ii) PABX

The direct-in-dial (hereinafter refer to call "DID") service can allow a customer to call an extension number of a centrex (CES) with direct dialing from the outside. Centrex can save main telephone lines to an exchange office; however, it need as many telephone numbers as the number of extensions. If PABX has the function of the DID service, telephone numbers are requested as many as the number of PABX extension telephones.

iii) Facsimile Service

At present, a facsimile terminal and a telephone set often share one telephone line. However, as the facsimile communications traffic increase, the facsimile terminal needs its own line to be connected, which requires an additional telephone number. The demand of the facsimile terminals in the BMA is estimated as two-thirds (rate of business telephone lines) of that in the whole Kingdom.

iv) ISDN Services

The reason why the ISDN services should be considered for examining the numbering capacity is stated in the next section 12.3.2. As long as the present analog telephone services are provided simultaneously with ISDN, the required subscriber numbers become large. In this study, two subscriber numbers are given for the BRI service and 30 subscriber telephone numbers are given for the PRI service.

2) Case Study

Three cases are selected to examine the shortage issue of the numbering capacity as shown in Table 12.3.1-2.

Table 12.3.1-2 Assumption of the Three Cases

	Case-A	Case-B	Case-C
No. of ordinary tel.	Demand up to the year 2007	Demand up to the year 2007	Demand up to the year 2007
No. of extension telephones of PABX	Based on the existing large users	Based on all extension telephones	Based on 50% of No. of extension telephones
No. of facsimiles	50% of the No. of subscribers up to the year 2007	100% of the No. of subscribers up to the year 2007	100% of the No. of subscribers up to the year 2007
No. of ISDN services	Demand up to the year 2007	Demand up to the year 2007	Demand up to the year 2007

3) Estimation of Extension Telephone of PABX

In order to estimate the figures in the above table, the present state is used.

a) Estimation of the Number of Main Lines of PABX

Figure 12.3.1-1 shows the relationship between the number of main lines of PABX and the number of business telephone lines, which is applied to estimate the number of main lines of PABX.

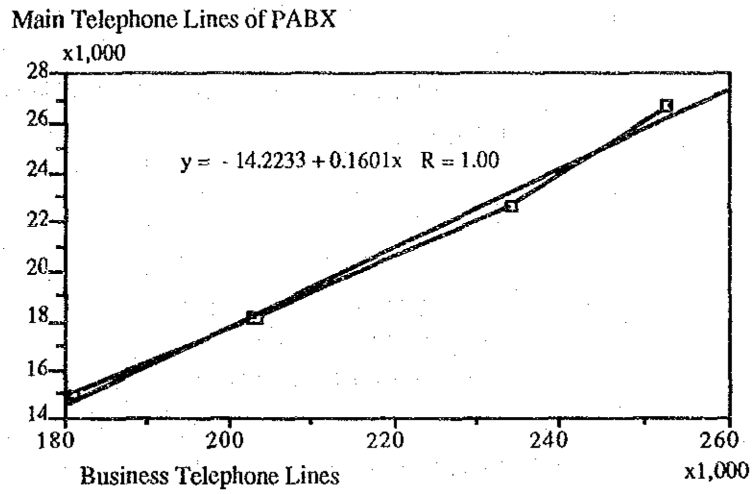


Figure 12.3.1-1 Relationship between Number of Main Lines of PABX and the Number of Business Telephones Lines

b) Estimation of the Number of Extension Telephones

Figure 12.3.1-2 shows the relationship between the number of extension telephones and the number of main lines of PABX, which is applied to the estimation.

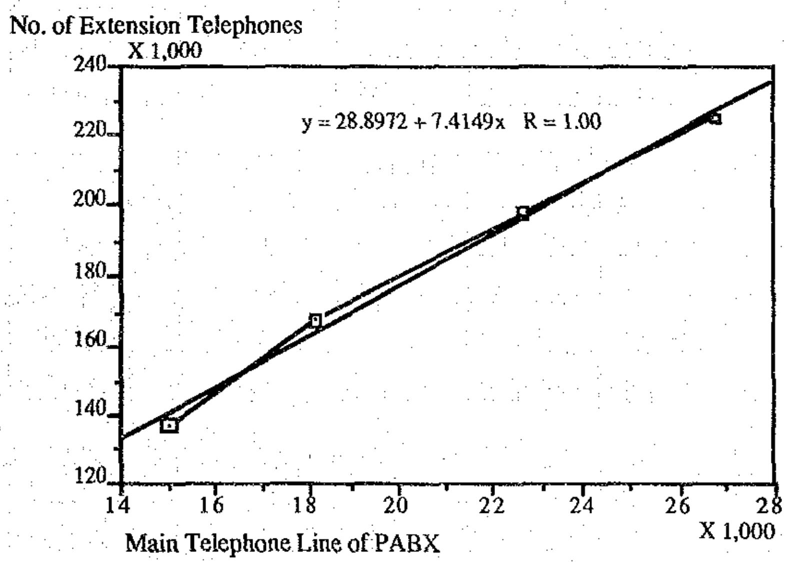


Figure 12.3.1-2 Relationship between the Number of Extension Telephones and Main Lines of PABX

c) Estimation of the Number of Extension Telephones of Large Users

This estimated figure is used for Case-A. The number of large users is estimated by using the following formula:

No. of large users = No. of extension telephones / a

a: Constant = $\frac{\text{No. of extension telephones as of 1987}}{\text{No. of large user as of 1987}}$

Large User : Having more than 400 extension telephones

4) Result of Estimation on Each Case

The estimation results on each case are shown in Table 12.3.1-3 and Figure 12.3.1-3, Figure 12.3.1-4, Figure 12.3.1-5.

Table 12.3.1-3 Estimation Results of Necessary Numbering Capacity

Case-A

Year	DID Tel	Fax (50%)	Ordinary Tel.	ISDN Tel.	Necessary No. Capa.	Numbering Capa.	Permission Limit
1992	13,563	34,500	2,133,026	2,338	2,152,427	8,000,000	6,400,000
1997	26,746	153,123	3,563,796	138,390	3,746,432	8,000,000	6,400,000
2002	45,642	220,220	5,040,245	1,440,928	6,586,811	8,000,000	6,400,000
2007	66,665	290,672	6,054,703	3,677,858	10,004,921	8,000,000	6,400,000

Case-B

Year	DID Tel	Fax(100%)	Ordinary Tel.	ISDN Tel.	Necessary No. Capa.	Numbering Capa.	Permission Limit
1992	37,078	69,000	2,133,026	2,338	2,179,442	8,000,000	6,400,000
1997	571,068	270,245	3,563,796	138,390	4,308,254	8,000,000	6,400,000
2002	954,128	440,441	5,040,245	1,440,928	7,555,293	8,000,000	6,400,000
2007	1,380,304	581,343	6,054,703	3,677,858	11,524,255	8,000,000	6,400,000

Case-C

Year	DID Tel	Fax(100%)	Ordinary Tel.	ISDN Tel.	Necessary No. Capa.	Numbering Capa.	Permission Limit
1992	151,914	69,000	2,133,026	2,338	2,294,278	8,000,000	6,400,000
1997	285,534	270,245	3,563,796	138,390	4,022,720	8,000,000	6,400,000
2002	477,064	440,441	5,040,245	1,440,928	7,078,229	8,000,000	6,400,000
2007	690,152	581,343	6,054,703	3,677,858	10,834,103	8,000,000	6,400,000

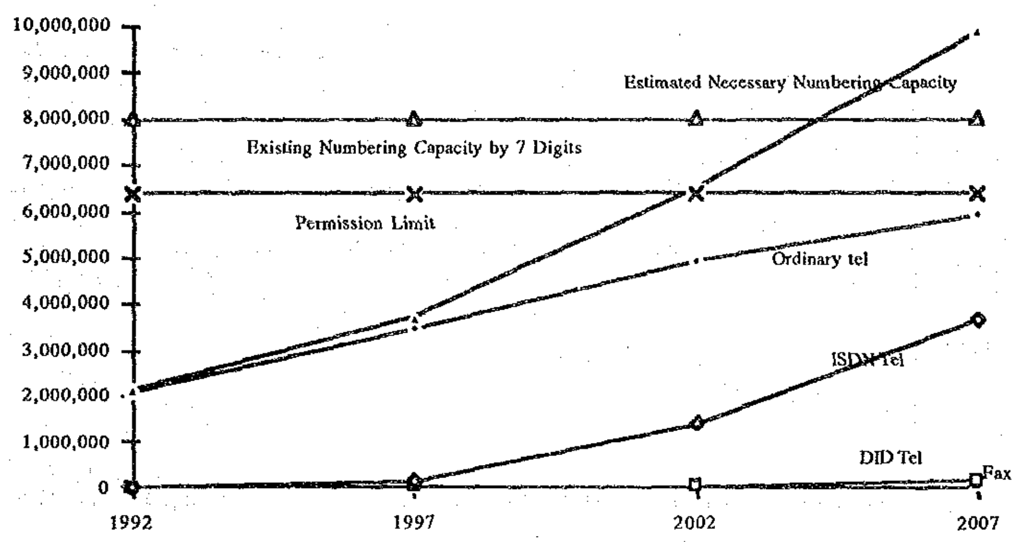


Figure 12.3.1-3 Estimation Results of Case-A

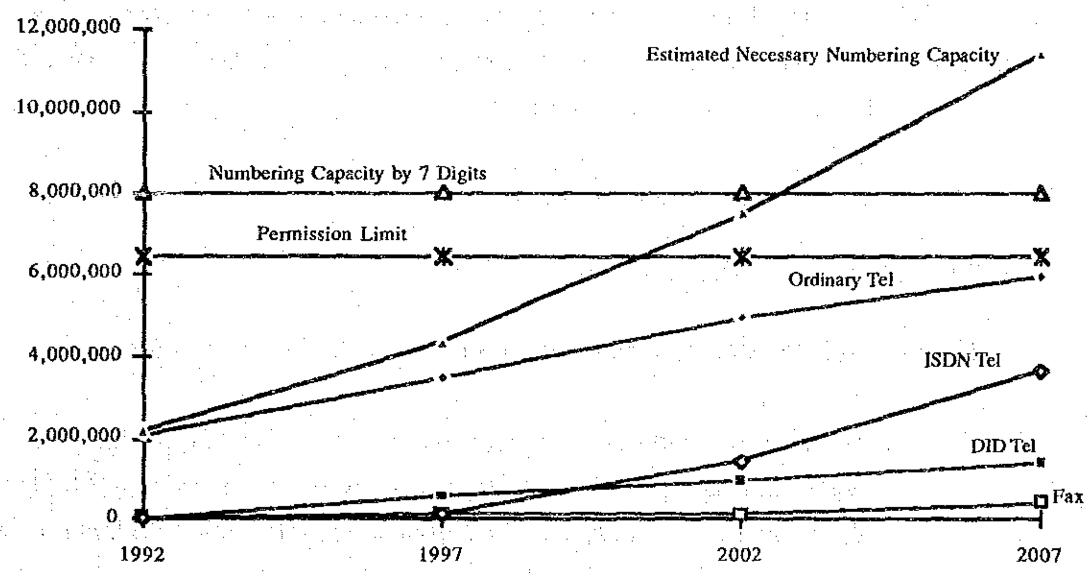


Figure 12.3.1-4 Estimation Results of Case-B

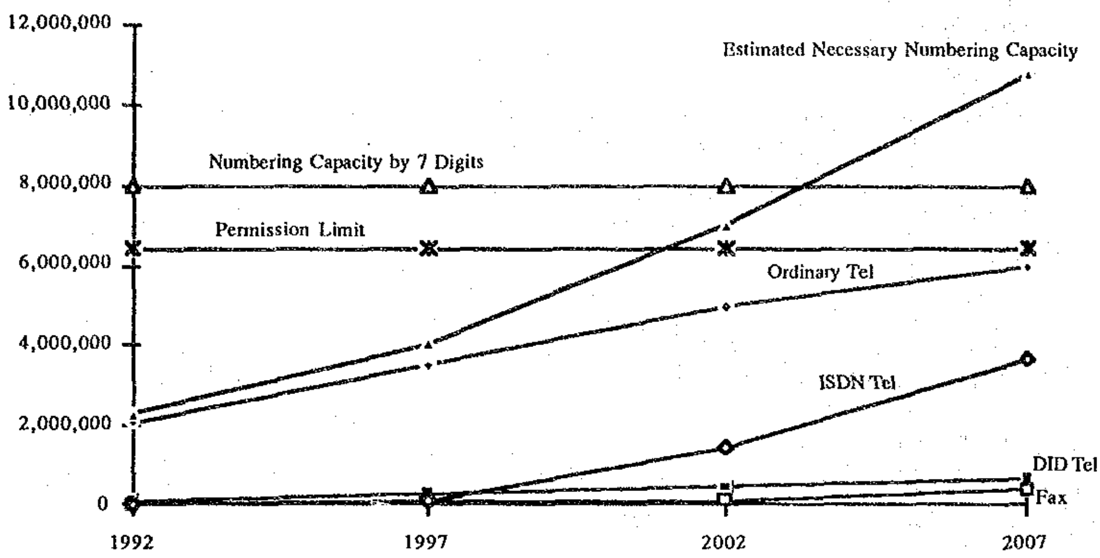


Figure 12.3.1-5 Estimation Results of Case-C

This case study result indicates that the numbering capacity shortage is expected to occur before FY 2002. The cellular mobile telephone demand and the private communications network service demand are not taken into consideration in this case study. Therefore, the time when the shortages occurs must be earlier.

5) The Issues to be Considered for the Solution

a) Provision of Subscriber Numbers

The following three cases are considered to solve the numbering shortage issue:

Case-A: By using the remaining three exchange office codes, e.g. 6xx, 7xx, 8xx and 9xx, it is able to have additional three million numbers (3,000,000) up to the maximum capacity of 7-digit style. After the 7-digit numbering capacity is fully occupied, 8-digit subscriber numbers are to be provided. The mixed numbering style of 7-digit and 8-digit is applied.

Case-B: Change the numbering system from 7-digit to 8-digit by adding one digit to the exchange office codes. The available numbers become eighty million (80,000,000).

Case-C: A 7-digit number is provided to a subscriber accommodated to an existing switch. An 8-digit number is provided to a subscriber accommodated to a new switch.
The mixed numbering style, 7-digit and 8-digit, is applied.

In conclusion, the Case-C is preferable from the following viewpoints:

i) The 7-digit numbering capacity can provide enough subscriber numbers for the time being,

ii) A preparation period from the existing 7-digit system to a new 8-digit system is required as described in Section 12.3.1 e).

b) Transition Methodology from 7-Digit to 8-Digit

In the seventh expansion project, it is not clear what kind of network configuration is to be applied. Therefore, the numbering system change should be carefully examined as described at the beginning of this section. The numbering system change methodology should be considered on the basis of the new network configuration after the sixth expansion project as follows:

i) Simultaneous Change
- Both existing and new networks
- In separate networks

ii) Gradual Change

In any case, there is no significant problem for both TOT and the customers sides. However, December 31 in the year of 1996 should not be selected for the change, because this is the date when the existing numbering plan is changed to the ISDN Era's numbering plan under the CCITT recommendation.

c) Transition Procedure

As the first step, a 7-digit subscriber number is assigned to a subscriber until the preparation for changing from 7-digit to 8-digit is finalized.

As the next step, after the preparation is finalized, the numbers should be changed from 7-digit to 8-digit simultaneously at a specific date. In this study, it is predicted that the numbering system change date must come before FY 1998 at latest.

d) Technical Consideration

If a 8-digit subscriber number is assigned to a new subscriber, the existing XB switches must be modified to send and receive the 8-digit dialing signal. At present, three types of XB switches are operating. Therefore, their modifiability from 7-digit to 8-digit should be examined immediately.

e) Preparation for Changing the Digits

Before changing the numbering system, a technical study is indispensable for all switching systems of the network and advanced notices for all subscribers are also necessary. TOT should coordinate the change with other common carriers.

Figure 12.3.1-6 shows the preparation period for changing the digits held in Tokyo, Japan on January 1 of 1991 as one example.

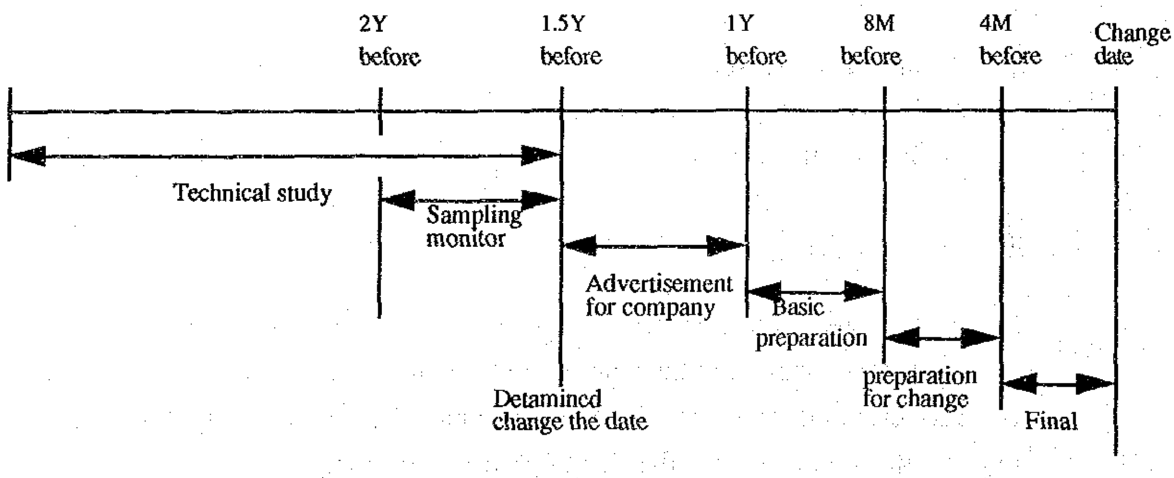


Figure 12.3.1-6 Outline of Preparation Term for Changing the Digit

6) Numbering Plan for Internetworking among Different Operating Carriers

In the future, it is expected that New Common Carriers (hereinafter referred to as NCCs) will enter into the telecommunications operation field. In this case, the numbering plan is required to be acceptable for the NCCs also. In studying the numbering plan, the following matters should be considered:

a) the difference from the existing numbering plan should be as small as possible,
b) the number of digits should be as small and easy as possible for users to understand,
c) the modification of the existing network should be as small as possible to make the preparation period short and the modification cost low.

Table 12.3.1-4 and Table 12.3.1-5 show the present numbering plan for internetworking among different operators in Japan as an example.

Table 12.3.1-4 The Numbering Plan for Internetworking among Different Operators

Connection Pattern		Configuration of the Number
Call through Transit NCCs Network	Termination Call to NTT Network	"00" + Z_1Z_2 + (Y_1Y_2) + 0 A ~ J
	Termination Call to NCC Network	"00" + Z_1Z_2 + (Y_1Y_2) + 091 + A ~ H
Call Between Different Local Operators	Termination Call to NTT Network	0 A ~ J
	Termination Call to NCC Network	091 + A ~ H
International Terminating Call	Termination Call to NTT Network	"81" + A ~ J
	Termination Call to NCC Network	"81" + 91 + A ~ H
International Originating Call through International NCCs		"00" + X(Y) + International Number

Legend
"00" : Prefix for inter-connection
Z_1Z_2 : Identification number for transit NCCs networks
Y_1Y_2 : Auxiliary number for service identification. It can be omitted
X(Y) : Identification number for international NCCs networks and services

Table 12.3.1-5 Assignment of "00" + XY

X	Assignment	Y	Assignment
1	KDD. Subscriber direct dialing (without charge information)		-
2	KDD subscriber direct dialing (with charge information)		-
3	KDD international additional services, etc.	1	Automatic collect call
		2	-
		3	-
		4	-
		5	-
		6	Data network access
		7	-
		8	Transfer account
		9	Home country direct
		0	-
4	International NCC, etc.(refer to Below Table)		
5	KDD international additional services, etc.	1	Other than subscriber direct dial
		2	-
		3	-
		4	-
		5	Automatic credit card call
		6	Information (ISD)
		7	Information (other than ISD)
		8	International facsimile service
		9	PB-ISD (note-1)
		0	Maintenance
6	International NCC, etc.(refer to below Table)		
7 8 9	Inter-NCC connection 70 : TWJ, 90 : NCC_L to NTT 77 : DDI, 91 : NTT to NCC_L 88 : JT		
0			

(note-1) Temporary use until introduction of LS-ID

(Continue to the next page.)

IDC (006Y)

Y	Assignment
1	Subscriber direct dialing (without charge information)
2	Subscriber direct dialing (with charge information)
3	Automatic the third subscriber charging
4	Answer back call service
5	Credit call service
6	Collect call service
7	International facsimile service
7 - 0	-

ITJ (004Y)

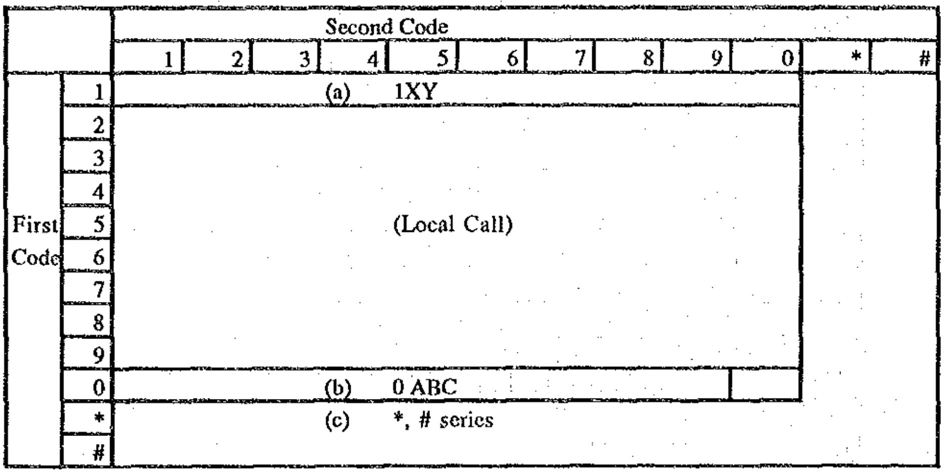
Y	Assignment
1	Subscriber direct dialing (without charge information)
2	Automatic the third subscriber charging
3	Automatic credit call service
4	Collect call service
5 - 0	-

12.3.2 Numbering Plan for Special Telecommunications Services

1) Category of Numbering Plan for Special Services

a) Categorization based on Numbering Composition

Figure 12.3.2-1 shows the categories necessary for the numbering plan.



Note (a) The numbering style started from "1"
(b) The numbering style stated from "0"
(c) The numbering style composed by *, # and figures

Figure 12.3.2-1 Numbering Plan

b) Numbering System and Services

In order to offer various service, the numbering system shown in Figure 12.3.2-2 should be considered as the basic principle for the numbering plan.

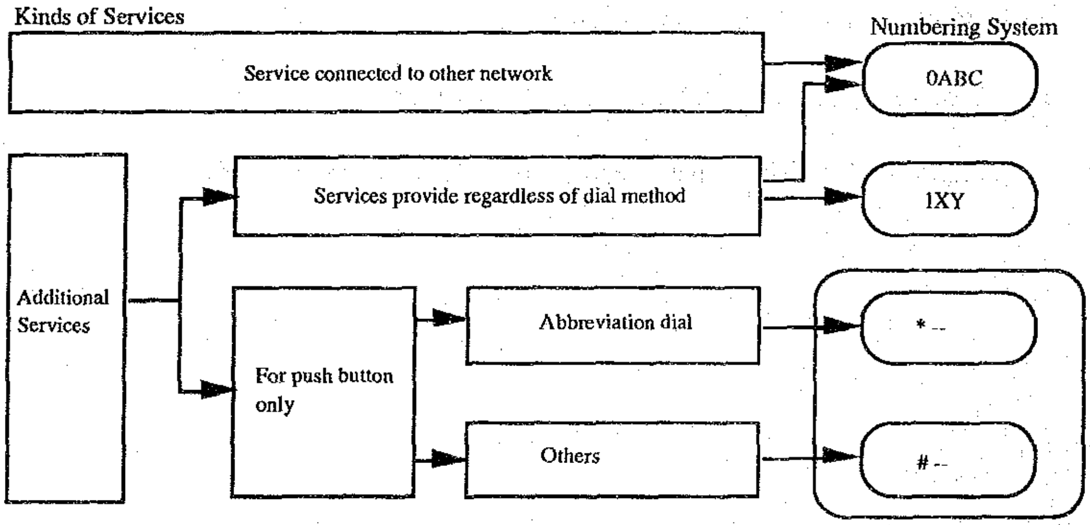


Figure 12.3.2-2 Numbering System and Services

c) 0ABC Numbering System

Services offered through non-telephone networks require network identification numbers.

Non-telephone networks will be easily accessed if interface points between the ordinary telephone network and non-telephone networks are placed at above primary center levels. This also simplifies network configurations.

Numbers which are not suitable for the ordinary telephone network should be assigned as identification numbers of non-telephone networks because area codes of the ordinary telephone network in the feature to cover the whole country will be short. Table 12.3.2-1 shows an example of 0A0.

Table 12.3.2-1 Usage Example of 0A0

B = 0

A	
1	Mobile Telephone (Cellular mobile, Paging, Train, Airplane, etc.)
2	Reservation for Mobile Telephone
3	Reservation
4	Data Communication
5	Reservation
6	Packet Switching Network
7	Reservation
8	Communication processing system
9	Reservation
0	International call, New common carrier

2) 0ABC Services

This numbering system will be also needed for the intelligent network services stated in Chapter 11 because these services must access to communication processing systems such as Service Control Point and Service Management System, to use date based information.

An example of a numbering system for the promising services is shown as follows:

- Free dial service 0801+DEFGH
- Voice message storing service 0802+DEFGH
- Other services 0803 ~ 0809 + DEFGH

3) Cellular Mobile Telephone

a) Examination of Requested Numbering Capacity

The number of cellular mobile telephone subscribers at the end of 2007 will be 1,400,000. In addition, more phone calls will be made from mobile telephones (personal communications service) in the future: therefore, a large scale of numbering system must be designed. Therefore, the numbering capacity and the style for the mobile telephone service should be considered well in advance.
The numbering capacity for the mobile telephone service is estimated according to the present numbering plan. The present numbering style can support enough mobile telephone service subscribers beyond 2007. Table 12.3.2-2 shows the numbering style and the subscriber capacity.

Table 12.3.2-2 Numbering Style and Subscriber Capacity

Numbering style	Service Carrier	Capacity
0 1 + A B + C D E F G	TOT	80 x 100,000 x 1 = 8,000,000
2 B C + D E F G	CAT	Depend on ordinary telephone
Demand in 2007	1,400,000	Regardless of carriers

TOT provides cellular mobile telephone numbers to CAT in the same way that ordinary telephone numbers are styled such as A B C + D E F G.

At present, the number of network services carriers is two, TOT and CAT in Thailand; therefore, it would be difficult to maintain the present numbering style though the same numbering style can be applied, if a new carrier would enter into this market. Even though no new carrier comes in, the present numbering style can not support a large number of ordinary telephone service subscribers. TOT has already examined this problem according to their numbering plan which was obtained during this study.

The numbering style has two purposes: a) identify who is called and b) to identify which network service is used. If TOT imposes the same numbering style on other service providers such as CAT, and shares the market with them, mobile telephones service providers except TOT will have difficulty in accommodating increasing subscribers.

In order to simplify the numbering style for both customers and telecommunications network service carriers, it is better to give an identification code the to cellular mobile telephone service for identifying the network.

If TOT could change the numbering style, it should be done as soon as possible. The later it is done, the higher the construction cost will be.

b) New Numbering Plan

As for assignment of identification numbers, the assigning method is stated in Table 12.3.2-1. A new numbering style is shown in Table 12.3.2-3.

Table 12.3.2-3 New Numbering Style

Numbering style	Carrier	Composition
0 + 1 0 + A B (I.D.)+ Subscribe Number	TOT	0 + 1 0+ A B + 5 digits
	CAT	0 + 1 0 + I.D.+ Subscriber Number
	New carrier	0 + 1 0 + I.D.+ Subscriber Number

4) ISDN Services

In order to connect to the terminal a caller wants to, a sub-address must be dialed. The sub-address consist of maximum 40 digit; however, it depends on the number of application services or the number of terminal equipment connected to a subscriber line.

Generally, the following numbering style is adopted:

ABCDEFGH + j + sub-address

j is used to identify the sub-address.

If an analog telephone service subscriber calls and a called party has two telephones, in the case of 64 kb/s service, two telephones ring at the same time. 2 Mb/s service case is the same as the 64 kb/s case. If the called subscriber requests for two telephones to ring individually, two telephone numbers must be assigned.

As ISDN service subscribers and dial-in PBX users increase in the future, assigning multiple telephone numbers to a subscriber will cause a severe shortage in available numbers. Chapter 12.3.1 discusses how this problem can be remedied.

12.4 Network Management Development Plan

12.4.1 Network Management

The size of the telecommunications network has been growing rapidly and customer demands for telecommunications services also have been diversified and sophisticated. It is important to develop an operation and maintenance system to offer high quality services by more effective maintenance.

Network management consists of real-time network performance monitoring and control of the network. And it is a technique designed to optimize the call-carrying capacity of the network when the network is under stress due to traffic overload or failure.

TOT has already decided to adopt the BTO scheme in its the seventh ESDP. It is said that a new telecommunications network in the seventh project will be constructed separately from the existing network, and that the operation and maintenance will also be done separately. Ill effects caused by malfunctions of one network to another networks can be avoidable. Furthermore, telecommunications networks play a vital role in case of emergencies and natural disasters. In these occasions, to manage the telecommunications networks effectively and economically, a centralized telecommunications network management is necessary.

Synchronous Digital Hierarchy (SDH) will be introduced into transmission systems in the near future. The telecommunications network management should consider to include new telecommunications network management systems such as SDH.

12.4.2 Network Management System for Switching System

Computerized operation and maintenance systems have been introduced. These are the NCOM for NEAX-61 switches and the AOM for AXE-10 switches. Further, O&M systems for EWSD switches are going to be established together with introduction of EWSD switches into the TOT telephone network. Their system configurations are shown in Figure 12.4.2-1 to Figure 12.4.2-3 and their main functions are shown in Table 12.4.2-1 to Table 12.4.2-3.

The XB switches cannot be connected with the above systems, nor with other centralized supervision equipment. They have traffic measurement equipment of their own or portable sets for common use in case of small size switches. However, these XB switches are to be replaced by SPC switches in the near future.

Regarding the TOT network management system, the problems are that the three systems mentioned above are not coordinated and that their O&M centers are located at different places. Furthermore no junction alarm or transmission alarm is displayed in the centers. This means that O&M staff can not monitor the over-all status of the network.

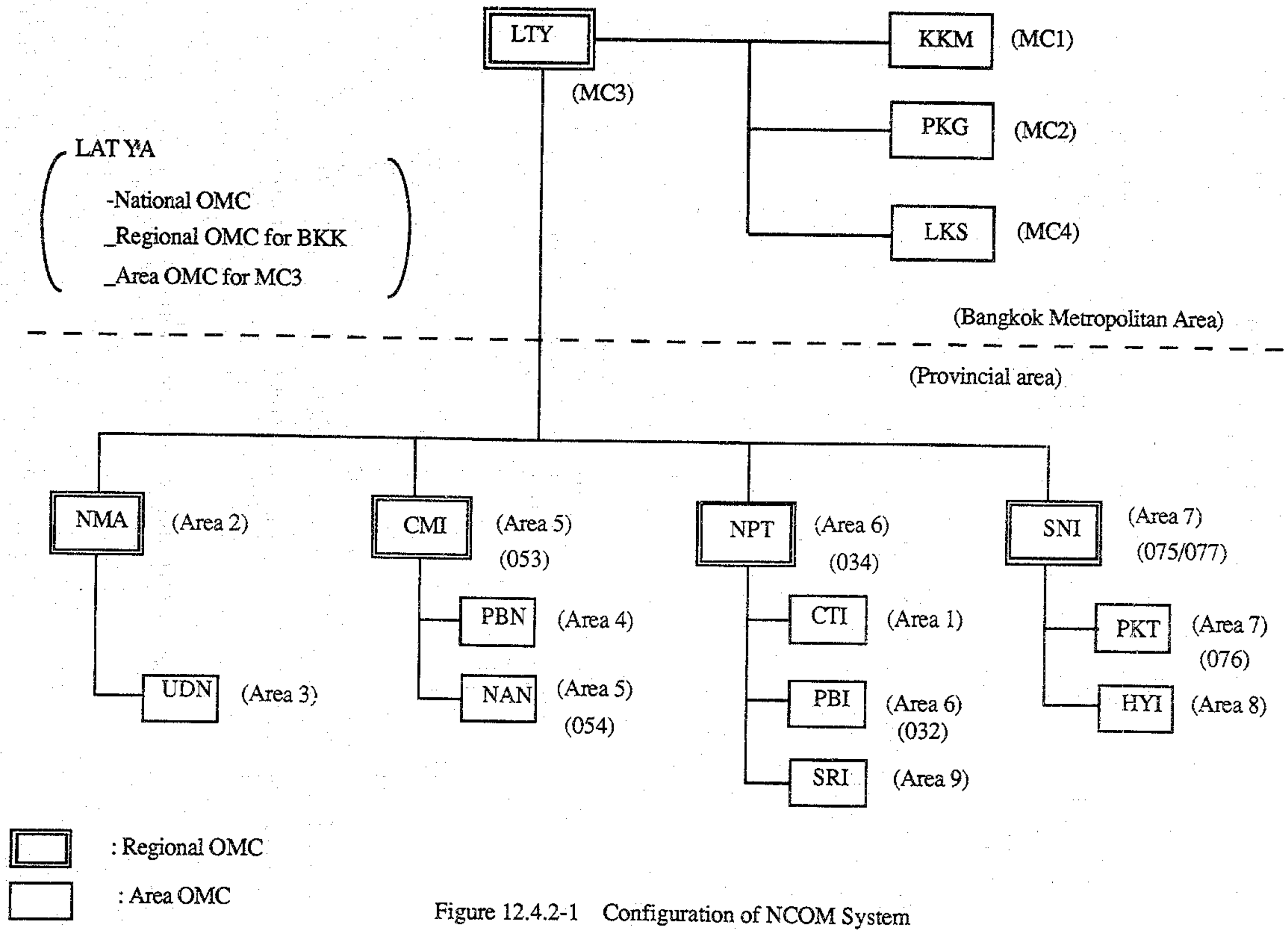


Figure 12.4.2-1 Configuration of NCOM System

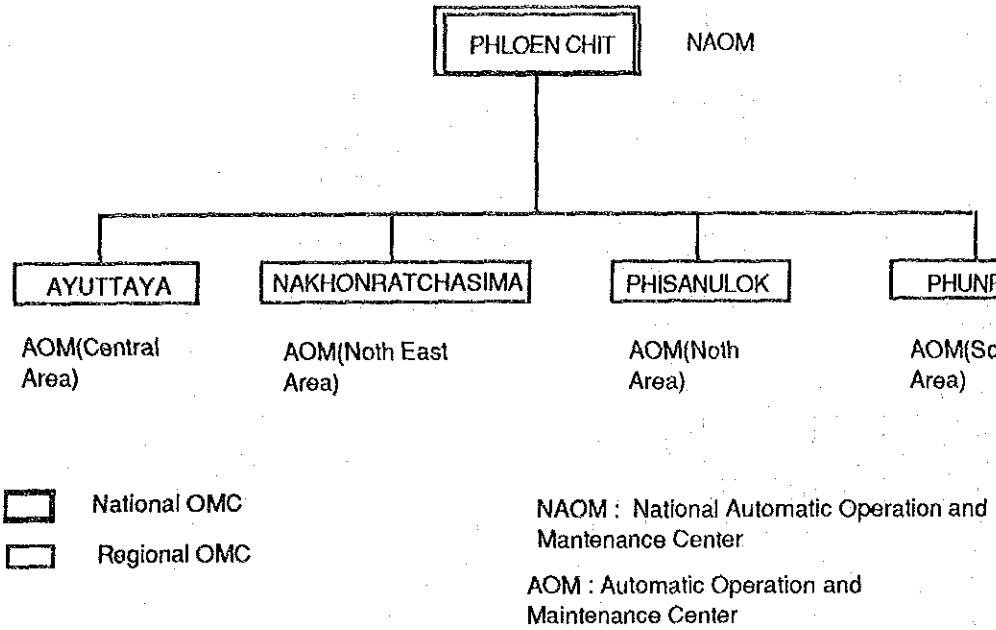


Figure 12.4.2-2 Configuration of AOM System

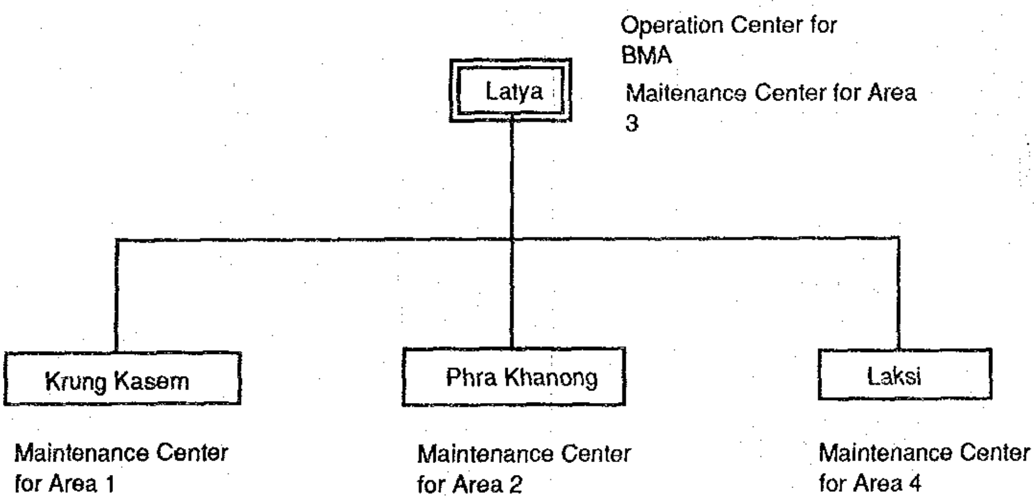


Figure 12.4.2-3 O&M System Configuration for EWSD

Table 12.4.2-1 Main Function of NCOM

Item	Main Function
Operation monitoring	Alarm supervision Monitoring network status
Maintenance	Trouble shooting Diagnosis Fault recovery Periodic routine testing Fault recording, etc.
Operation	Complaint processing support Monitoring services Statistical processing Charge auditing Collection of call data Service order processing support Office data charge processing support Traffic information compiling Emergency processing Measures against traffic congestion

Table 12.4.2-2 Main Function of AOM

Item	Main Function
Operation monitoring	Alarm supervision Monitoring network status
Maintenance	Fault tracing Software maintenance Trunk line testing
Operation	Charging data collection Traffic measurement Statistical data collection Device analysis data collection Subscriber data administration Network control

Table 12.4.2-3 Main Function of O&M System for EWSD exchange

Item	Main Function
Operation monitoring	Alarm supervision Monitoring network status
Maintenance	Testing and measuring subscriber line Trunk line testing and measurement transfer Fault tracing System software maintenance
Operation	Subscriber data administration Network control Traffic measurement Charging data collection

12.4.3 Transmission Network Management

1) Present State of Supervisory Operation System in TOT

TOT has already decided to install new supervisory systems both in the long distance transmission system and the Bangkok metropolitan junction transmission network in its fifth project. They are not completed yet by the end of 1991. However, it will be completed by the end of 1992. It is expected that the completion of the supervisory system will greatly contribute to TOT because it makes operating and maintaining the transmission network easier.

a) Layout of Transmission Supervisory System

Generally, the supervisory system should be coordinated with operation and maintenance activities because the supervisory system has to be a convenient tool for economical and effective O & M. The planned structure of the transmission supervisory system is shown in Figure 12.4.3-1. As shown in this figure, the supervisory system consists of the following four levels .

- First level — One national center located in Krung Kasem.
- Second level — Five zone centers, one in Krung Kasem located in the BMA, 4 in Ayutthaya, Nakhon Ratchasima, Phitsanulok and Surat Thani located in the provincial areas.

- Third level — 64 maintenance centers, 4 in the BMA and 60 in the provincial areas.
- Fourth level — There are 1007 remote stations located in the BMA and the provincial areas.

The zone centers and maintenance centers have operation and maintenance staff of the transmission systems in each area. Usually, the maintenance centers have day time work shifts and the zone centers are operating for 24 hours. However, TOT considers to revise the work systems. It means that TOT is now going to adjust the work system of the maintenance centers in accordance with the reorganization of O & M in each section.

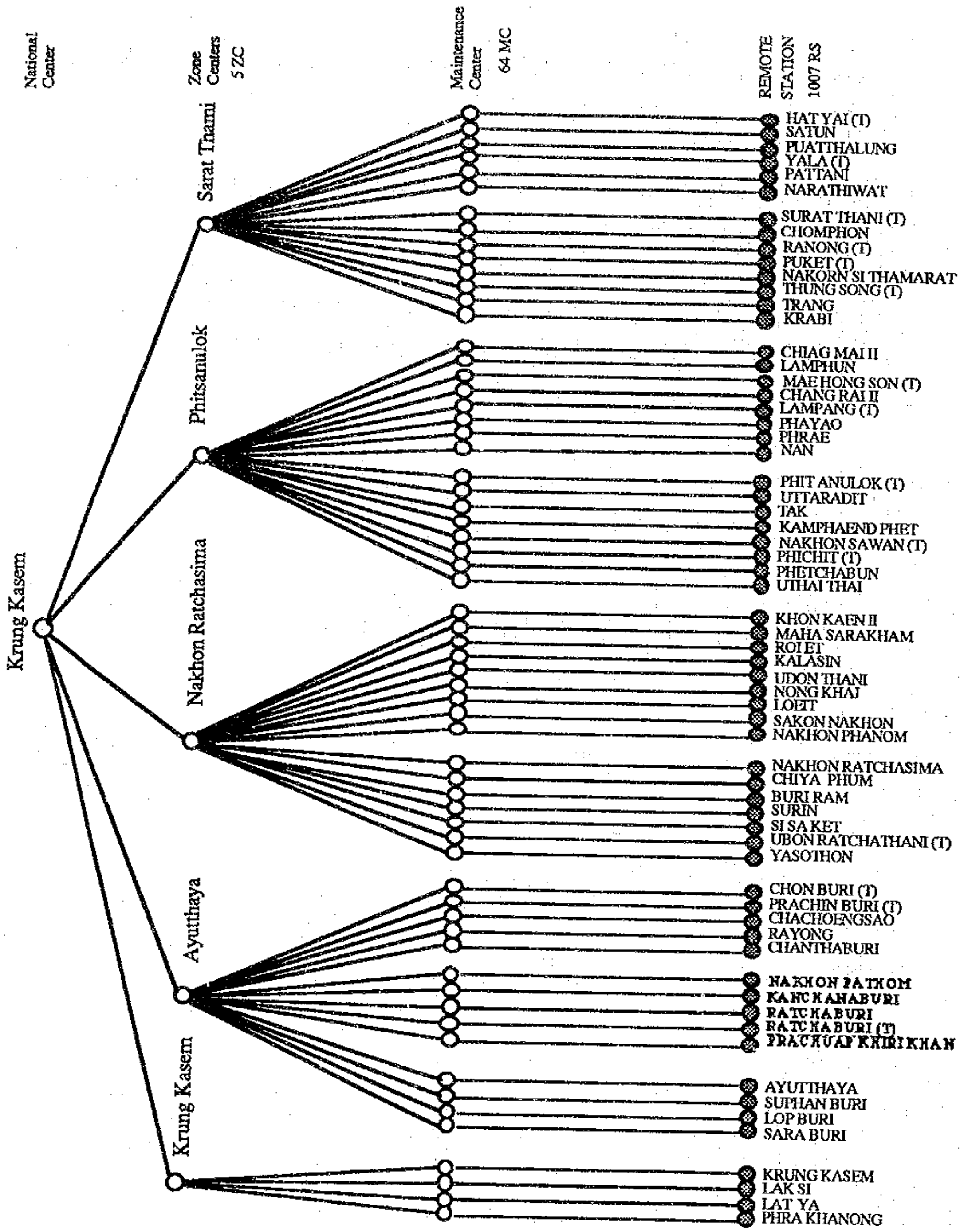
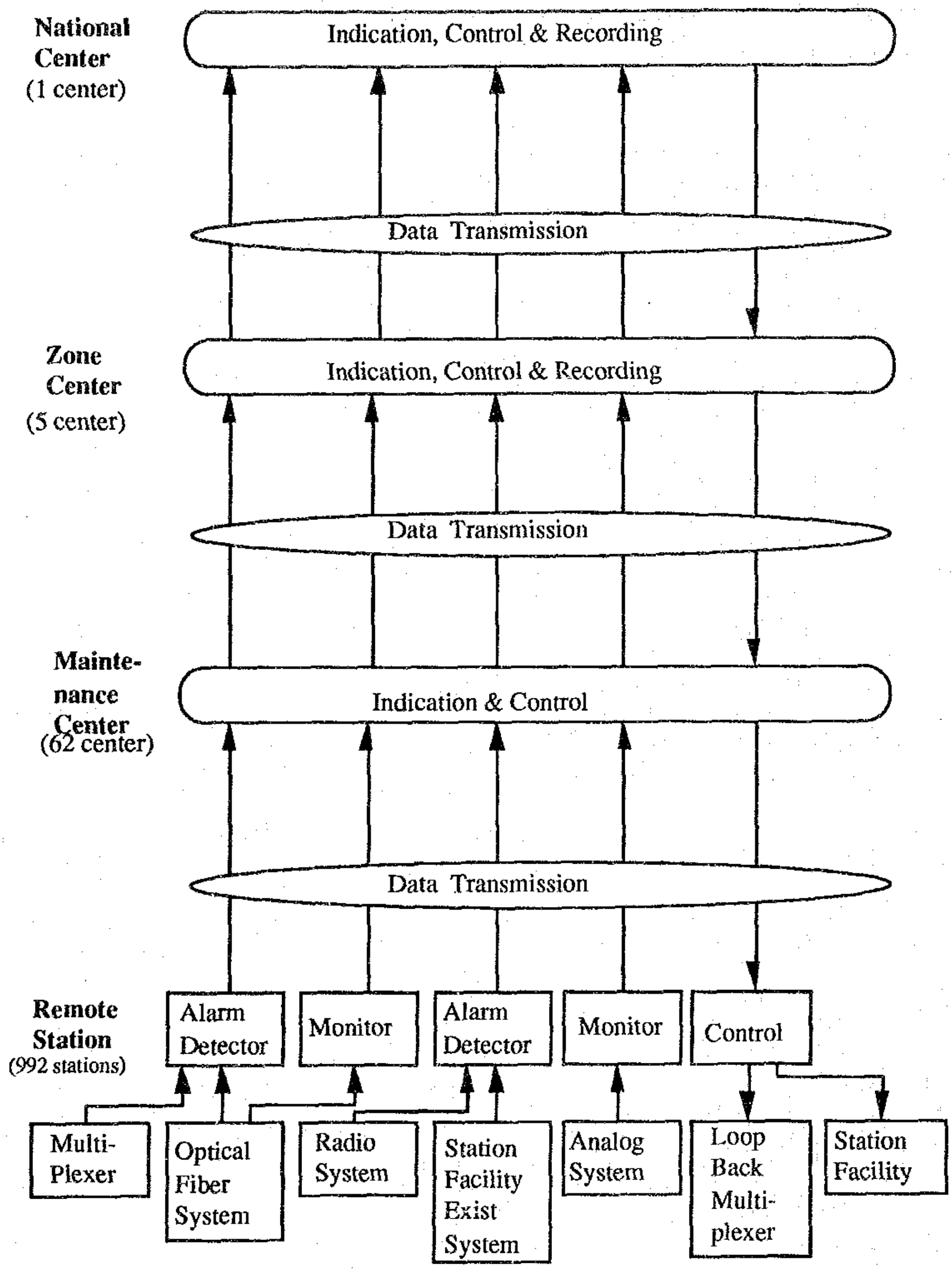


Figure 12.4.3-1 Supervisory Structure of Transmission Network

2) Long Distance Transmission Supervisory System

a) Function of the system

The new planned supervisory system for the long distance transmission network can operate not only long distance optical fiber systems but also existing microwave transmission systems as shown in Figure 12.4.3-2.



* OPTION : Utilization is in accordance with customer's preference additional plug-in units, extra wiring work, and network data input work are required.

Figure 12.4.3-2 Functional Configuration of Long Distance Supervisory System

As shown in this figure, each center such as a maintenance center or a zone center can monitor alarms of the transmission facilities in its maintenance area , analyze the alarms and control them. In addition, the zone centers can store the alarms in the data base. A zone center can pick up the information concerned and use the information to grade up the telecommunications services.

Thus, the main objective of this supervisory system is to make efficient maintenance with monitoring performance of the transmission routes, to reduce the cost and to reduce the time for maintenance activities of fault.

b) System Configuration Concept

This system uses a super mini computer in each zone center and the national center to realize the many functions mentioned above, That is shown in Figure 12.4.3-3. The necessary information such as alarm of the monitored facilities and control signals is communicated by using a data communication system via the MODEM equipment.

3) Junction Transmission Network Supervisory System

The supervisory system in the Bangkok metropolitan junction network is shown in Figure 12.4.3-4. This system can operate in both optical fiber systems and existing metallic PCM-30 systems as shown in the figure.

All alarm monitoring and control systems are connected to each other by digital branching and analog units. They also cover the transmission routes for the RSU facilities. Every maintenance center such as Krung Kasem, Lak Si, Lat Ya, Phra Khanong, Pahonyothin can monitor and control the alarms of the transmission facilities and control them in their maintenance areas. And the main operation is centralized in Pahonyothin.

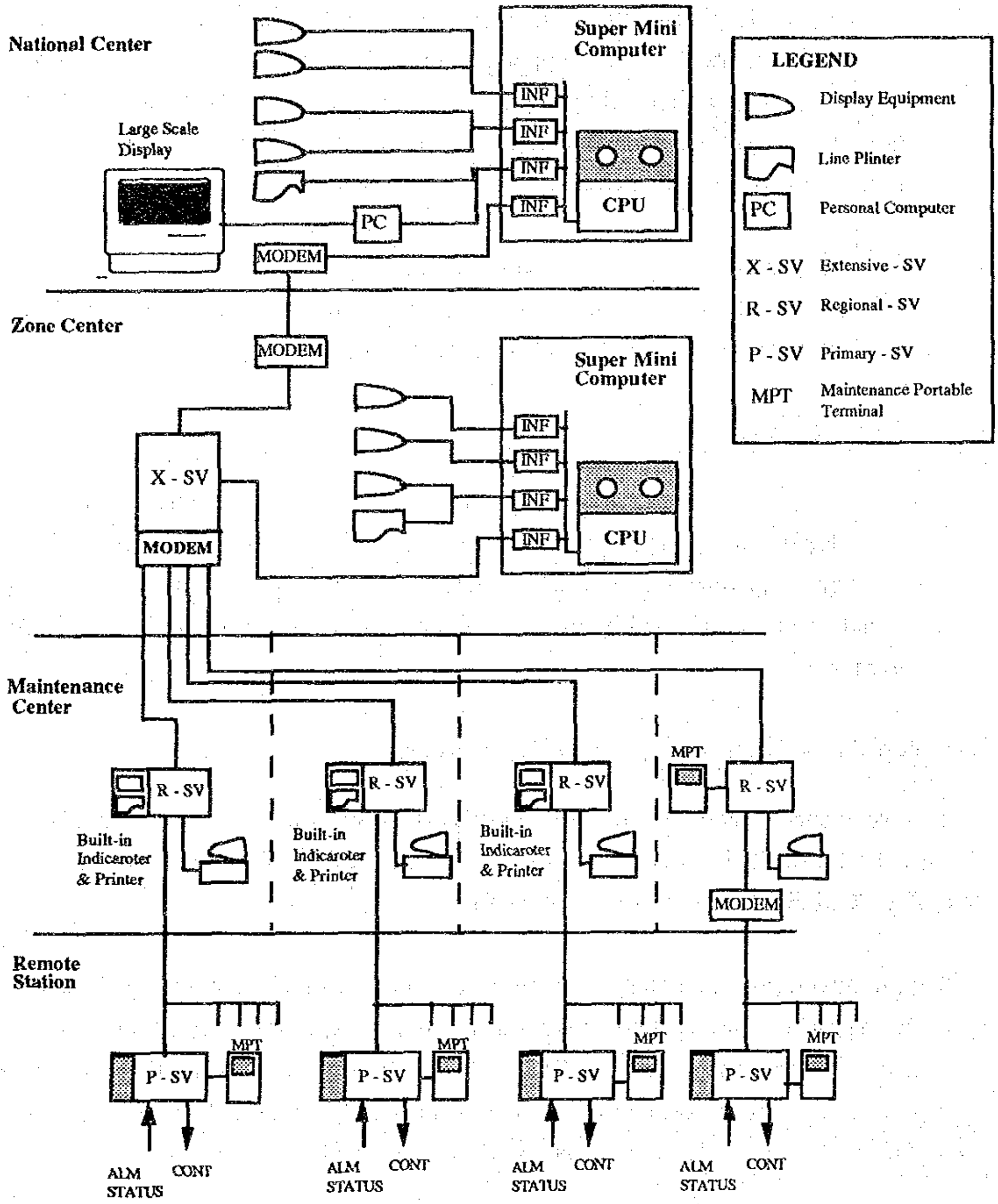


Figure 12.4.3-3 System Configuration of Centralized Supervisory System

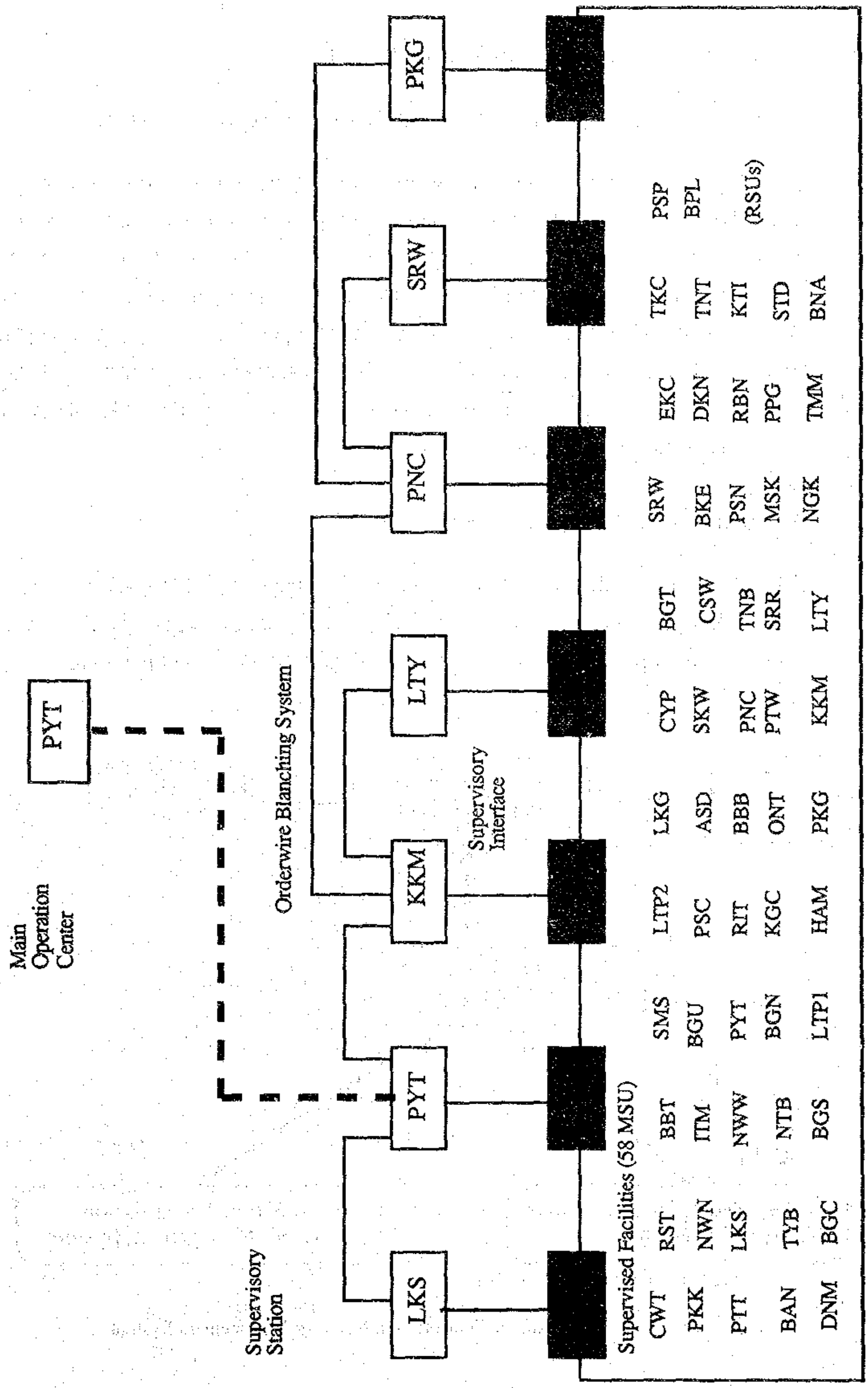


Figure 12.4.3-4 Supervisory System in Bangkok Metropolitan Junction Network

4) Transmission Network Management Improvement Plan

a) Unification of the Junction and the Long Distance Supervisory System

The transmission supervisory system should be unified into the national transmission management center which can control both the junction and long distance transmission network as shown in Figure 12.4.3-5. Because controlling the entire transmission network will be necessary for grading up the service quality. The unification of the transmission network management system is planned in the Phase-1. In this case, the national transmission management center may be unified into the national network management center. The details of the national center are described in the next section.

b) Integration of the Maintenance Centers

The integration of the maintenance centers is planned in the Phase-1. It means that the Phahonyothin maintenance center will be integrated with Krung Kasem in the Phase-2 for more efficient work style. The details are described in Chapter 14.

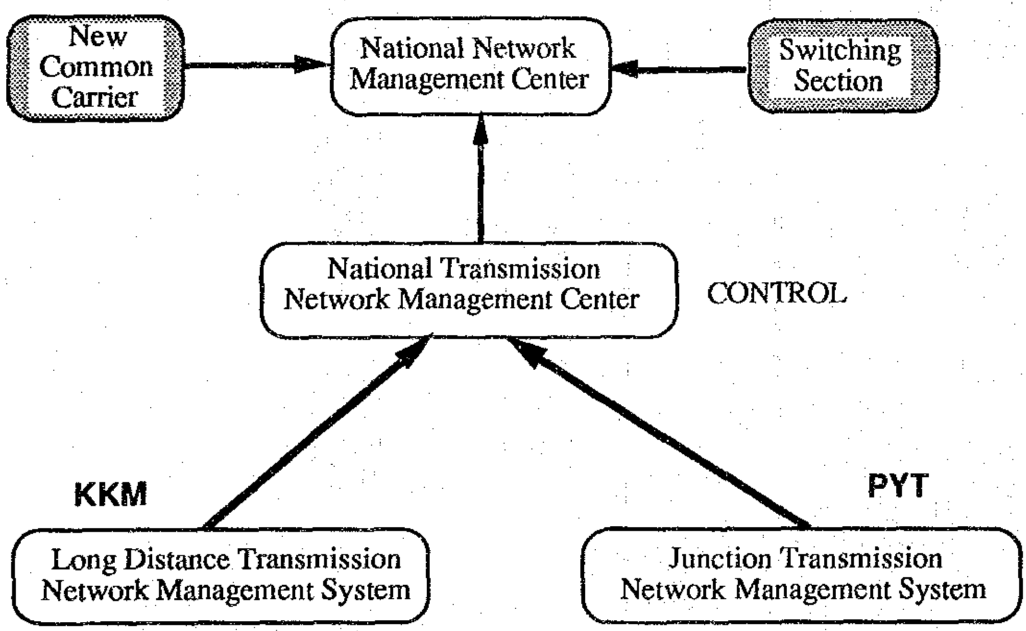


Figure 12.4.3-5 Integration of Transmission Network Management System

12.4.4 Network Management Improvement Plan

1) Issues at present and in future

a) National Center

Regarding the network management work of TOT, the problem is that its supervisory and management systems are not established in the same place and they are working independently. In the switching field, O & M systems are 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 the situation of both long and junction transmission networks has not been established yet. However, it is considered that the national center should be able to monitor both transmission and switching networks.

b) Monitor of the Private Sector Network

It has been decided that the TOT seventh telecommunications expansion in the BMA is carried out by the private firm. It will be also the same in the provincial areas. However, it is considered that TOT should monitor all the networks in the country because TOT has a responsibility for all network users as a government enterprise As the size and complexity of the telephone network expands, a need for a large volume of more accurate information in the network emerge.

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. The conceptual system configuration is shown in Figure 12.4.4. 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.

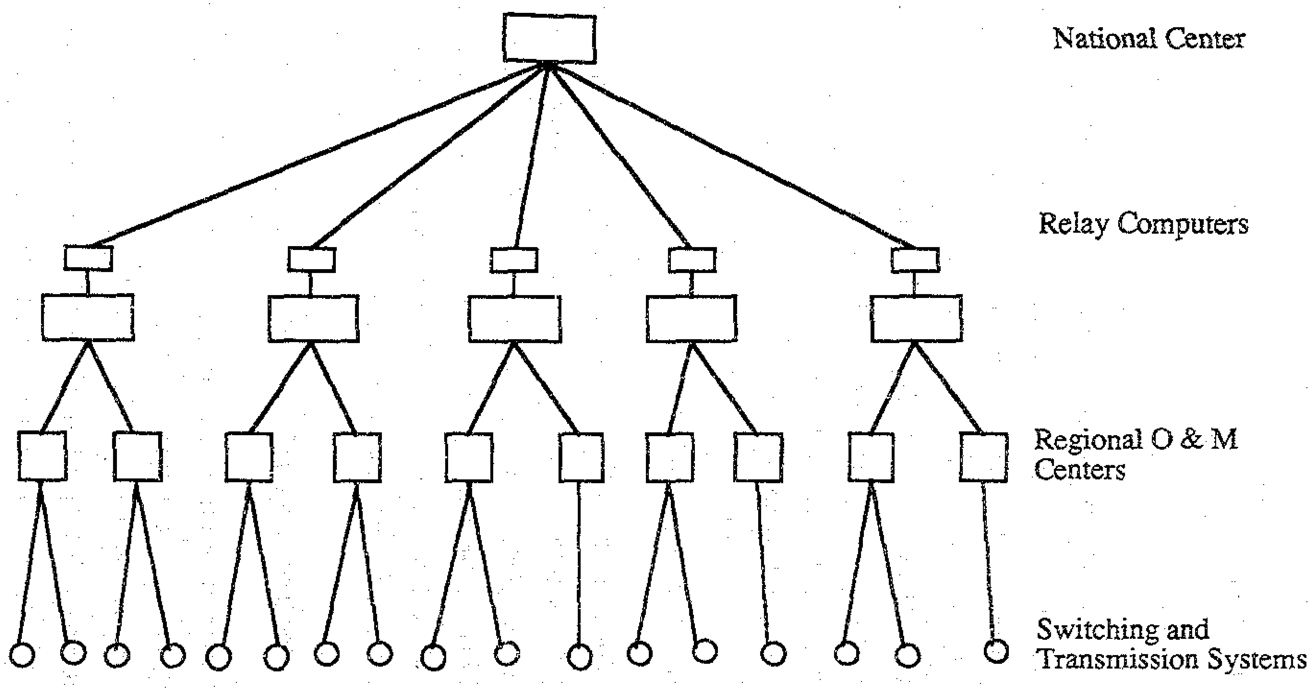


Figure 12.4.4 System Configuration of Integrated Network Management System

12.5 Reliability Development Plan of Telecommunications Network

12.5.1 Background

In an information-oriented society, interruptions of communications will cause great losses and confusions to the society because telecommunications facilities have become the most important part of the social and economic infrastructure.

TOT experienced great damages in its telecommunications facilities caused by a big typhoon in 1989. One microwave tower fell down. In the southern part of Thailand, Hat Yai, Surat Thani, communications were cut off from other regions. In that time, TOT made its best effort to recover its own microwave transmission system as soon as possible. As a result, TOT could quickly restore its telecommunications network system between Bangkok and the southern areas. TOT also rented fifty channels of the submarine coaxial transmission system to keep communications between the southern provinces and the Bangkok Metropolitan Area from Communication Authority of Thailand (CAT) at that time. TOT still rents these channels as leased channels from CAT.

Since then, TOT has formulated own restoration plan and immediately set up projects to reinforce the reliability of the telecommunications networks against disasters. Some projects have been finished and some are under way.

12.5.2 Network Reliability Improvement Plan of TOT

As mentioned above, TOT has already set up their telecommunications reliability improvement plan against disasters from the view point of the following two objectives.

1) Improvement of Network Reliability against Disasters

   a) Doubled or Looped Transmission Network in the Fifth Project

      During the fifth project period, TOT installed many long-distance microwave and optical fiber transmission systems which can connect most Secondary Centers (SCs) and Tertiary Centers (TCs) with looped or doubled routes. Particularly, the long-distance optical fiber transmission systems, which were mainly installed between Phisanulok in the northern part and Surat Thani in the southern part via Bangkok, make transmission routes doubled links as sown in Figure 12.5.2-1. As shown in the figure, the microwave transmission system can make the transmission routes looped links. This project will be completed in 1992.

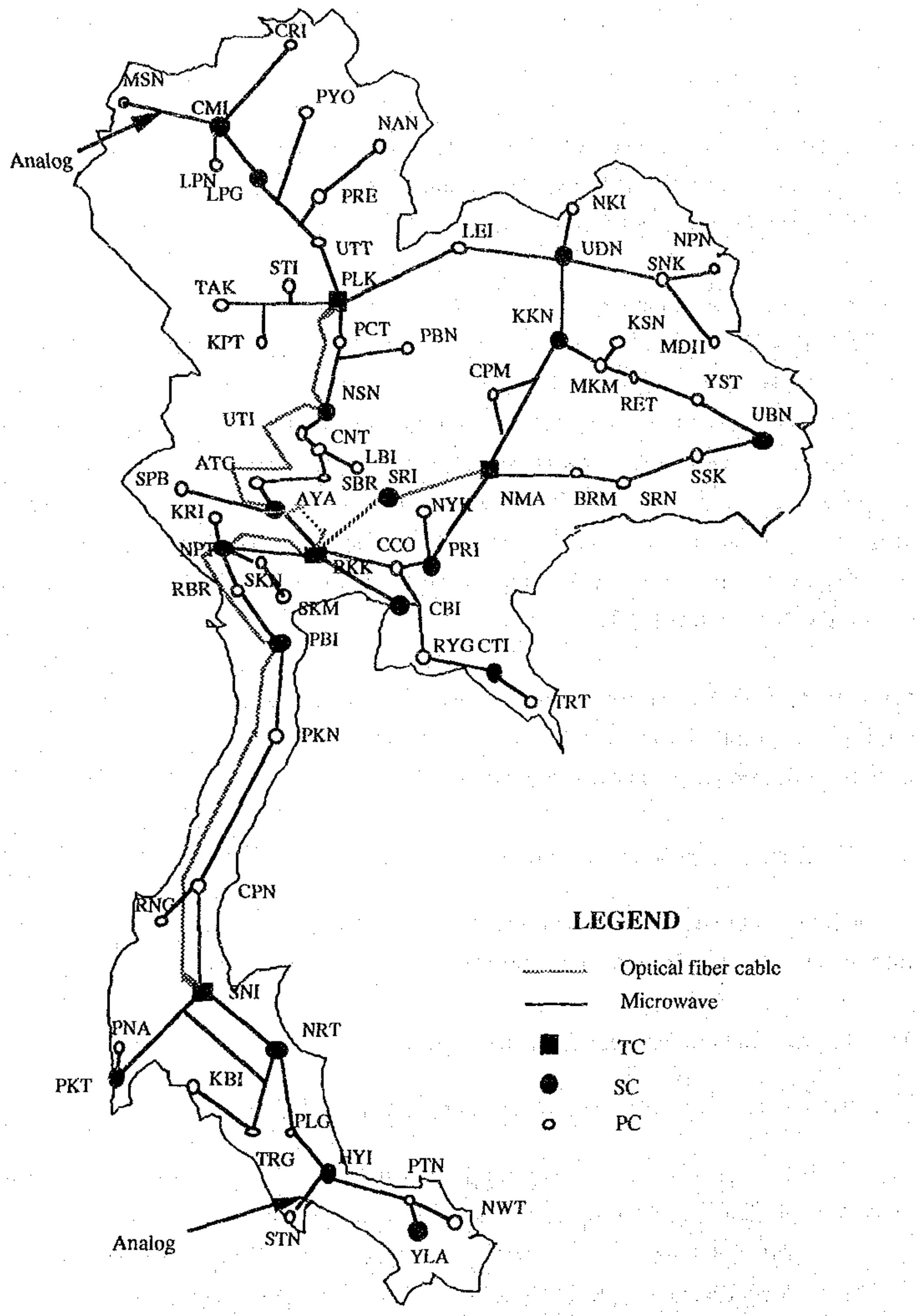


Figure 12.5.2-1 Long-distance Transmission System (end of 1992)

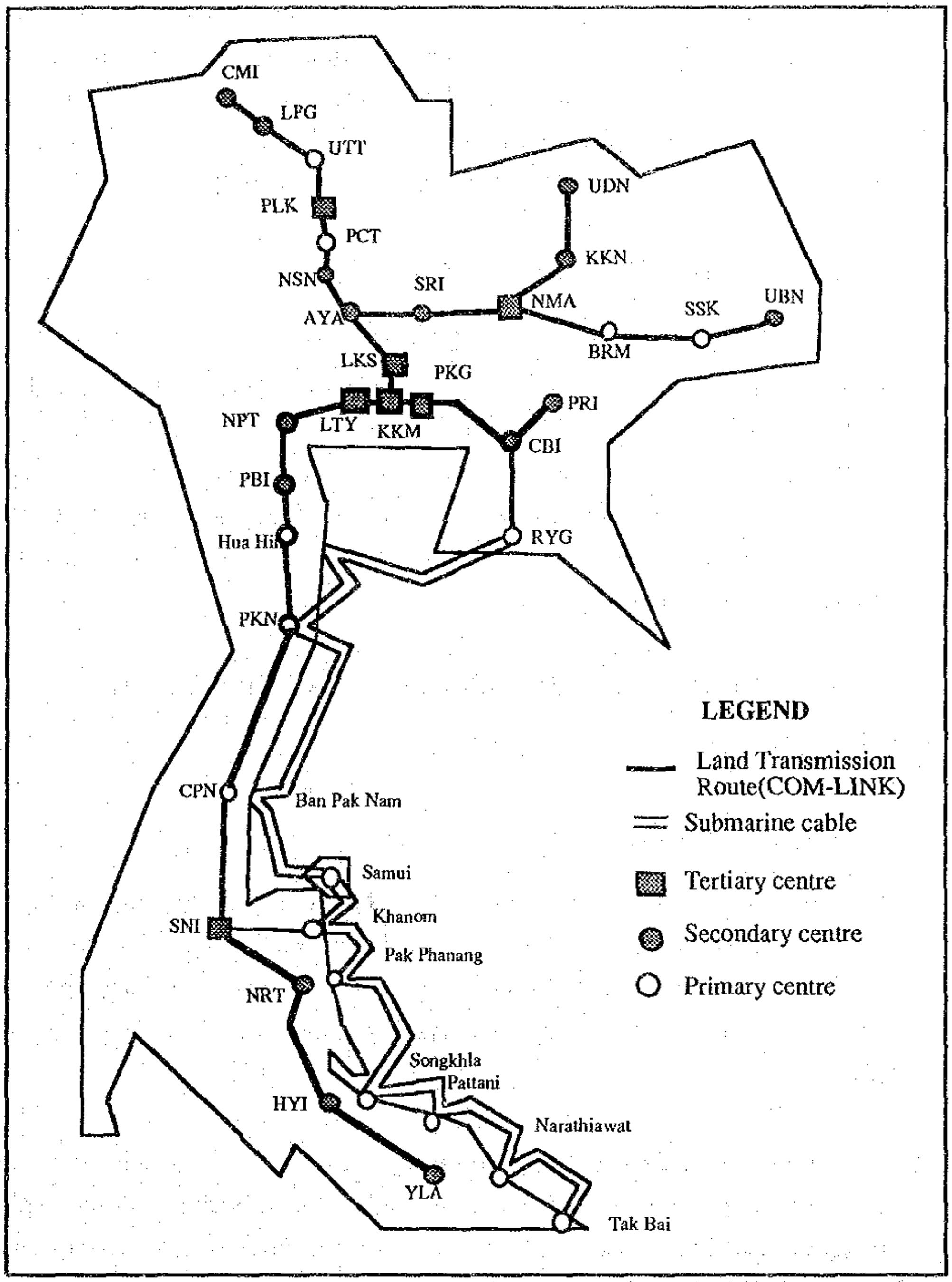


Figure 12.5.2-2 Submarine and COM-LINK Transmission Network Installation Plan

b) The Planned Submarine Optical Fiber Transmission Network

TOT has already set up a project to install a submarine optical fiber transmission system as shown in Figure 12.5.2-2 which will be installed between Rayong and Takbai in Naratiwat province via Hua Hin, Prachuap Khiri Kham, Ban Pak Nam, Samui, Khanon, Pak Phanang, Songkhla, Pattani and Narathiwat. This route can connect the southern part to Bangkok without going through the southern terrestrial transmission routes. When terrestrial transmission routes such as the microwave and optical fiber routes are cut off by disasters such as typhoons, etc., the southern provinces can communicate with other regions by this submarine optical fiber transmission route. This project is expected to start in 1992.

c) COM-LINK Optical Fiber Cable Transmission Plan

TOT has also set up the 'COM-LINK FIBER OPTIC CABLE PROJECT', which installs a big capacity optical fiber cable transmission system (565 Mb/s) along the state rail way. Figure 12.5.2-2 shows the layout of this project. This is a BTO scheme project. This route can connect all SCs with optical fiber cable transmission systems. After this project will be completed, all SCs and TCs will be duplicated routes with both optical fiber cable and microwave transmission systems. It is expected to complete in 1992.

12.5.3 Telecommunications Network Recovery Plan Against Disasters in TOT

1) Satellite Communication Transmission System

a) Present State of the System

TOT set up a project to introduce a satellite communication system, when southern parts of Thailand were cut off in communications with Bangkok by the typhoon in 1989. This project was done by a private sector with concession basis and ten earth stations have already been completed and working by using PALAPA transponders of Indonesia.

The structure of the system is shown in Figure in 12.5.3-1, which shows that the ten Earth stations are connected to each other by time division multiplexing access systems (TDMA). The capacity of the system consists of two digital trunk interfaces (DTI), which means the capacity of this system is 60 channels (64 kb/s), and the frequency of them are C (up link 6 GHz, down link 4 GHz) band.

b) Emergency Use

They are used for the ordinal communication service, such as data communications, etc. in normal time; however, they will be used for detour transmission systems in emergency time when the terrestrial transmission systems are cut off by disasters, such as typhoons, earthquakes, etc.

c) Expansion Plan

More 20 earth stations have already been planned to be expanded in this project in the phase-2 as shown in Figure 12.5.3-2. By the completion of this expansion plan, most remote PCs, which are very difficult to be connected to other PCs, SCs and TCs (Tertiary Center) with duplicated or looped transmission routes, such as Mae Hongson, Tark etc., will be covered by this system.

2) Cooperation Plan with Governmental Organizations to Recover the Telecommunications Network Against Disasters

It is planned that TOT cooperates with the government telecommunications agencies, such as Communication Authority of Thailand, Post and Telegraph (Internal Satellite Communication Center), etc., in order to secure the terrestrial telecommunications network when the network gets damaged by natural disasters, etc. According to this plan, when an accident happens in the northeastern part, TOT cooperates with Post and Telecommunications Bureau (PTD), etc. in order to establish essential and urgent telephone channels from the area to Bangkok through the satellite communication network.

3) Provision of Mobile Switching Facilities

In provision for emergency, TOT has also planned to provide 1,000 mobile switching facilities for the provinces and Bangkok; however, they are now under consideration.

4) Mobile Power Supply System

For emergency power troubles, TOT has already provided mobile power supply systems in its telephone offices. Two mobile power supply systems are arranged in the Phra Khanong office and the other three in the Krung Kasem office.

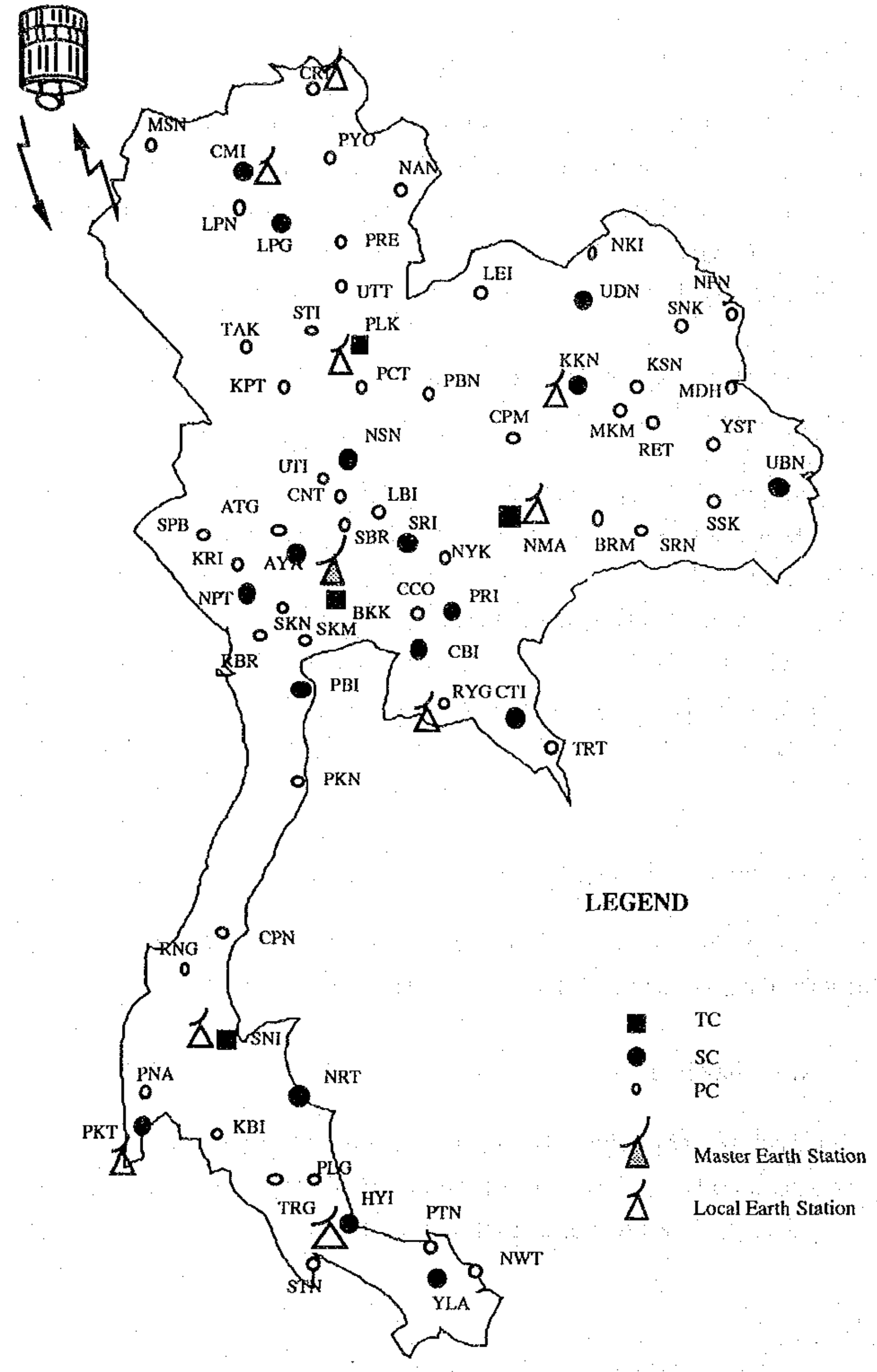


Figure 12.5.3-1 Configuration of Satellite Communication System

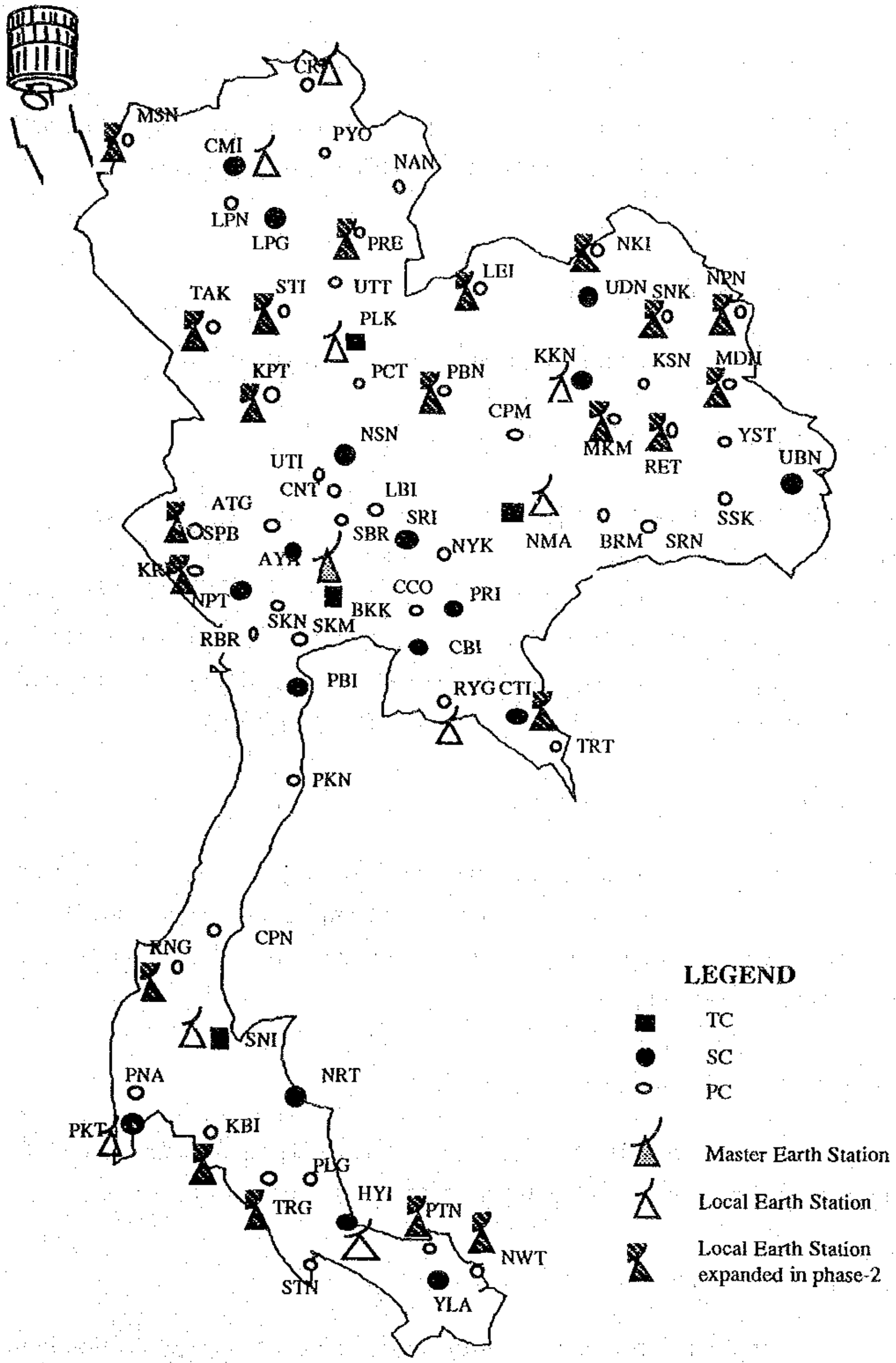


Figure 12.5.3-2 Expansion Plan of Satellite Communication System

It is planned that they are used when power troubles happen in switching offices in the Metropolitan area. Since they seem too old and heavy, the improvement should be studied in the view point of size, weight, capacity, etc.

12.5.4 Network Reliability Improvement Plan

The reliability of the telecommunications network in TOT has been improved year by year, especially all SCs and TCs will be connected to each other with duplicated routes by the end of 1992.

1) Transmission Network Reliability

Transmission network reliability improvement plan is described in Chapter 12.

2) Switching Trunk Facility Network Reliability Plan

The switching trunk facility network reliability plan depends on the network plan. As described in CHAPTER 4, TOT has implemented a routing plan in which most local switching offices have direct trunk circuits to other local switches, tandem switches, etc. This means that traffic from one switching facility is allocated to some another switching facilities. This way is effective for the network reliability in the event of disasters. This routing plan will be continued through the long-term plan period.

12.5.5 Restoration Plan Against Disasters

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. The following plans are recommended.

1) Improvement of Mobile Power Supply System

It is necessary to reconsider the existing power supply system plan in the view point of both sides allocation procedure and grading up the power supply systems.

a) Allocation of the Power Supply System

In this study, the present state of the power supply system allocation in the whole country could not be examined. However, it is said that many places in this country, such as north, northeastern, southern regions, etc. got big damages by typhoons this year. Further more, it was recorded that many regions had big damages by typhoons before. The power supply system allocation plan, therefore, is necessary to be considered for the whole country with respect to distance to a power supply system location and necessary time to transport a power supply system. One idea is that, in first stage, renewed power supply systems are installed in each TC office such as Phisanulok, Nakhon Ratchasima and Surat Thani, and in the second stage, main cities which were damaged by typhoons before should be considered for the installation.

b) Grade up the Power Supply System

The existing power supply systems are diesel type engines with generators merely put on trucks and very heavy. The improvement is necessary for weight, size, power capacity, etc. To make mobilization and demobilization easily, the system should be fixed in a potable box, which can be set on a vehicle easily. To make the weight of the system light, light weight engine should be adopted, such as gas turbine type.

Recently, the digital telecommunications facilities have been introduced in both switching and transmission sections; therefore, the capacity of the emergency power supply systems should be reconsidered in the view point of the power consumption capacity of the digital switching facilities and the transmission facilities.

When this plan is implemented, a detailed study will be required for the whole kingdom.

2) Provision of Mobile Satellite Earth Station

TOT must provide the telecommunications services in any time and any places in the near future. To meet this mission, the sector must provide the mobile satellite communication earth stations. Because, when telecommunications facilities got big damage by flood, fire, etc., the earth stations would be sent there with the mobile power supply and switching equipment and they will be set up immediately to recover the telecommunications service in the area.

- Capacity of the mobile earth station is 34 Mb/s.
- Priority of the introduction of the earth stations is as follows.

Phase-1	Bangkok, Cheing Mai, Hat Yai
Phase-2	Nakhon Ratchasima, Surat Thani

3) Potable Radio Transmission System

a) Necessity

TOT telephone offices have never been isolated from other telephone offices; however, it is important to consider of this case in the future because, as mentioned above, interruptions of communications will give big losses both economically and socially to an information oriented society.

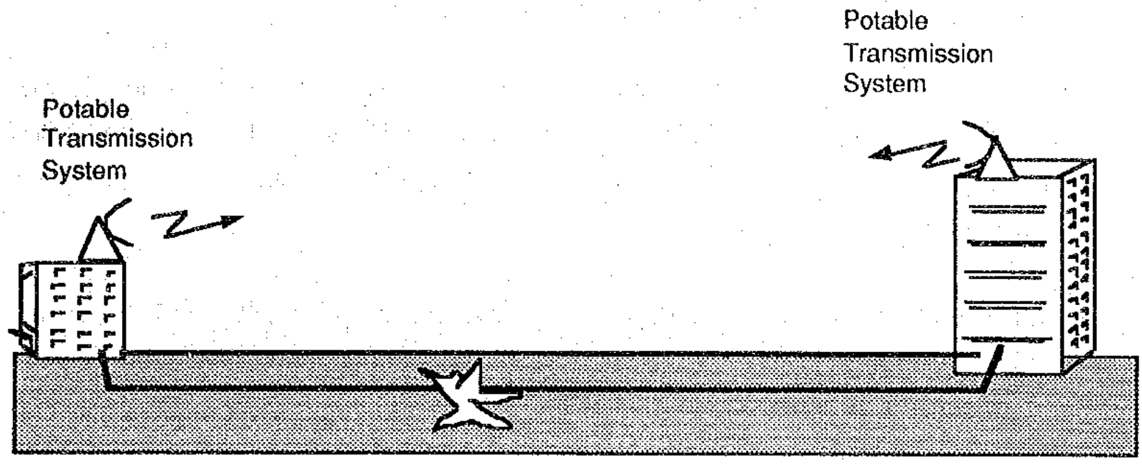
In that case, a potable radio transmission system is very useful in the view point of recovering time of the transmission system. This system must be a potable type for carrying and setting easily in any places. As an example, the following Super High Frequency (SHF) type is proposed.

b) Concept of the System

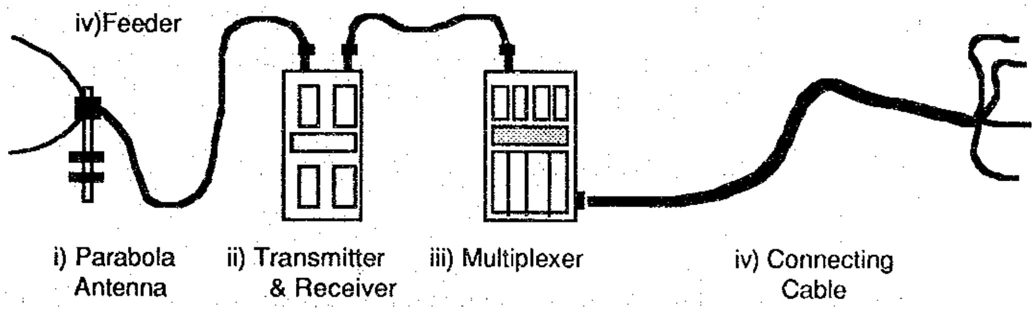
- Component
  * Parabola Antenna
  * Transmitter & Receiver
  * 140 Mb/s or 155 Mb/s (SDH system) capacity
  * Multiplexer
  * Connecting parts

c) Application Plan

An application of the potable transmission system is shown in Figure 12.5.5-1 In this case, the optical fiber system is cut by an accident and this system is temporally used for recovering the damaged trunk circuits. This system will be applied both in the metropolitan area and the provincial areas.



(a) An application of Potable Radio Transmission System



(b) Composition of Potable Radio Transmission System

Figure 12.5.5-1 An Application of Potable Transmission System

d) Introduction Plan

This system will be provide in accordance with the emergency telecommunications system. The Priority of the introduction of the system is as follows.

Phase-1 Bangkok, Cheing Mai, Hat Yai

Phase-2 Nakhon Ratchasima, Surat Thani

4) Emergency Telecommunications System (ETS)

This system is generally considered to be used for establishing emergency communication channels for sectors which must act to help the damaged areas by public telephones and general subscribers in short time when telecommunications facilities are damaged by disasters.

- The ETS consists of not only a mobile switching equipment but also a mobile power supply system, a transmission system , a mobile earth communication system and subscriber cable as shown in Figure 12.5.5-2.

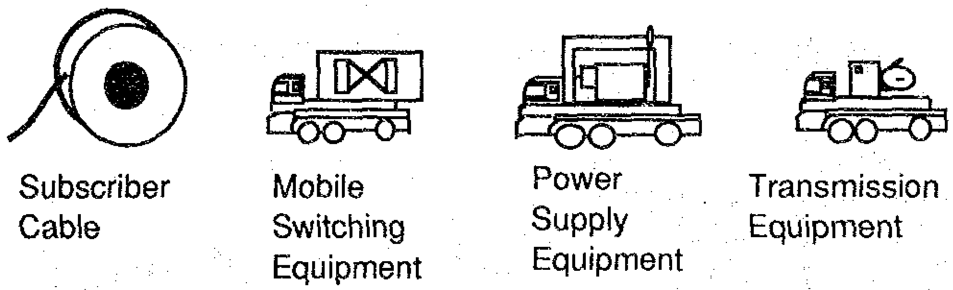


Figure 12.5.5-2 Composition of Mobile Switching System

- The capacity of a mobile switching equipment is considered around 1,000 lines because seems to be limited to emergent cable capacity and also transmission equipment capacity.

a) ETS Application Plan

Figure 12.5.5-3 (a) shows an application of the ETS. In this case, a telephone office is completely damaged by a natural disaster such as flood and the ETS will be dispatched to provide communication channels for the government sectors and people in the area with another places. As shown in the figure, the ETS is used as subscriber lines via the satellite communication system and telephone sets are used for special public telephones.

In the case of Figure 12.5.5-3 (b), the ETS is used as an emergency telephone office. The damaged area is connected to a designated switching office with the satellite communication systems.

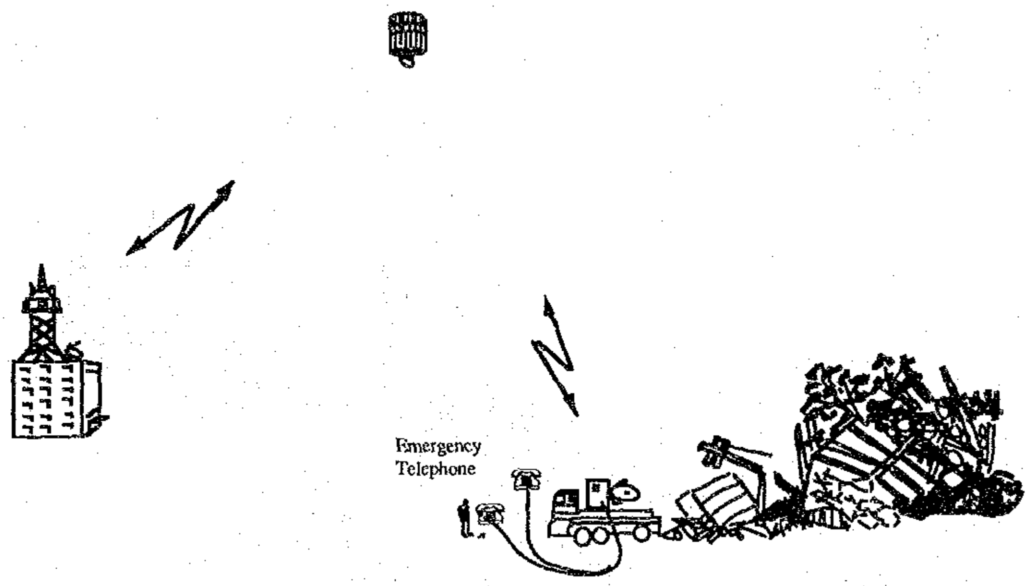


Figure 12.5.5-3 (a) Application of ETS

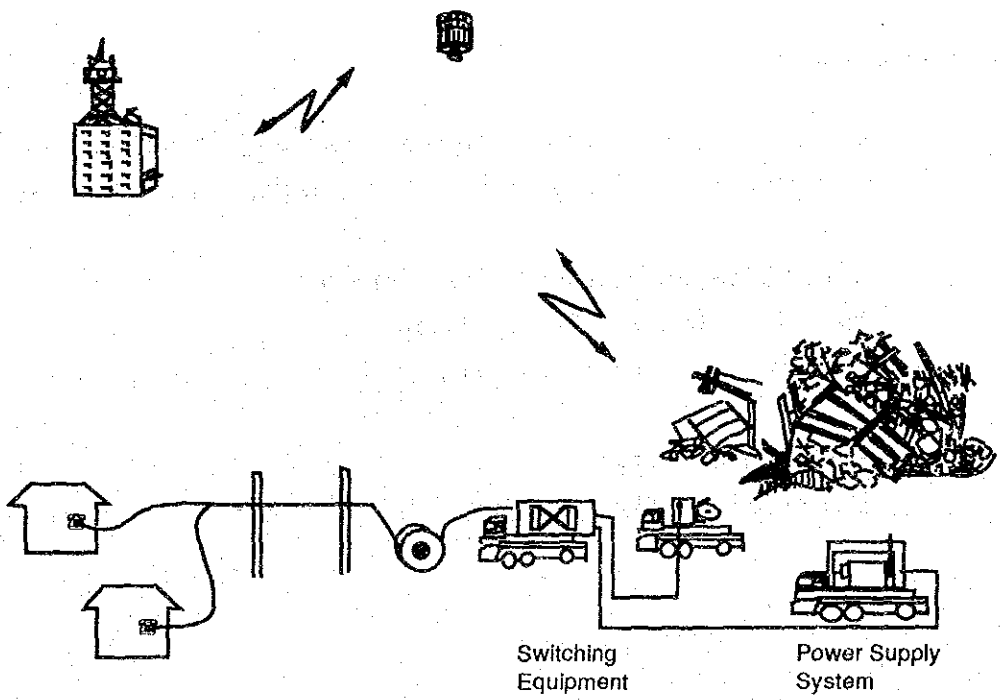


Figure 12.5.5-3 (b) Application of ETS

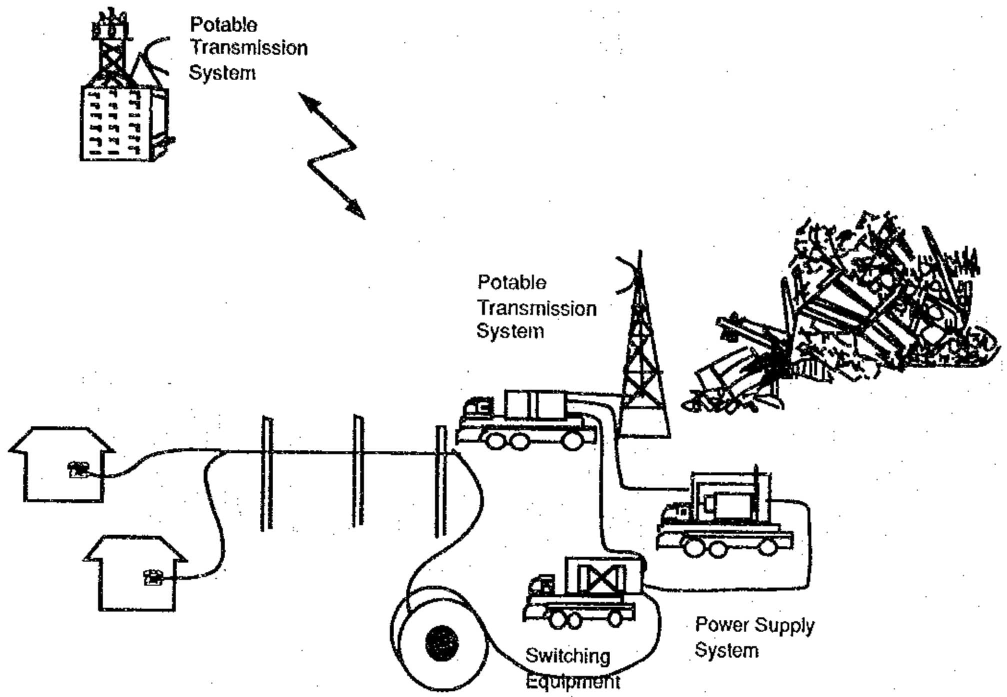


Figure 12.5.5-3 (c) Application of ETS

b) Introduction Plan

The areas where experienced big damages by natural disasters and the BMA should have the highest priority. The priority of the introduction of the ETS is as follows.

- Mobile Switching Equipment, Subscriber cable
  Phase-1 Bangkok, Cheing Mai, Hat Yai
  Phase-2 Nakhon Ratchasima, Surat Thani

- Power Supply System
  Described in the above paragraph.

CHAPTER 13

TELECOMMUNICATIONS FACILITY PLAN

CHAPTER 13 TELECOMMUNICATIONS FACILITY PLAN

This chapter describes a future installation and expansion plan of the telecommunications networks and facilities during the long-term plan covering from FY 1993 until FY 2007. This plan contains the following three major facilities:

1) Outside plant facilities,
2) Switching facilities, and
3) Transmission facilities.

At first, this chapter shows overall features of the facility plan including a telephone line installation plan, which includes the subscriber main telephone line connection plan and the public telephone installation plan, and a summary of the total facility plan. Next, this chapter explains the facility plans with cost estimation procedures of the three major facilities individually in detail.

13.1 Outline of the Facility Plan

13.1.1 Installation Schedule of Main Telephone Lines (Sales Plan)

The first objective and target of the long-term plan is to eliminate the waiting applicants in the Phase-1 (FY 1993 - FY 1997). Therefore, the telephone installation plan is to be set for the purpose that the total number of subscriber main telephone lines at the end of FY 1997 should satisfy the forecasted demand at FY 1997.
In addition to the subscriber telephone installation plan, the public telephone installation plan also needs to be set up so as to achieve the public telephone density target.

Table 13.1.1-1 shows the number of main telephone lines to be connected in each study area for the three phases.

Table 13.1.1-1 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.

Table 13.1.1-2 shows the number of public telephones to be installed in each study area for the three phases.

Table 13.1.1-2 Public Telephone Installation Plan for Each Phase

	BMA	Nakhon Pathom	Samut Sakhon	Ayutthaya	Total Study Area	Share
Phase-1 (1993-1997)	19,500	1,100	600	1,300	22,500	29%
Phase-2 (1998-2002)	23,100	900	500	1,000	25,500	33%
Phase-3 (2003-2007)	26,200	1,000	600	1,100	28,900	38%
Total	68,800	3,000	1,700	3,400	76,900	100%

The total number of main telephone lines connected in 15 years is approximately 5.3 million lines, almost five (5) times larger than the current number. 4.9 million lines, more than 90% of the total connected lines, will be connected in the BMA.

In order to fulfill all the unsatisfied telephone demand within the Phase-1 and eliminate the waiting applicants by the end of this phase, the Phase-1 needs the largest number of lines to be connected approximately 2.5 million lines, 47% of the total. The Phase-2 has 1.7 million lines, 31%; and the Phase-3, 1 million line, 22%.

When the 15-year long-term plan is successfully completed, the Study Area is expected to have 6.6 million connected main telephone lines, six times larger than the current number.

Table 13.1.1-3 and Figure 13.1.1-1 show the number of estimated main telephone lines to be connected in the Study Area: the BMA and the Surrounding Area, i.e., Nakhon Pathom, Samut Sakhon, and Ayutthaya according to the telephone installation schedule.

Table 13.1.1-4 shows the installation schedule and the total number of main telephone lines in the BMA. Table 13.1.1-5 to 7 show the installation schedules in Nakhon Pathom, Samut Sakhon, and Ayutthaya, respectively. The Number of subscribers in each telephone exchange office is estimated with the result of telephone demand forecast and the fulfillment targets proposed in Chapter 9 (refer to APPENDIX).

The annual growth rate of TOT's internal lines is set to be 10% by considering the expansion speed of the TOT's services and staff.

Table 13.1.1-3 Estimated Main Telephone Lines Connected in the Study Area

Year	BMA	Nakhon Pathom	Samut Sakhon	Ayutthaya	Total Study Area
1990	900,941	14,267	9,198	11,869	936,275
1991	1,054,832	15,101	9,769	12,360	1,092,063
1992	1,229,394	15,934	10,341	12,852	1,268,521
1993	1,703,345	25,743	21,645	19,158	1,769,891
1994	2,177,446	35,562	32,956	25,471	2,271,435
1995	2,651,680	45,384	44,270	31,794	2,773,128
1996	3,126,024	55,218	55,591	38,122	3,274,955
1997	3,600,488	65,057	66,916	44,458	3,776,919
1998	3,900,125	80,168	78,149	51,401	4,109,843
1999	4,199,928	95,285	89,386	58,347	4,442,945
2000	4,499,861	110,403	100,625	65,303	4,776,191
2001	4,799,869	125,532	111,871	72,256	5,109,527
2002	5,100,029	140,664	123,117	79,216	5,443,026
2003	5,307,892	153,629	130,067	84,206	5,675,794
2004	5,515,905	166,598	137,021	89,205	5,908,728
2005	5,724,052	179,575	143,977	94,205	6,141,809
2006	5,932,295	192,561	150,941	99,206	6,375,003
2007	6,140,655	205,548	157,908	104,211	6,608,322

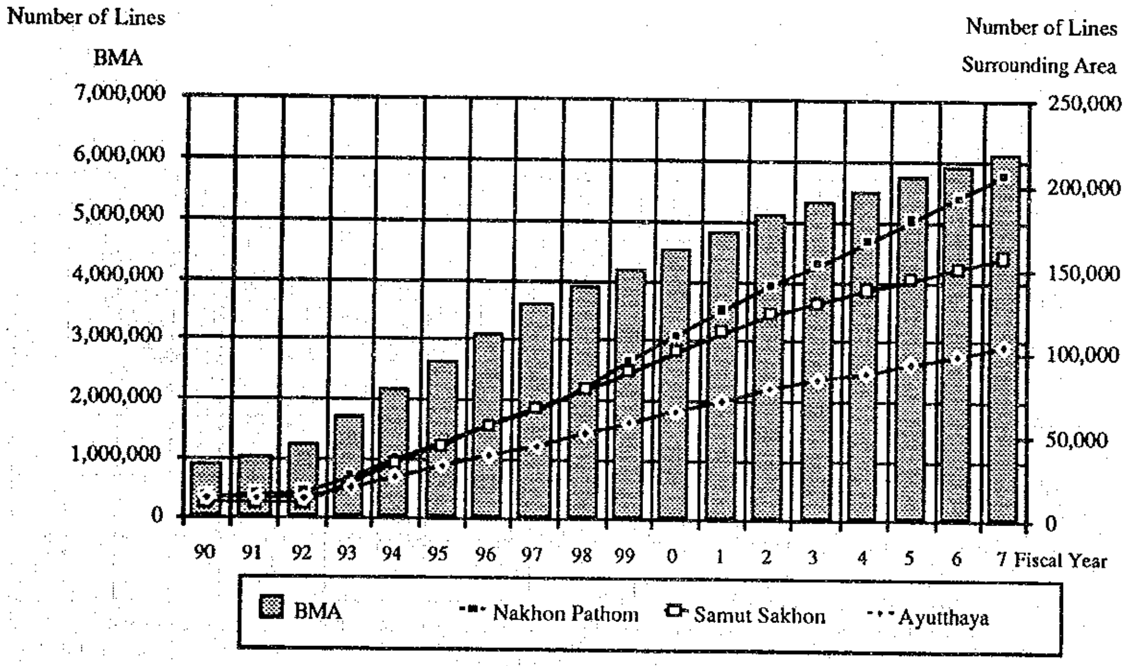


Figure 13.1.1-1 Estimated Main Telephone Lines Connected in the Study Area

Table 13.1.1-4 Installation Plan of Main Telephone Lines for Type of Subscribers in the BMA

Year	Line Connected				Annual Net Increased Line			
	Private + Government	TOT	Public Tel.	Total	Prv.+Govn.	TOT	Public Tel.	Total
1989*	771,588	6,082	14,533	792,203				
1990*	879,635	6,641	14,665	900,941	108,047	559	132	108,738
1991	1,031,618	7,305	15,909	1,054,832	151,983	664	1,244	153,891
1992	1,204,205	8,036	17,153	1,229,394	172,587	731	1,244	174,562
1993	1,673,713	8,839	20,793	1,703,345	469,507	804	3,640	473,951
1994	2,143,140	9,723	24,583	2,177,446	469,427	884	3,790	474,101
1995	2,612,479	10,695	28,506	2,651,680	469,339	972	3,923	474,234
1996	3,081,720	11,765	32,539	3,126,024	469,241	1,070	4,033	474,344
1997	3,550,855	12,941	36,692	3,600,488	469,135	1,176	4,153	474,464
1998	3,844,850	14,236	41,039	3,900,125	293,996	1,294	4,347	299,637
1999	4,138,716	15,659	45,552	4,199,928	293,866	1,424	4,513	299,803
2000	4,432,440	17,225	50,196	4,499,861	293,724	1,566	4,644	299,933
2001	4,726,008	18,948	54,914	4,799,869	293,567	1,723	4,718	300,008
2002	5,019,403	20,842	59,784	5,100,029	293,395	1,895	4,870	300,160
2003	5,220,210	22,927	64,755	5,307,892	200,807	2,084	4,971	207,863
2004	5,420,809	25,219	69,877	5,515,905	200,599	2,293	5,122	208,013
2005	5,621,179	27,741	75,132	5,724,052	200,370	2,522	5,255	208,147
2006	5,821,296	30,515	80,484	5,932,295	200,117	2,774	5,352	208,244
2007	6,021,136	33,567	85,952	6,140,655	199,840	3,052	5,468	208,360

Note: The figures of FY 1989 and 1990 are the actual figures. The figures from FY 1991 are the estimates made by the Study Team

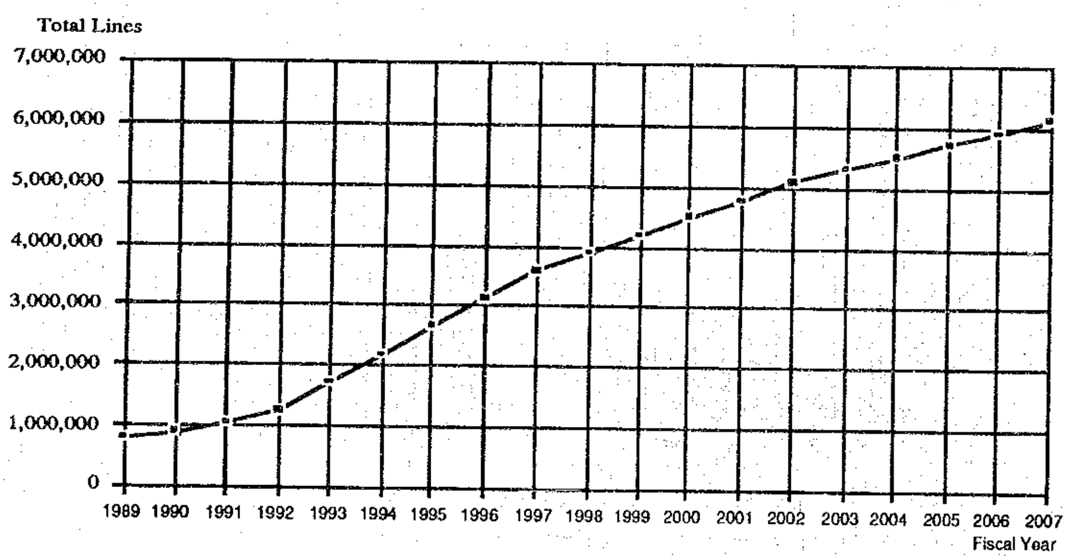


Figure 13.1.1-2 The Estimated Main Telephone Lines Connected in the BMA

Table 13.1.1-5 Installation Plan of Main Telephone Lines for Type of Subscribers in Nakhon Pathom

Year	Line Connected				Annual Net Increased Line			
	Private + Government	TOT	Public Tel.	Total	Prv.+Govn.	TOT	Public Tel.	Total
1990	14,001	165	101	14,267				
1991	14,717	182	202	15,101	716	17	101	834
1992	15,431	200	303	15,934	714	18	101	834
1993	25,015	220	508	25,743	9,584	20	205	9,809
1994	34,597	242	723	35,562	9,582	22	214	9,818
1995	44,177	266	941	45,384	9,580	24	218	9,822
1996	53,755	292	1,171	55,218	9,577	27	229	9,833
1997	63,329	322	1,406	65,057	9,575	29	235	9,839
1998	78,243	354	1,571	80,168	14,914	32	165	15,111
1999	93,154	389	1,742	95,285	14,911	35	172	15,118
2000	108,061	428	1,914	110,403	14,907	39	171	15,117
2001	122,964	471	2,097	125,532	14,903	43	184	15,130
2002	137,863	518	2,283	140,664	14,899	47	186	15,132
2003	150,589	570	2,470	153,629	12,726	52	187	12,965
2004	163,309	627	2,662	166,598	12,720	57	192	12,969
2005	176,024	689	2,862	179,575	12,715	63	200	12,977
2006	188,732	758	3,070	192,561	12,708	69	208	12,986
2007	201,434	834	3,280	205,548	12,702	76	210	12,987

Note: The figures from FY 1991 are the estimates made by the Study Team

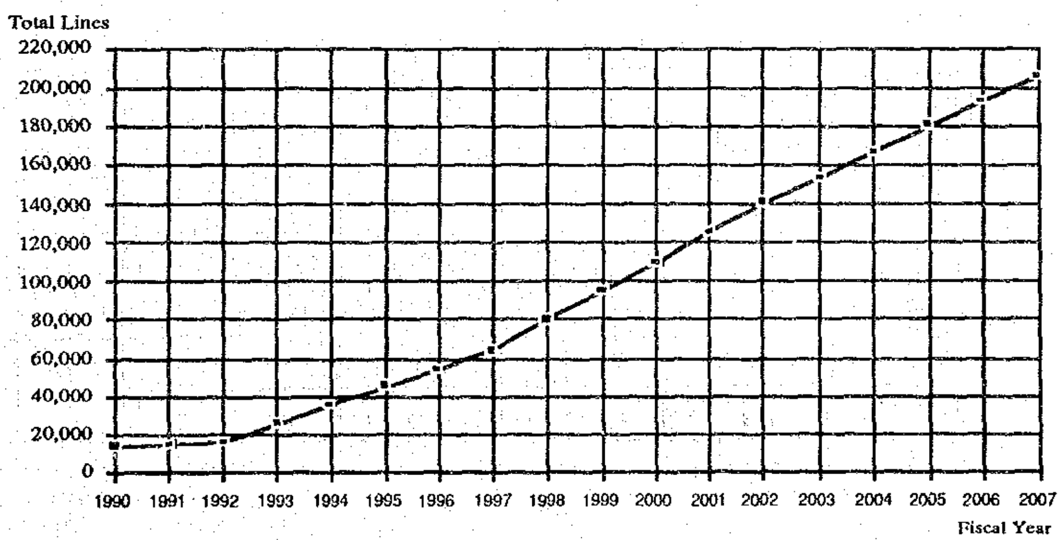


Figure 13.1.1-3 The Estimated Main Telephone Lines Connected in Nakhon Pathom

Table 13.1.1-6 Installation Plan of Main Telephone Lines for Type of Subscribers in Samut Sakhon

Year	Line Connected				Annual Net Increased Line			
	Private + Government	TOT	Public Tel.	Total	Prv.+Govn.	TOT	Public Tel.	Total
1990	9,090	43	65	9,198				
1991	9,607	47	115	9,769	517	4	50	571
1992	10,124	52	165	10,341	517	5	50	571
1993	21,310	57	278	21,645	11,186	5	113	11,304
1994	32,496	63	397	32,956	11,186	6	119	11,311
1995	43,682	69	519	44,270	11,185	6	122	11,314
1996	54,866	76	649	55,591	11,185	7	130	11,321
1997	66,050	84	782	66,916	11,184	8	133	11,325
1998	77,179	92	878	78,149	11,129	8	96	11,233
1999	88,307	101	977	89,386	11,128	9	99	11,236
2000	99,435	112	1,079	100,625	11,127	10	102	11,240
2001	110,561	123	1,187	111,871	11,126	11	108	11,246
2002	121,686	135	1,296	123,117	11,125	12	109	11,246
2003	128,511	148	1,408	130,067	6,825	13	112	6,950
2004	135,334	163	1,523	137,021	6,823	15	115	6,953
2005	142,156	180	1,642	143,977	6,822	16	118	6,957
2006	148,976	198	1,767	150,941	6,820	18	125	6,964
2007	155,795	217	1,896	157,908	6,818	20	129	6,967

Note: The figures from FY 1991 are the estimates made by the Study Team

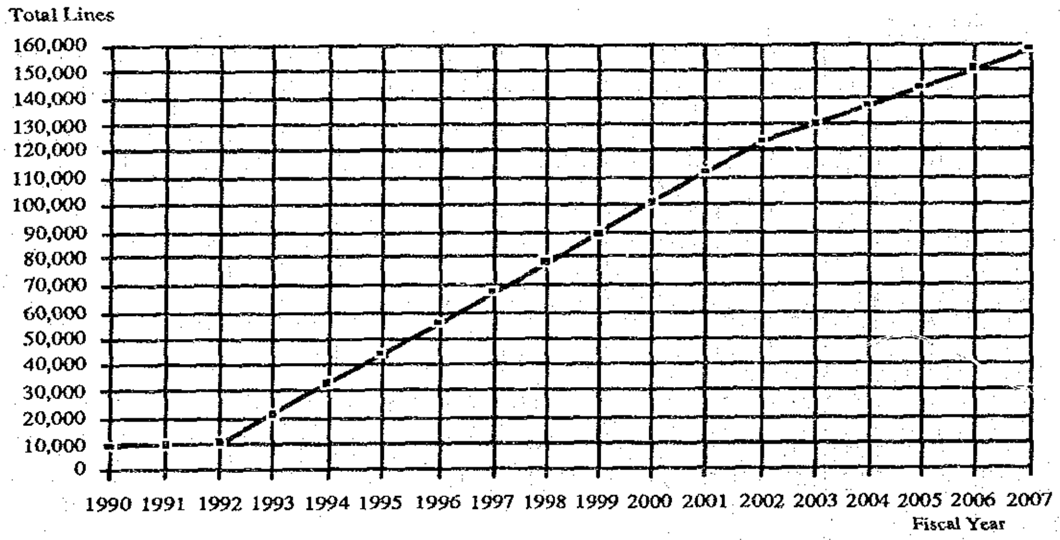


Figure 13.1.1-4 The Estimated Main Telephone Lines Connected in Samut Sakhon

Table 13.1.1-7 Installation Plan of Main Telephone Lines for Type of Subscribers in Ayutthaya

Year	Line Connected				Annual Net Increased Line			
	Private + Government	TOT	Public Tel.	Total	Prv.+Govn.	TOT	Public Tel.	Total
1990	11,533	185	151	11,869				
1991	11,907	204	250	12,360	374	19	99	491
1992	12,279	224	349	12,852	372	20	99	491
1993	18,326	246	585	19,158	6,047	22	236	6,306
1994	24,371	271	829	25,471	6,045	25	244	6,313
1995	30,413	298	1,083	31,794	6,042	27	254	6,323
1996	36,453	328	1,342	38,122	6,040	30	259	6,328
1997	42,489	361	1,608	44,458	6,037	33	266	6,336
1998	49,207	397	1,797	51,401	6,718	36	189	6,943
1999	55,921	436	1,990	58,347	6,714	40	192	6,946
2000	62,631	480	2,192	65,303	6,710	44	202	6,956
2001	69,337	528	2,391	72,256	6,706	48	199	6,953
2002	76,037	581	2,598	79,216	6,701	53	207	6,960
2003	80,758	639	2,810	84,206	4,721	58	212	4,990
2004	85,473	703	3,029	89,205	4,715	64	220	4,998
2005	90,181	773	3,251	94,205	4,708	70	221	5,000
2006	94,882	850	3,473	99,206	4,701	77	222	5,001
2007	99,576	935	3,700	104,211	4,694	85	227	5,005

Note: The figures from FY 1991 are the estimates made by the Study Team

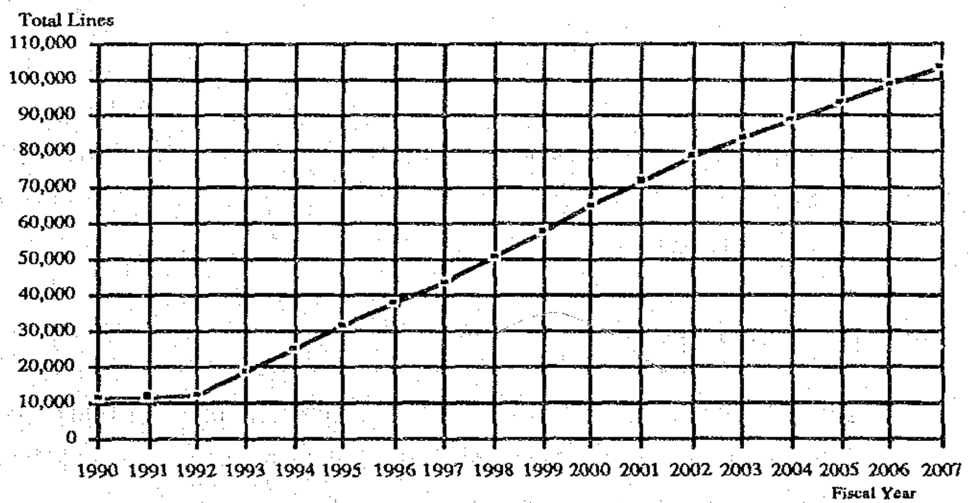


Figure 13.1.1-5 The Estimated Main Telephone Lines Connected in Ayutthaya

13.1.2 Outline of the Expansion Plan

The concept of the Expansion Plans are as follows.

1) Main Telephone

The main telephone lines (exclude the public telephone lines) in the Study Area will be increased by approximately 2,486 thousand lines during the Phase-1, 1,641 thousand lines during the Phase-2, 1,136 thousand lines during the Phase-3 lines and total 5,264 thousand lines.

This expansion plan can completely eliminate the waiting applicants in the Phase-1 in the BMA.

2) Public Telephone

The expansion of the public telephones in the area is proposed at 22,500 sets during the Phase-1, 25,500 sets during the Phase-2, 28,900 sets during the Phase-3 and total 76,900 sets.
As a result, the density of the public telephones will become 8.0 per 1000 persons in the BMA by the end of 2007.

3) Outside Plant Facilities

a) Local Cable

The expansion of local cables in the area is proposed at 4,461 thousand pairs during the Phase-1, 2,033 thousand pairs during the Phase-2, 1,276 thousand pairs during the Phase-3 and total 7,771 thousand pairs.

b) Rehabilitation Plan

The rehabilitation of local cables will be required during the period of 1993 to 2007. As the execution results of this rehabilitation plan, the fault rate can be expected to be better than the present rate at the end of Phase-3.

4) Switching Facilities

The expansion of the local switching capacity in the study area is proposed at 857 thousand lines during the Phase-1, 220 thousand lines during the Phase-2, 72 thousand lines during the Phase-3 and total 1,149 lines. The replacement of the analog switches will be proposed in order to change to larger capacity SPC switches.

5) Transmission Facilities

a) Long Distance Trunk

The expansion of the long distance trunk circuits in the BMA is proposed at 17,000 circuits during the Phase-1, 11,000 circuits during the Phase-2, 4,000 circuits during the Phase-3 and total 32,000 circuits.

b) Metropolitan Junction Trunk Circuits

The expansion of the junction trunk circuits in the BMA is proposed at 138,000 circuits during the Phase-1, 74,000 circuits during the Phase-2, 44,000 circuits during the Phase-3 and total 256,000 circuits.

c) Replacement of PCM System

The replacement of the PCM-30 systems in the BMA proposes 34,000 circuit replacement during the Phase-1, 33,000 circuits during the Phase-2, 20,000 circuits during the Phase-3 and total 87,000 circuits.

6) Mobile Communication Facilities

a) Cellular Mobile Facilities

The cellular mobile communication facilities are planned to be expanded by 857 thousand line units during the Phase-1, 220 thousand line units during the Phase-2, 72 thousand line units during the Phase-3 and total 646,000 line units.

b) Paging Facilities

The paging facilities are planned to be expanded by 822 thousand line units during the Phase-1, 199 thousand line units during the Phase-2, 13 thousand line units during the Phase-3, total 1,034 thousand line units.

7) Investment cost

The investment cost of this expansion plan in the Study Area is 91.9 billion Baht during the Phase-1, 59.1 billion Baht during the Phase-2, 47.2 billion Baht during the Phase-3 and total 198.2 billion Baht. Table 13.1.2 shows the outline of the expansion plan in the Study Area.

Table 13.1.2 Outline of the Expansion Plan in the Study Area

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 *1	(line unt)	857,000	220,000	72,000	1,149,000
	Paging *1	(line unit)	822,000	199,000	13,000	1,034,000
Investment Cost		(billion Baht)	91.9	59.1	47.2	198.2

*1 The demand figures show the whole Kingdom

13.2 Outside Plant Facilities

In the Phase-1, a large amount of local cables will be installed in the local cable net work and approximately 8% of the total investment cost will be put into replacement of timeworn cables for improvement of its quality.

13.2.1 Expansion Plan of Local Cable

1) Expansion Policies

The proposed policies for the local cable capacity expansion are as follows;

a) The proposed number of cable pairs is estimated on the basis of the target number of connected subscribers.
b) The number of leased lines, test pairs and other lines are estimated at 3% of the whole connected lines. The percentage of leased lines is about 1% in the Study Area at the end of 1990.
c) The cable pair slack margin rate is estimated at 30% for the whole primary cable pairs. In other word, the portion of available pairs is 70% of all primary cable pairs.
d) Expansion is carried out evenly over Phase-1.

2) The Number of Primary Cable Pairs to be Installed in Each Phase

The number of primary cable pairs to be installed in each phase is proposed as shown in Table 13.2.1. 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 13.2.1 Number of Primary Cable Pairs to be Installed in Each Phase

(Unit: 1,000 pairs, Million Baht)

	Phase1		Phase2		Phase3		Total	
	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
BMA1	1,086	8,629	394	3,128	253	2,011	1,733	13,768
BMA2	1,084	8,613	490	3,890	292	2,321	1,865	14,824
BMA3	876	6,960	388	3,081	236	1,876	1,500	11,917
BMA4	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

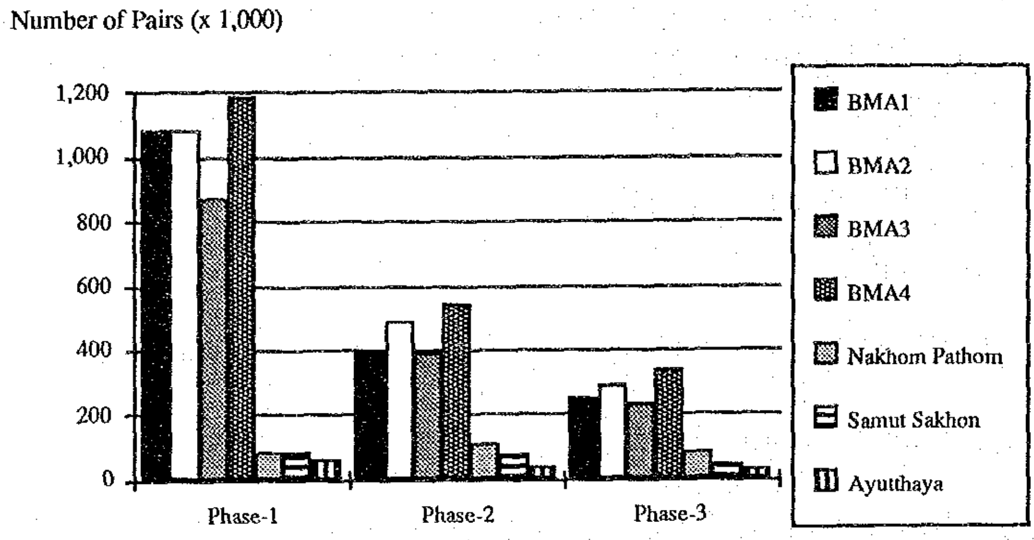


Figure 13.2.1-1 Number of Primary Cable Pairs to be Installed in Each Phase

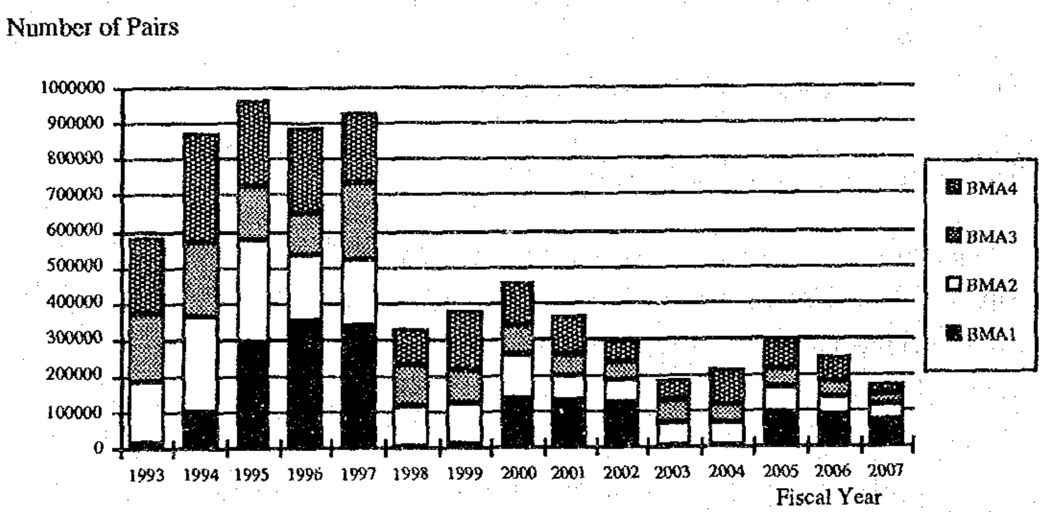


Figure 13.2.1-2 Number of Primary Cable Pairs to be Installed in the BMA

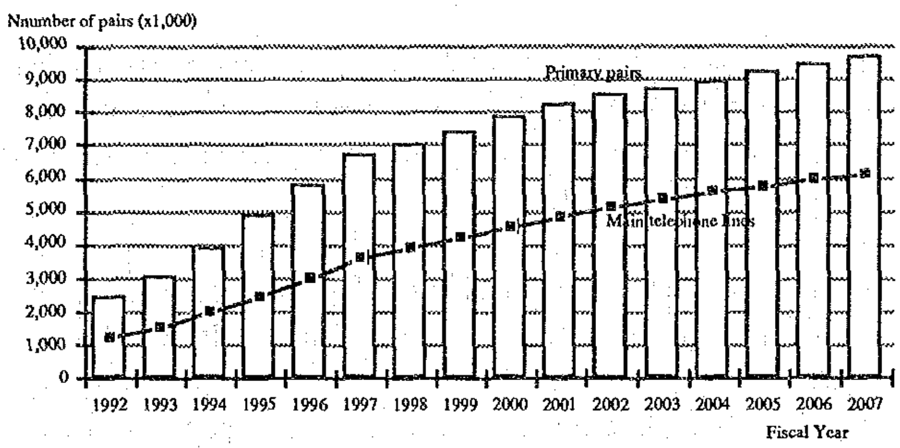


Figure 13.2.1-3 Number of Primary Cable Pairs and Number of Subscribers in the BMA

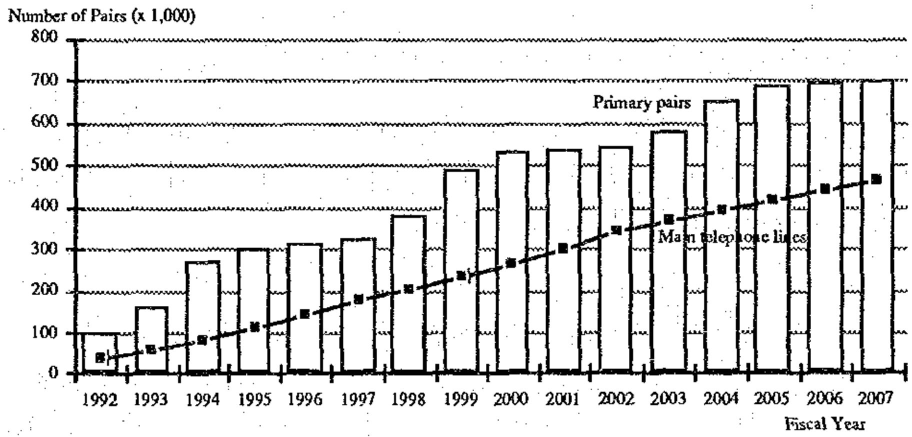


Figure 13.2.1-4 Number of Primary Cable Pairs and Number of Subscribers in the Surrounding Area

3) For Future Expansions

At the end of 1997, the waiting applicants will be all connected. At that time, TOT will have finished installing the enormous volume of local cables. The management of the local cable network will be more complicated as its size increase. Therefore, urgent introduction and enlargement of a facility management system such as COLNETR is required for effective management of future projects.

As for the construction work, TOT has been conducting time and manpower ensuring process tests, because TOT has been using the census method on the process tests. It is required for smooth and even construction works that the process tests should employ a sampling method or abolished. Because completion tests are executed after construction work is finished.

One more issue that should be considered is the fix distribution system of the local cable pairs as mentioned in Chapter 6. TOT has adopted a free access type closure on some parts of the secondary cables, but TOT has recently decided to stop using it because of its low reliability.

The free access type closure is an useful article for increasing flexibility of the secondary cable pairs against fluctuations of the telephone demand. Therefore, if TOT wishes to have an economical local cable network and effective operation of the local cable pairs, necessary research and development of some free access type closures must be started to apply free access distribution systems onto the local cable network. A comparison between fix distribution system and free access distribution about advantages and disadvantages is described in APPENDIX.

13.2.2 Installation Plan of Main Telephone Line (Drop Wire)

According to the telephone sales plan described in the section 13.1.1, the number of drop wires to be installed in each phase is as shown in Table 13.2.2. The estimation procedure for the drop wire installation cost is described in APPENDIX.

Table 13.2.2 Number of Drop Wires to be Installed in Each Phase

(Unit: 1,000 drop wires, Million Baht)

	Phase1		Phase2		Phase3		Total	
	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
BMA1	512	307	332	200	249	150	1,094	656
BMA2	655	393	396	238	269	162	1,320	792
BMA3	499	299	322	193	215	129	1,036	622
BMA4	705	423	449	269	307	184	1,461	877
Sub Total	2,371	1,423	1,500	900	1,041	624	4,911	2,947
Nakhom Pathom	49	29	76	45	65	39	190	114
Samut Sakhon	57	34	56	34	35	21	148	89
Ayutthaya	32	19	35	21	25	15	91	55
Sub Total	137	82	167	100	125	75	429	257
Total	2,508	1,505	1,666	1,000	1,165	699	5,340	3,204

Note: The above figures include the number of drop wire installation for the public telephone expansion.

13.2.3 Expansion Plan of Public Telephone Sets

According to the target density of the public telephones proposed in Chapter 9, the number of public telephones to be expanded in each phase is as shown in Table 13.2.3. The estimation procedure for the public telephone installation cost is described in APPENDIX.

Table 13.2.3 Number of Public Telephone Sets to be expanded in Each Phase

(Unit: Sets, Million Baht)

	Phase1		Phase2		Phase3		Total	
	Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
BMA1	4,294	390	5,134	467	6,083	553	15,511	1,409
BMA2	5,388	490	6,176	561	6,948	631	18,512	1,682
BMA3	4,207	382	4,948	450	5,478	498	14,633	1,330
BMA4	5,650	513	6,834	621	7,659	696	20,143	1,830
Sub Total	19,539	1,775	23,092	2,099	26,168	2,378	68,799	6,252
Nakhom Pathom	1,103	100	877	80	997	91	2,977	271
Samut Sakhon	617	56	514	47	600	55	1,731	157
Ayutthaya	1,259	114	990	90	1,102	100	3,351	304
Sub Total	2,979	271	2,381	216	2,699	245	8,059	732
Total	22,518	2,046	25,473	2,315	28,867	2,263	76,858	6,984

13.2.4 Rehabilitation Plan of Local Cable and Wire

The main purpose of rehabilitation of the local cable network is to improve the service quality such as reduction of the fault rate. There are two major ways to improve the quality of the local cables. One is to replace old or deteriorated facilities. The other is to repair them. And to decrease the fault rate, it is necessary that the both ways are vigorously pursued.

The target of this rehabilitation plan is to accomplish the fault rate of 13 per month per 1,000 subscribers at the end of 2007 proposed by the Master Plan study by JICA in 1989.

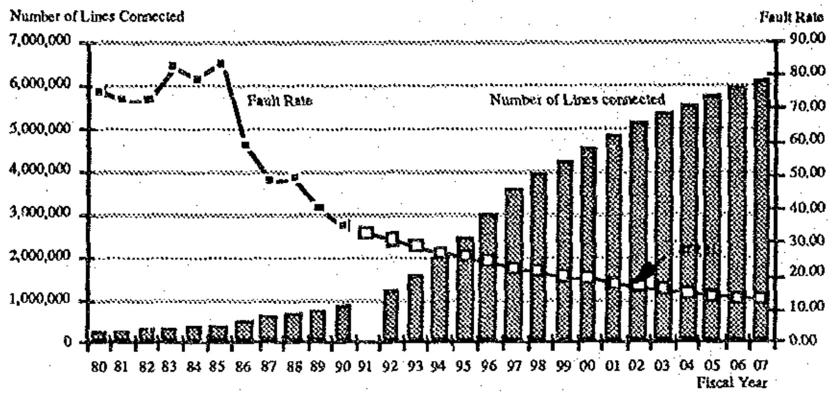


Figure 13.2.4-1 Fault Rate and Number of Lines Connected in the BMA

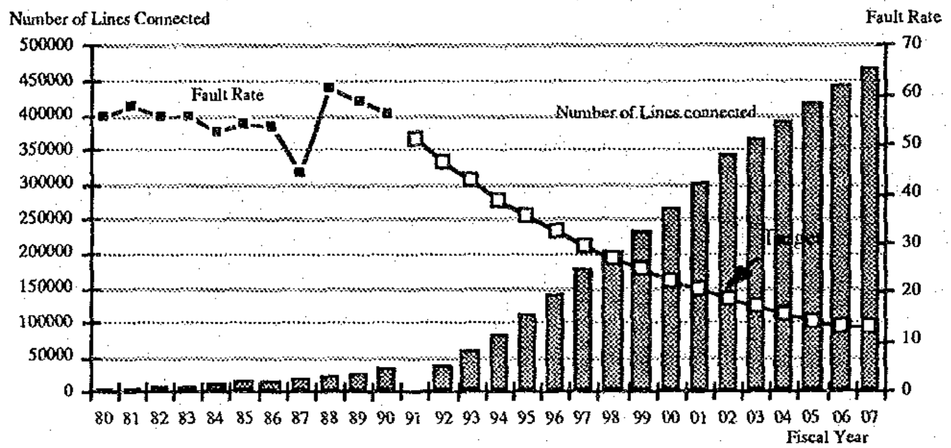


Figure 13.2.4-2 Fault Rate and Number of Lines Connected in the Surrounding Area

1) Necessity of Replacement of Local Cable

TOT has been expanding the local cable network to fulfill the telephone subscription demand. The number of primary cable pairs will be approximately 2.6 millions at the end of 1992. However, the local cables are not in a good condition. The average fault rate caused by bad cables was 51.5 per 1,000 main telephone stations per month in the BMA and 74.2 in the provincial areas in 1990. This means that if the rate would not be improved in the future, the number of faults caused by bad cables would go up to about 17 thousands a month in 1997 in the Study Area. It means not only the increase of the maintenance cost but also the deterioration of the public trust.

One of the effective causes is surmised decrepitude of local cables. TOT has been carrying out the replacement of the old cables on which faults occurred frequently, but distinct decrease of the number of faults could not be find out in any reports. It is a duty of TOT to provide good telecommunication services. Therefore, deteriorated cables, which will increase more in the future, must be replaced as a preventive maintenance work.

Additional reason for replacing the old cables is the introduction of new services such as ISDN services. The basic rate service of ISDN is provided with digital transmission systems through metallic cable loops. Quality of the local cables is one of the most important elements to provide it in a good condition. According to the PROGRESS REPORT-1 of INVESTIGATION on LOCAL CABLE NETWORK for ISDN, the number of paper insulated cables was 40% of all cables in the BMA in 1989 as shown in Table 13.2.4-1. And the paper insulated cables are a major cause of burst errors when digital signals are transmitted through metallic loops. Because they are usually twisted to be connected to each other. Hence the connections will become loose as they become old.

Therefore, by taking the above matter into account, the Study Team strongly proposes the replacement of the existing paper insulated cables. And, to carry it out effectively and economically, it should be performed together with the expansion of local cables.

Table 13.2.4-1 Number of Cables in the BMA in 1989

	LTJ		LTJ&ASP		ASP		ASP(PEF)		AP		AP-FSF	
Area	Line	Pair	Line	Pair	Line	Pair	Line	Pair	Line	Pair	Line	Pair
Area 1	0	0	9	9,600	58	137,200	25	91,200	0	0	39	101,100
Area 2	0	0	0	0	60	144,800	0	0	13	8,025	109	264,300
Area 3	3	1,100	0	0	35	87,700	0	0	5	3,700	58	140,100
Area 4	8	3,500	0	0	46	109,000	0	0	6	3,600	54	128,100
Total	11	4,600	9	9,600	199	478,700	25	91,200	24	15,325	260	633,600

Note: LTJ and ASP are paper insulated cables, others are plastic insulated cable

2) Replaced Number of the Local Cables

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

a) Policy

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

b) Presumption of the Constructed Year of the Cables

When these paper insulated cables were installed was estimated by examining the number of local cables connected in each year during the last 18 years.

c) Replaced Number

The replaced number of the local cables is shown in Table 13.2.4-2 (details are shown in APPENDIX). The cost estimation procedure for the replacement of local cables is described in APPENDIX.

Table 13.2.4-2 Number of Cables to be Replaced in Each Phase

(Unit: Primary Cable Pairs, Million Baht)

	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

d) Priority for the Replacement of the Paper Insulated Cables

The replacement should be carried out by the following priority order if there is not much difference in the conditions on individual cable:

i) First priority : Central business area,
ii) Second priority : Rapidly growing suburban area,
iii) Third priority : Industrial area,
iv) Fourth priority : Outer area.

3) Rehabilitation for Aerial Cables and Drop Wires

There are many issues to be improved on the existing aerial cable facilities as mentioned in Chapter 6. The rehabilitation of aerial cables and drop wires is the most effective way to reduce the number of faults. When the rehabilitation will be performed, the important things to be considered are as follows:

a) Many cables are installed on one pole. There is not enough space to install new cables for expansion. Therefore, the number of cables installed on one pole should be reduced.

b) Many aerial cables are not installed on sufficiently high place on poles. It increases the probability of cable damages caused by car accidents or construction machines. Therefore, the cables should be installed on higher places.

c) Many temporary repaired closures and damaged ones are found in the local cable network. They are a cause of the high fault rate. Therefore, those cables should be immediately replaced.

d) Most of the drop wires were crowded, disheveled and long. Sometimes twisted splices for repair were found on the drop wires. These are major factors of the faults on the drop wires. Therefore, those drop wires should be replaced with new ones or changed to cables.

4) For the Effective Rehabilitation of the Local Cables and Wires

The problems on the local cables are related to many things such as facility planning, facility design, quality of materials, cable assignment for installation, repair method, budgets for maintenance. Therefore, it is not so simple to eliminate all faults of the local cables and drop wires without total organizational efforts.

There are three important things for reduction of the fault rate caused by the local cable facilities. First is the improvement of its distribution system. Second is the improvement of reliability of the materials. Third is the ages of the facilities.

a) On the existing local cable network of TOT, one of the problems to be considered for improvement of its quality is the distribution system on the secondary cables. The fix distribution system does not have enough flexibility to accommodate demand fluctuations. It is also a main cause of longer drop wires. In other words, the fix distribution system is a cause of many faulty facilities. Therefore, introduction of the free access distribution system is required for the secondary cables.

b) Outside plant facilities are exposed to severe natural environment such as sun light, wind, rain fall, temperature, and social environment such as traffic, construction works, electricity induction. TOT has mainly adopted technologies and materials developed by foreign countries. Those technologies and materials are not perfectly suited for the Thai environment. Research and development efforts to develop suitable technologies and materials are needed.

c) Replacement of deteriorated facilities as preventive maintenance is the most effective way to decrease the fault rate. Preventive maintenance has not been established in the maintenance activities in TOT. It is not economical to spend a lot of money to maintain the facilities because the budget for maintenance activity is usually not enough. It is important for effective replacement that the conditions of the facilities are examined all the time. Therefore, introduction of a facility management system such as COLNETR and establishment of an organic maintenance system are required as soon as possible.

When the above measures are completed, it will be expected that the fault rate will fall within the target range set by the Master Plan.

13.3 Switching Facilities

13.3.1 Outline of the Expansion Plan

1) Principles

The expansion plan is formulated on the basis of objectives and strategies described in Chapter 9, the demand forecast described in Chapter 8 and the traffic forecast described in Chapter 10.

a) The quantity of the facilities to be installed in the switching facility expansion plan was decided on the basis of the telephone subscriber demand forecast described in Chapter 8.

b) Design margin period for switching capacity was set at 2 years after the completion of the project.

c) The XB switch replacement plan is formulated on the basis of the switching facility expansion plan and consists of two phases (Phase-1, Phase-2) because of the availability of facility room space.

d) The number of circuits is based on the traffic forecast data in Annex, and the Erlang-B formula were applied.

2) Outline of the Expansion Plan

Switching expansion will be proposed in order to meet the demand increase as follows:

- The expansion of local switching capacity is proposed to be 2,861 thousand lines during the Phase-1, 1,418 thousand lines during the Phase-2, 1,136 thousand lines during the Phase-3, and the total 5,416 thousand lines,
- The expansion of toll switching capacity is proposed to be 19 thousand circuits during the Phase-1, 12 thousand circuits during the Phase-2, 6 thousand circuits during the Phase-3, and the total 37 thousand circuits,
- The expansion of tandem switching capacity is proposed to be 83 thousand circuits during the Phase-1, 30 thousand circuits during the Phase-2, 13 thousand circuits during the Phase-3, and the total 126 thousand circuits.

The analog exchanges will be proposed to be replaced with larger capacity SPC exchanges as follows: