7.4 Network Management

7.4.1 General

1) Introduction

The digitization of telecommunication network is a worldwide trend. In Thailand too, the number of digital circuits and facilities in both switching and transmission sections, are increasing in proportion to the growth in traffic and the rapid expansion of various kinds of services.

In the meantime, the demands from customers will be more diversified and sophisticated. It will become increasingly important to develop a operation and maintenance system for more effective maintenance than has been available up to now, in order to manage the telecommunication systems in both quantity and quality.

Therefore, network management will be very important matter for operation and maintenance of telecommunication network.

For managing the telecommunication network effectively and economically, centralization of telecommunication network management is necessary. It has mainly two merits. One is to grasp the situation of the whole network (e.g traffic, troubles and so on). Other is to improve the technical level of the staff concerned, so that to be able to carry out the efficient operation and maintenance work.

In this chapter, the present states of network management systems are reviewed, and then the concepts of the network management system in the future are studied and proposed.

2) Organization of Operation and Maintenance

In connection with the improvement of operation and maintenance system, it should be considered to improve the organization of each system, essentially and economically. Generally, it will be separated to two groups. One is for operation and the other is for maintenance.

They should be studied that the number of staffs and range of the centers by the time when the new network management system is introduced.

7.4.2 Switching Management

1) Present State of Maintenance and Network Management

a) Present Maintenance Center and Expansion Plan

At present, there are 8 maintenance centers, namely, 4 metropolitan maintenance centers and 4 provincial maintenance centers. These centers perform 24 hour services. Metropolitan maintenance centers are in charge of maintenance and operation for all types of exchanges and provincial maintenance centers are in charge of operation and maintenance for AXE 10 exchanges. The locations of these maintenance centers are as follows:

- Metro. Area -

Maintenance Center 1	Krung Kasem
Maintenance Center 2	Phrakhanong
Maintenance Center 3	Lat Ya
Maintenance Center 4	Lak Si

- Provincial Area -

Maintenance Center 1	Ayutthaya AOM
Maintenance Center 2	Nakhon Ratchasima AOM
Maintenance Center 3	Phitsanulok AOM
Maintenance Center 4	Phun Phin AOM

Meanwhile, there are national AOM and NCOM in Ploenchit office. AOM covers nationwide AXE 10 exchanges. However, NCOM covers 49 NEAX61 exchanges including 8 provincial exchanges at present time. Therefore, new NCOM which cover nationwide NEAX61 exchanges in the near future will be installed. After that, Operation and maintenance of AXE10 and NEAX61 exchanges will become controlled efficiently by these compterized system. The new maintenance centers will be located as follows:

- Metro. Area -

Maintenance Center	Lat Ya

- Provincial Area -

Maintenance Center 1	Lat Ya
Maintenance Center 2	Nakhon Ratchasima
Maintenance Center 3	Phitsanulok
Maintenance Center 4	Phun Phin (Surat Thani)

b) Main Functions of Operation and Maintenance System

The NCOM main functions show in Table 7.4.2-1 and the AOM main functions show in Table 7.4.2-2.

Table 7.4.2-1 NCOM Main Functions

Item	Function
Operation Monitoring	(1) Monitoring network status (2) Monitoring computer status
Maintenance	(1) Trouble shooting (2) Diagnosis (3) Fault recovery (4) Periodic routine testing (5) Fault recording, etc.
Operation	(1) Complaint processing support (2) Monitoring services (3) Statistical processing (4) Charge auditing (5) Collection of call data (6) Service order processing support (7) Office data change processing support (8) Traffic information compiling (9) Emergency processing (10) Measures against traffic congestion, etc.

Table 7.4.2-2 AOM Main Functions

Item	Function
Maintenance	(1) Fault tracing (2) Software maintenance (3) Alarm collection and presentation (4) Trunk line testing (5) Supervision of routes (6) Supervision of common devices, etc.
Operation	(1) Charging data collection (2) Traffic measurement (3) Statistical data collection (4) Device analysis data collection (5) Subscriber data administration (6) Network control, etc.

c) Organization and Working Time

Each big exchange has its own maintenance staff. The staff maintains not only parent exchange but also unattended exchange such as RSU, if there are any. The exchange maintenance staff works usually from 8:00 to 16:00 and in the night time, maintenance center staff works not only day time but also from 16:00 to 24:00 and from 0:00 to 8:00.

2) Maintenance and Network Management Plan

a) General

The number of telephone subscribers will be expected to increase more and more in Thailand. Therefore, the number of exchanges will also increase and the network will develop more and more all over the country. Taking account of these situations, it is necessary to promote the maintenance efficiency and to grasp the traffic condition. With network expansion, the network will be enhanced gradually through offering many kind of new services. Therefore, software technology will become more important for the maintenance staff. And when natural disaster or accident occur at some area, a rapid increase of traffic flow may bring about traffic congestion. It is necessary to consider the measure to cope with such an extraordinarily traffic congestion.

b) Computerized Operation and Maintenance System

i) Accommodation to NCOM and AOM

For promoting maintenance efficiency, all SPC exchanges should be accommodated with NCOM or AOM from Phase-1. As these systems have many functions, some parts of maintenance and operation work can be centralized. Meanwhile, NCOM and AOM are the products from different manufacturers. Therefore, integration of both system will have to be considered separately, through the both manufacturers' possible cooperation.

ii) NCOM and AOM for ISDN Exchange

ISDN service is expected to introduce in Thailand in the near future. For the maintenance and operation of ISDN exchanges, NCOM and AOM will be supplemented with ISDN test function such as subscriber terminal test, user-network separation test and trouble shooting in network, if possible. Because many NEAX61s and AXE10s are already installed in Thailand and some of them will be applied for ISDN service. And as ISDN exchange will increase from Phase-2, these functions should be added by the same term.

iii) Relation between NCOM/AOM and Integrated Network Management System

Integrated Network Management System is described in Section 7.4.5. Though this system has to be studied after CCITT recommendation, probably the existing operation and maintenance system such as NCOM and AOM will be incorporated with Integrated Network Management System as a subsystem.

c) Technical Skill Advancement

i) Fault Recovery Recording Document

When a major fault occurred in one exchange, it is important to make document which is described with the system name, the contents of problem, the cause and the recovery method, etc. after recovery. And these documents should be explained to maintenance staff at periodical meeting, etc. from Phase-1. The explanation will be useful for maintenance staff to advance the skill and the recovery time will be reduced when the same fault occurred.

ii) Software Technology Acquirement

SPC exchanges will replace all existing XB exchange in future and many part of new service functions will be replaced by software. At present, all the software jobs are carried out by the software support center. However, software technology will be more necessary for all the maintenance staff of the exchanges.

Therefore, if maintenance staff of exchanges and maintenance center staff, who completed at least basic technical training course, can participate software job together with support center staff for 6 months to 1 year from Phase-1 as OJT, it is expected that their software skill will advance and they will have opportunities for promoting to the staff of maintenance center and software support center in future.

As the center jobs does not seem to carry out regularly, some of the following jobs will be useful for OJT:

- Telephone consulting about software for the maintenance staff
- Office data modification and assignment
- Fault processing
- File management and patch management, etc.

d) Periodical Traffic Measurement

At present, the periodical traffic measurement in Bangkok and the irregular traffic measurement all over the country are carried out. However, it is necessary to execute the periodical nationwide traffic measurement for calculating the number of circuits and facilities for network expansion from Phase-1.

The traffic measurement is divided two patterns. One is the periodical measurement for grasping the nation wide traffic data. It is preferable to measure once per month during the busy hour. The other is irregular measurement which is carried out when some extraordinary traffic is expected.

On the other hand, traffic management is composed of 4 steps, that is investigation, judgement, countermeasure and a result. Figure 7.4.2-1 shows the cycle of traffic management. Traffic management sector will propose to plant planning sector for establishment of circuits, etc. through this cycle.

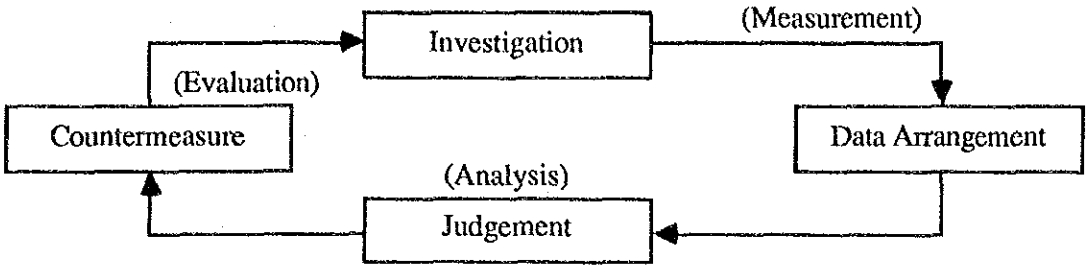


Figure 7.4.2-1 Cycle of Traffic Management

e) Traffic Congestion Control System

Owing to telecommunication facilities fault or social extraordinary matters, telecommunications may be confused. And for anticipating these things, it is necessary to get the correct information and to instruct the action to the sector concerned. To prevent the telecommunication service deterioration, network monitor and network control will become essential.

There are two way to solve the problem. One is to introduce the new traffic congestion control system. The other is to upgrade the present OM system, if possible. This traffic congestion control system will have the traffic restriction control function for traffic congestion area from each area after detecting the extraordinary condition, etc.

7.4.3 Transmission Network Management

1) Present State of Network Management

a) Operation and Maintenance

i) Long Distance

TOT has four provincial zone centers and one metropolitan maintenance center. That is, Ayutthaya (Central zone), Phitsanulok (Northern zone), Nakhon Ratchasima (North-Eastern zone), Srat Thani (Southern zone) and Krung Kasem (Metropolitan area). The provincial zone centers control 10 sub centers and 63 maintenance centers, which operate and maintain 1,007 remote stations, as shown in Figure 7.4.3-1.

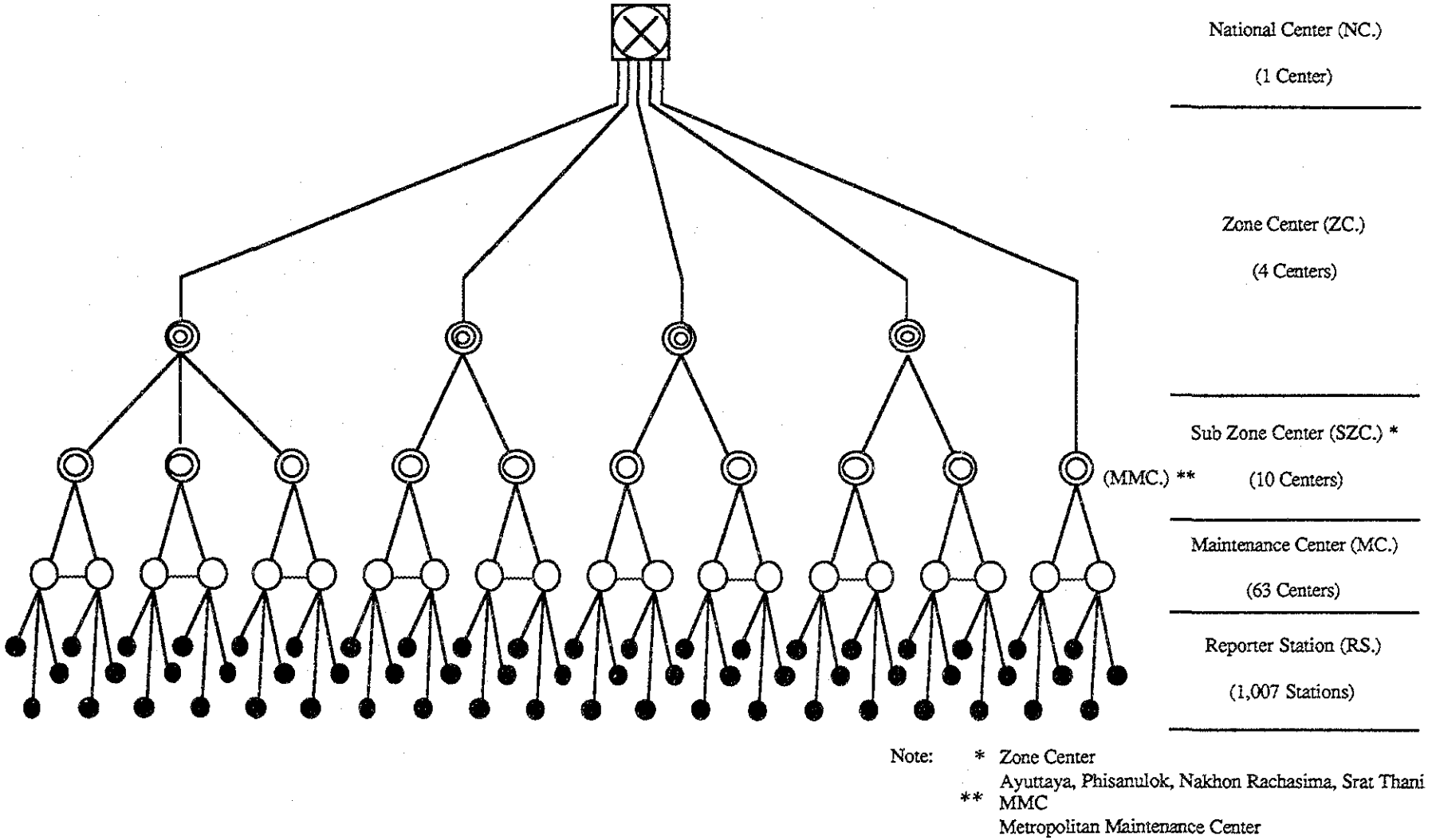
In principle, each zone center is responsible for fixing the fault in its area. In operation of transmission network, Krung Kasem maintenance center controls long distance transmission network and metropolitan radio junction network, however, it is not possible yet to be informed about faults in the transmission network in an instant.

ii) Spur Route

Spur routes are operated and maintained by the maintenance centers, which are administered by the zone centers. It seems that the supervisory system of spur routes are now completed, and each remote station is supervised and controlled by the maintenance center.

iii) Metropolitan Junction Transmission

Metropolitan junction transmission network is operated by the Section of Metropolitan Junction Network in Phaholyothin. Most of the junction transmission network is composed of Optical Fiber systems and metallic PCM systems at present. Ordinarily, when an accident occurs, it is informed by the switching section through ordinary telephone up to now.



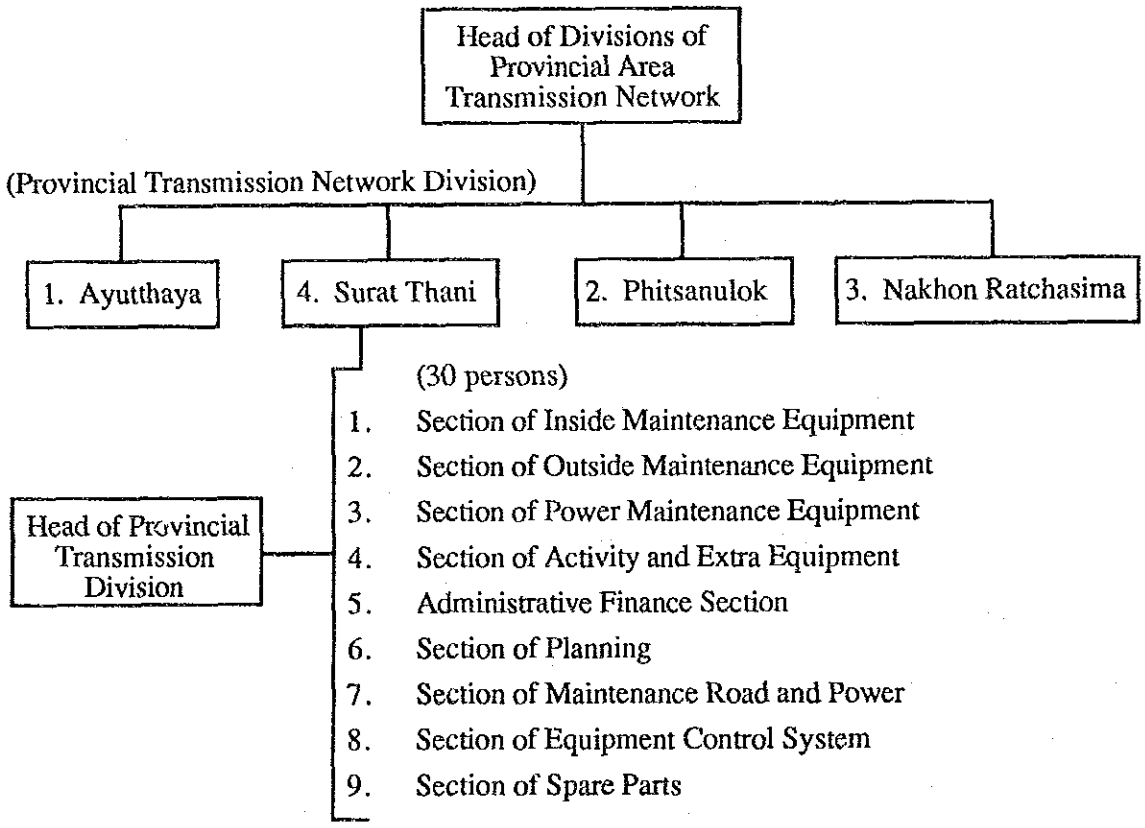
Note: * Zone Center
Ayuttaya, Phisanulok, Nakhon Rachasima, Srat Thani
** MMC
Metropolitan Maintenance Center

Figure 7.4.3-1 Transmission Supervisory System (T.S.S End of 1992)

b) Organization and Function of Transmission Division

i) Organization of Provincial Transmission Division

Each Provincial Division has nine sections, which are administered by Head of Provincial Transmission Division. Figure 7.4.3-2 shows the organization of a Provincial Transmission Division. According to the organization, it seems that a provincial division can make a plan, do it and see it, because it has the planning section, design section and the finance section.



Note; 1. Inside Plant Maintenance
(Work in Maintenance Center)
2. Outside Work Maintenance
(Work for Repeater Stations)
3. Planning
(Work for research, development and design in the region)

Figure 7.4.3-2 Organization of Provincial Transmission Division

ii) Organization of Maintenance Center

In principle, each maintenance center has five sections which are administered by the chief of the maintenance center. Figure 7.4.3-3 shows the organization of a middle sized maintenance center. Normal work of a maintenance center is operation and maintenance. Some of the maintenance centers are working 24 hours, and the other maintenance centers working in day time only. One maintenance center operates and maintains about 15 remote stations on the average.

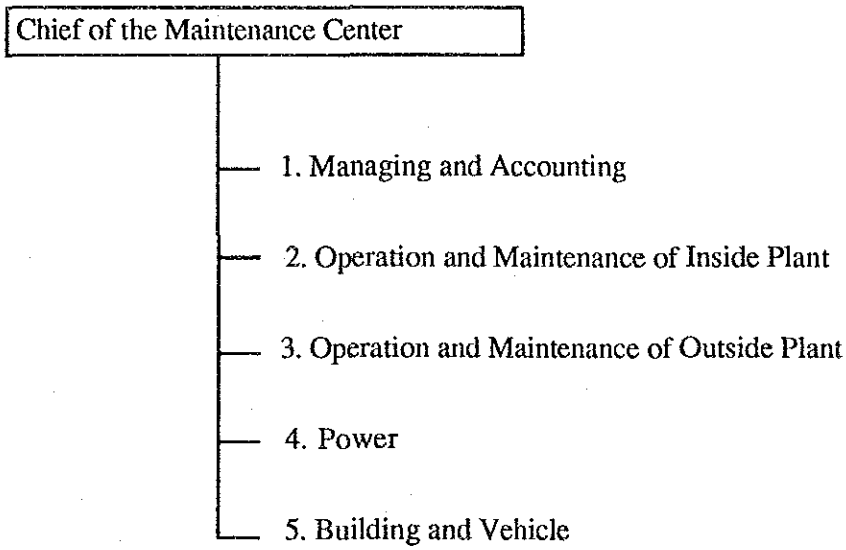
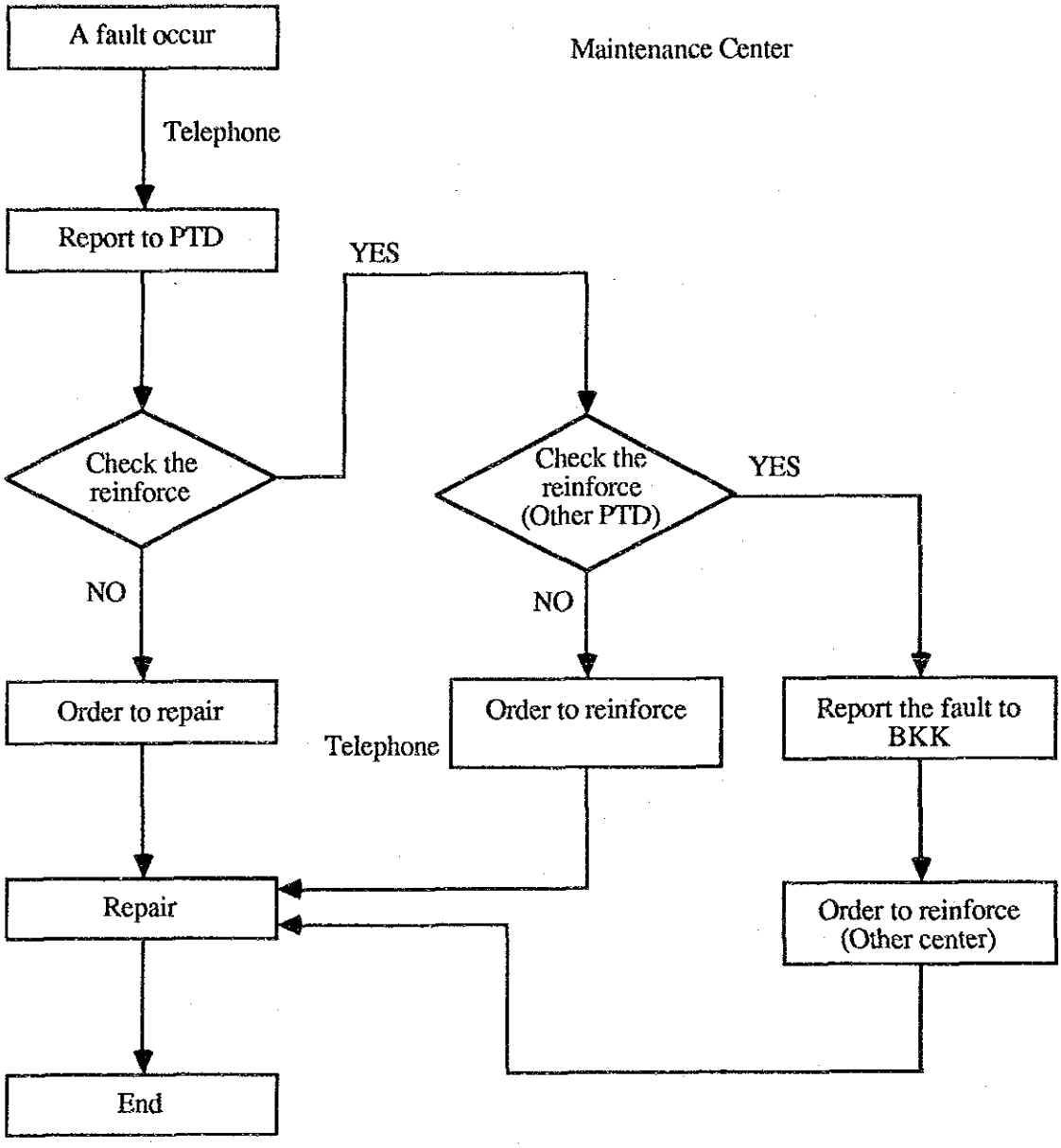


Figure 7.4.3-3 Organization of Maintenance Center

iii) Operation and Maintenance

As mentioned above, each Provincial Transmission Division is responsible to the maintenance and operation in the spur routes and the long distance routes, which are in their territory.

Figure 7.4.3-4, 5 and 6 show situation of operation and maintenance in the transmission system. As shown in these figures, when a fault occurs the maintenance center has to inform it to the provincial division by ordinary telephone, so the fault can not be informed to the division immediately. Therefore, provision of hot-lines should be considered at least until the introduction of new supervisory system.



Note; PTD Provincial Transmission Division

Figure 7.4.3-4 Flow Chart of Transmission System Interruption

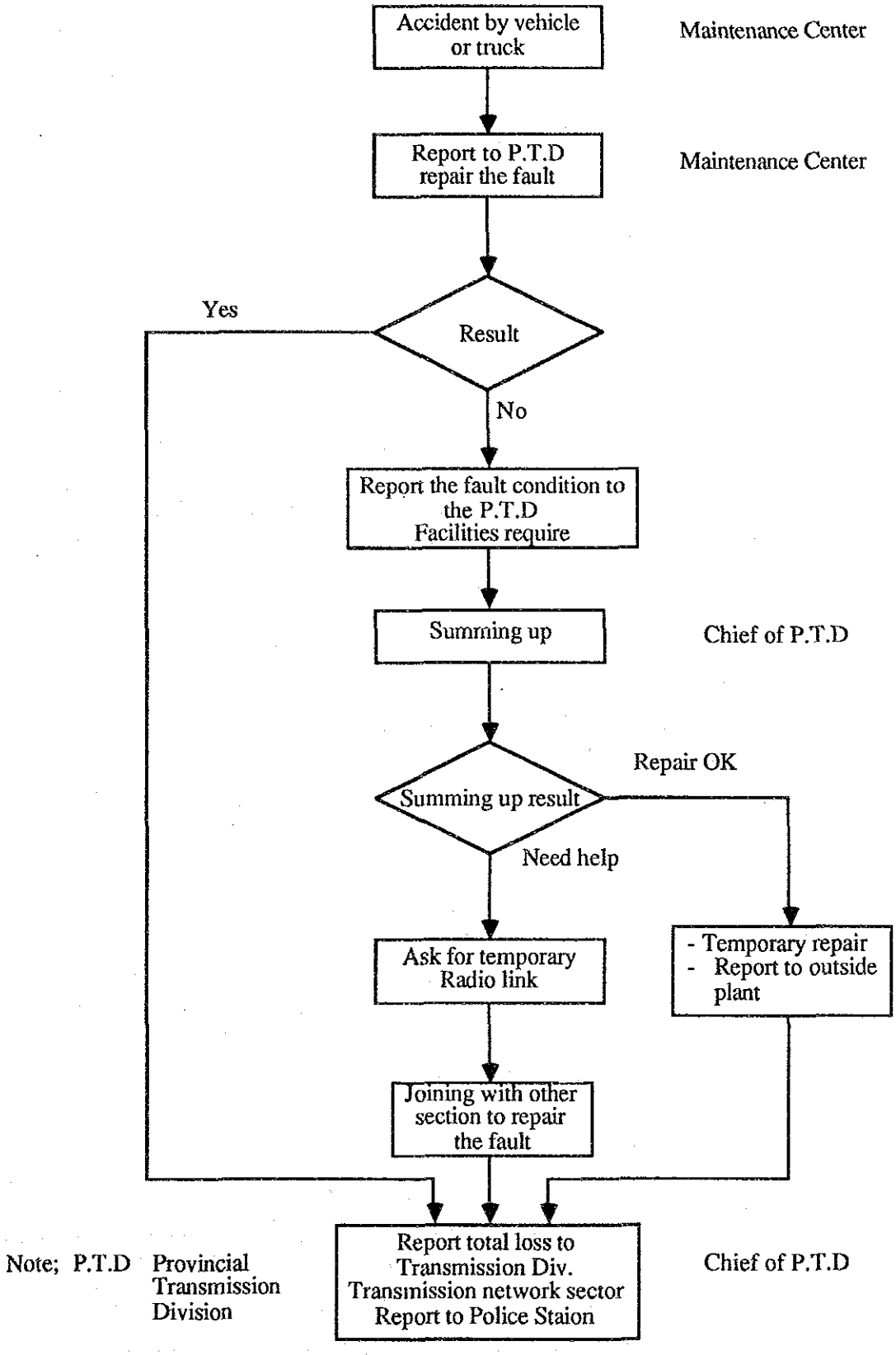


Figure 7.4.3-5 Flow Chart of Transmission Cable in Emergency Case

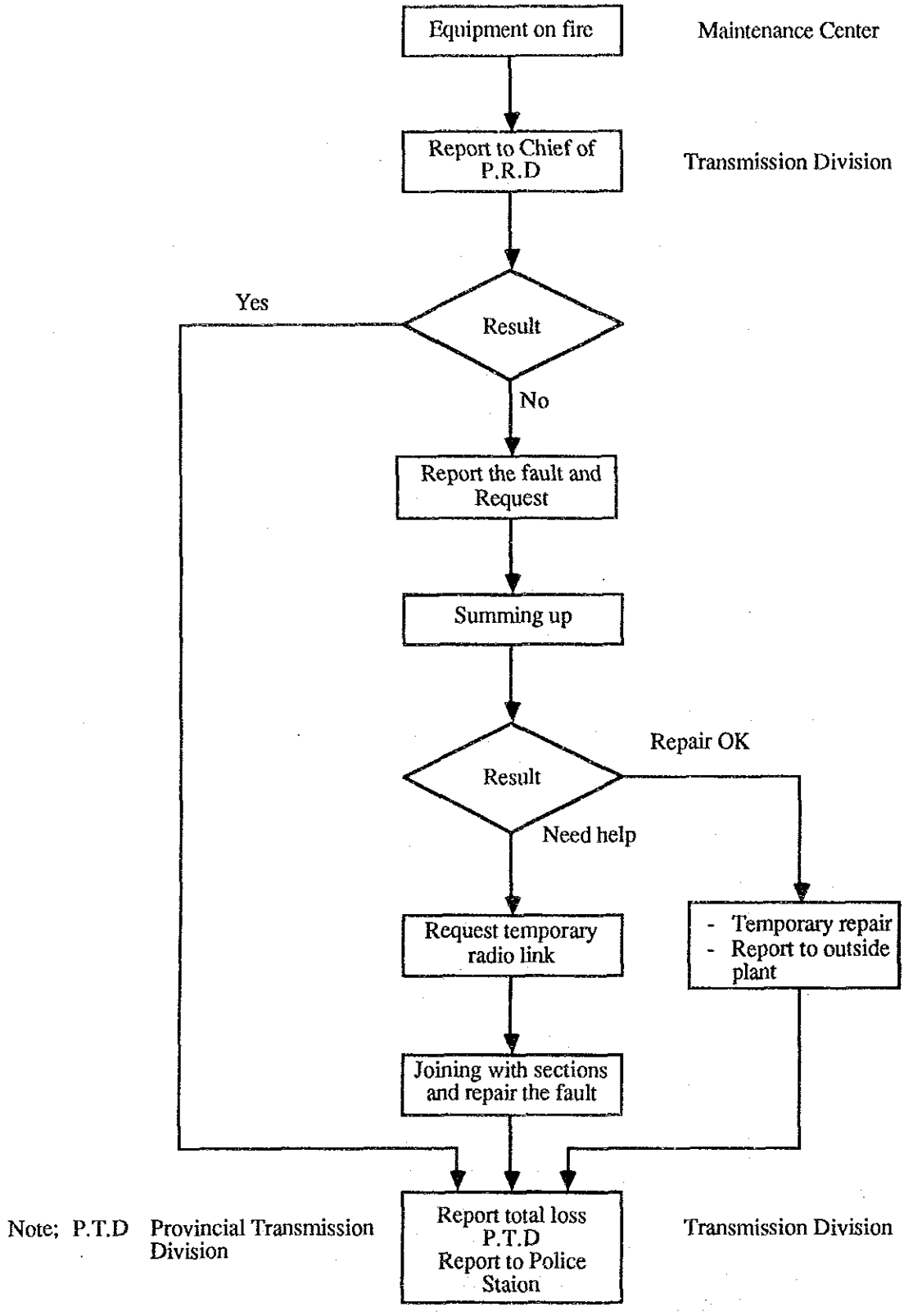
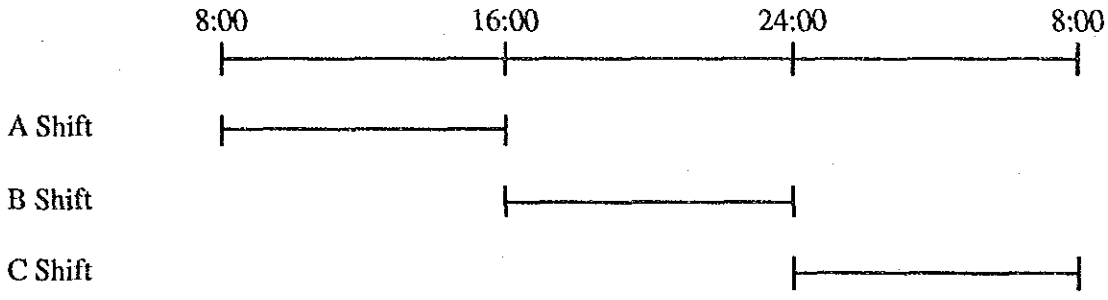


Figure 7.4.3-6 Flow Chart of Transmission Equipment on Fire

Figure 7.4.3-7 shows the configuration of working time in maintenance centers. Each maintenance center has three types of working time. A better working shift for advanced operation and maintenance in future should be studied.



Note:	A working time (8:00 ~ 16:00)	some persons (according to the facility scale)
	B working time (16:00 ~ 24:00)	about 2 persons
	C working time (24:00 ~ 8:00)	about 1 person

Figure 7.4.3-7 Configuration of Working Time

iv) Supervisory System

TOT has already a plan to provide the new supervisory system, which is shown in Figure 7.4.3-1. The transmission supervisory system is composed corresponding to the organization of transmission operation and maintenance system.

In Metropolitan Transmission Network, the transmission supervisory system is now constructing, however, in Long Distance Transmission Network, it is not started constructing yet as of the end of FY 1989.

2) Network Management Plan

a) Introduction

Interruption of information will give loss and confusion to society, therefore, it is necessary to provide for controlling the telecommunication network according to the volume of traffic and the frequency of accidents in the telecommunication network.

As mentioned above, the centralization of the supervisory system will be completed by the end of 5th project. According to this situation, it will be planed to unify all transmission operation systems between Phase-1 and Phase-2.

It means that the long distance network management system (included spur route) should be introduced this new system, after that, it will be combined with Metropolitan Junction Transmission Network system through data base.

A plan for centralizing Transmission Operation and Maintenance System, which is recommended, is described in the following paragraph.

b) Centralized Operation System

i) Configuration of the Operation System

Figure 7.4.3-8 shows a component of transmission operation system recommended. This system includes not only Long Distance Transmission Systems, but also Spur routes and Metropolitan Junction Transmission Systems.

Figure 7.4.3-9 shows a layout of operation room in the provincial maintenance centers and the central network management center.

This system is composed by the Alarm collecting equipment, the alarm processing and transmitting equipment and the supervisory and operation equipment including CPU.

ii) Concept of the Function

This system will have the following functions;

A. Centralizing Alarm

All alarm of the transmission facilities in the maintenance centers and remote stations (include repeater stations) will be collected at the alarm collecting equipments in maintenance centers by metallic cables or data links.(the alarm occurred in maintenance centers will be collected by metallic cables, and those occurred in repeater stations will be collected by data links) And then, they are transmitted to the supervisory and

operation equipment through the alarm processing and transmitting equipment.

After processed by CPU, they are also sent to provincial operation centers and the central network management center. And the alarm of many maintenance centers will be centralized to the other maintenance centers in night time and week ends.

B. Alarm Analysis and Record

The system will be provided with the function to analyze the section of faults and record them in the data base, and also transmit them to provincial operation centers and the central network management center. Therefore, the maintenance centers can look up them at any time.

C. Safeguard for Faults

As the system will be provided with the function to record the frequency of alarm of particular facilities, it will be able to indicate alarm of the facilities on the work station-1 (see Figure 7.4.3-8).

D. Remote Control

The system will be provided with the function to control all alarm of the transmission facilities, and switch over the fault system to the stand-by system from the maintenance center.

E. Data Base

The system will be provided with the function to record configuration of the transmission systems, the accommodated circuits and also the information of customers of leased circuits in the data base. Therefore, each maintenance center, provincial operation center and the central network management center can pick up the information concerned at any time.

iii) Consideration on Introduction of this System

The system will be combined with the Integrated Network Operation System in the next stage. Therefore, it should be considered that the equipment of this system are designed to apply for the Integrated Network Operation System in the next stage.

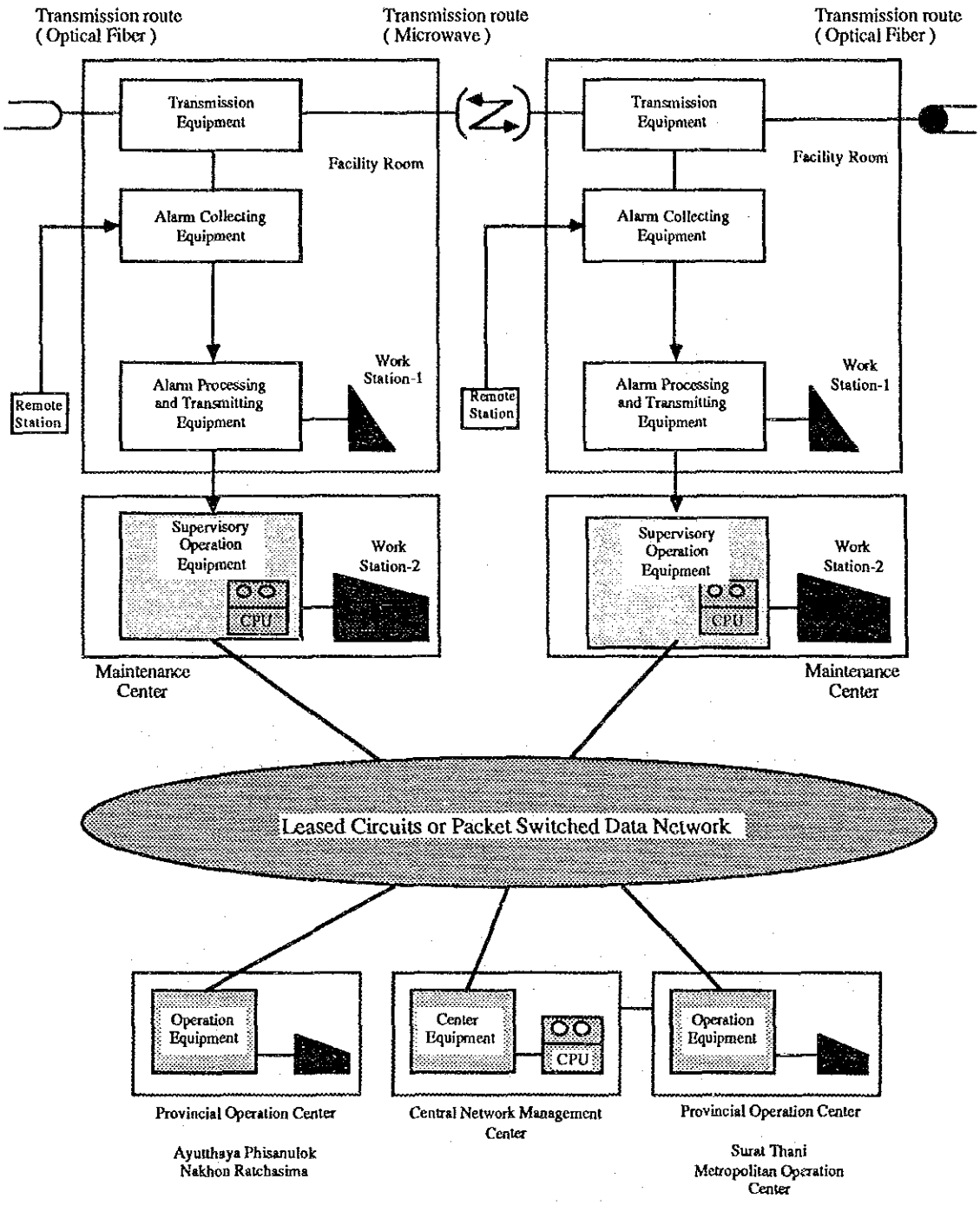


Figure 7.4.3-8 Transmission Network Management System (Phase-1 ~ Phase-2)

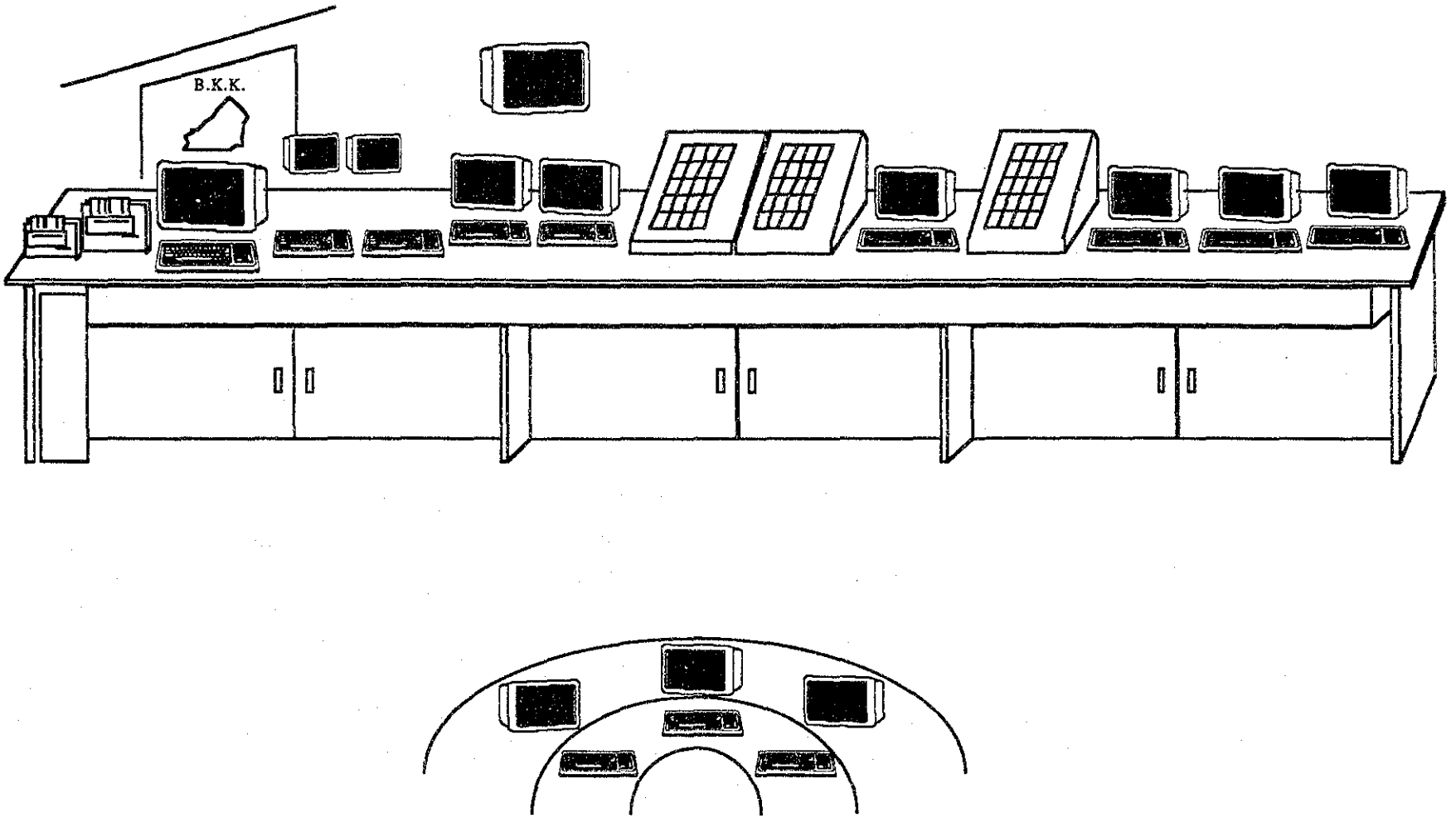


Figure 7.4.3-9 Layout of Operation Room

7.4.4 Local Network Management

1) Present and Future Situation of Local Cable Network

TOT has some big problems, which have to be solved, such as reduction of waiting applicants, upgrade of service quality, diversification of services and so forth. In order to reduce waiting applicants, TOT needs to expand large amounts of telecommunication facilities nationwidely. In order to improve service quality, it is necessary to reduce fault occurrence and to replace deteriorated facilities. And, as regards diversification of services, digitization and enhancement of telecommunication networks are required.

Taking the situation of telecommunication sector above mentioned into consideration, outside plant sector will find itself in a very important situation.

As estimated in Chapter 8, the main telephone lines at the end of Phase-1 (end of 1997) will become twice as much as that of the end of 1992, and also it will be increased by 2.7 times at the end of Phase-2 and by 3.5 times at the end of Phase-3 respectively.

Thus, the local cable expansion projects will become one of the big projects in this Master Plan and the role of the outside plant maintenance activity will become more important proportionately to increase of newly installed facilities as well as the existing ones.

Local cable network management in TOT does not seem to be appropriately controlled at present. For example, there are many unusable and faulty cables and wires, and plant records of outside plant facilities are not revised sufficiently to cope with newly installed facilities. And as described in Chapter 2, the service quality is not so good condition.

2) Installation of OPMC

To improve these situations and to utilize the existing facilities in a more efficient manner, Outside Plant Maintenance Center (OPMC) should be installed at all telecommunication areas.

The proposed major works of the OPMC center are as follows:

a) Intensive data collection and analysis of facilities for effective preventive maintenance and rehabilitation plan,

b) Setting up training plans for maintenance personnel to get advanced maintenance techniques for newly introduced telecommunication facilities,

c) Preparation of advanced measuring equipment/tools and operation know-how for them,

d) Improvement of work environment and arrangement of vehicles for the mobile and safety work.

3) Expansion of OPMC

The expansion of OPMCs should be carried out as the following stages taking the on-going expansion project, long-term plan and present situation of maintenance activity into consideration.

a) First stage is to be applied in each Metropolitan maintenance area,
b) Second stage is to be applied in Provincial Area 1,4,6 and 7 respectively,
c) Third stage is to be applied in other provincial areas.

4) Benefit from Installation of OPMC

As the result of OPMC installation, the following benefits can be expected.

a) Realization of high-quality services,
b) Reduction of fault occurrence,
c) Shortening of downtime.

And also these benefits will bring increase of revenue to TOT.

Figure 7.4.4-1 shows the concept of OPMC.

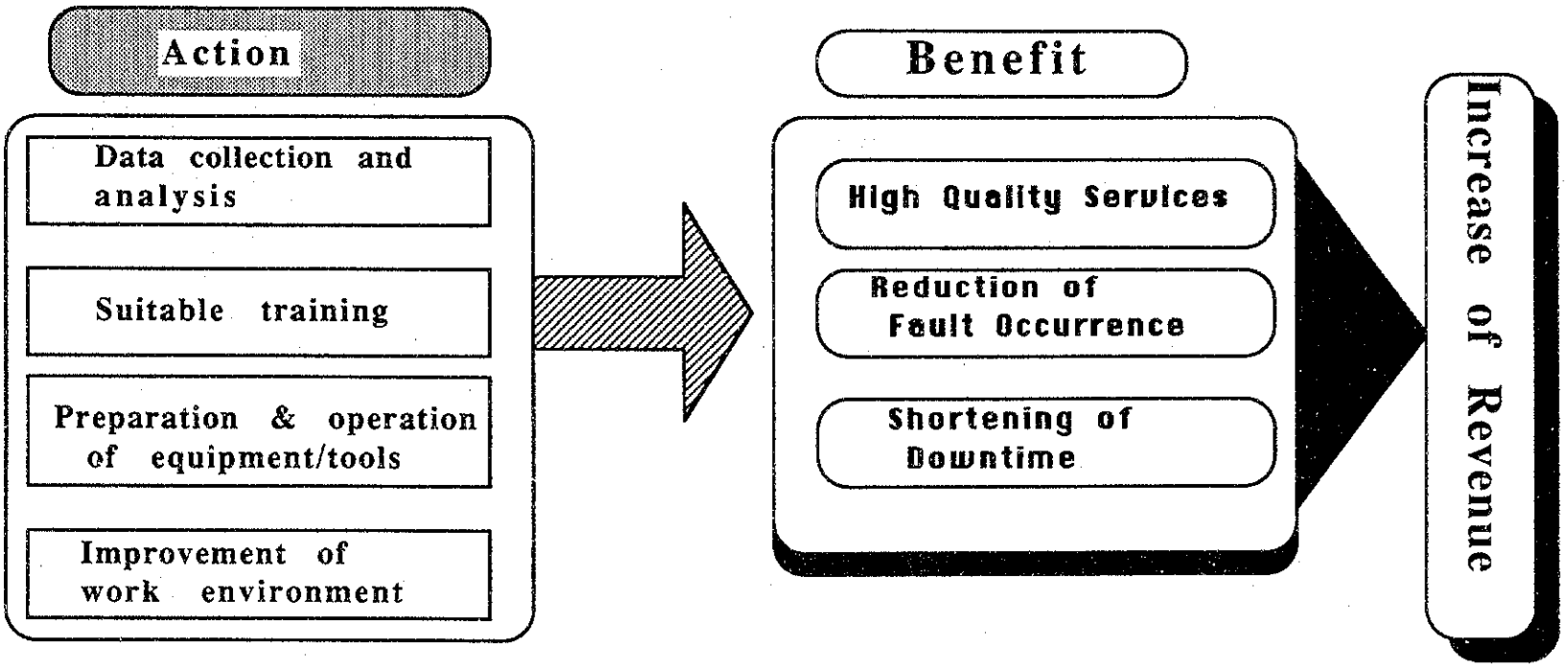


Figure 7.4.4-1 Concept of OPMC

7.4.5 Integrated Network Management System

1) Introduction

As mentioned before, in an information-oriented society, interruption of communication will give greater loss and confusion to the society. Therefore, it will be necessary to provide with the function for controlling the telecommunication network according to the volume of traffic and the frequency of faults.

It means that all link of information on network operation, including outside plant, switching and transmission facilities, will be integrated to a general operation center. In the general center, as all network management informations concerned will be collected, the operator there, can give instructions to the each operation center concerned for controlling the network. Network operation and maintenance will be managed by each section.

In addition to this, it should be provided with the function to pick up some managing information, like the information of leased circuits users and traffic data used for billing job.

2) Configuration of the System

Figure 7.4.5-1 shows a concept of the integrated network management system to be recommended. This system will have the total function to get the information for customers administration, billing administration, management and facilities design.

For instance, customer and billing information will be able to use in commercial centers by applying terminal equipments.

3) Concept of the Function

a) Integrated Operation and Maintenance System

The system will be provided with the function to analyze immediately the section of faults in any kind of facilities and to transmit the information to each operation center concerned via the information transmitting network. And also, operation centers in each section, will be able to manage the each network.

b) Operation and Maintenance for Non-Telephone Service

The system will be provided with the function to control enhanced non-telephone service.

c) Collecting for Managing Information

The system will be provided with the function to collect some managing information from the telecommunication network, like billing information, customer information and so on.

d) Traffic Data and the Information for Facility Plan

The system will be provided with the function to get traffic data and apply them to the billing system and to control the telecommunication network, and to get the information for facility plan and facility design.

e) Common Data Base

One of the most important item in the integrated network management system is to possess a Common Data Base for effective telecommunication network management. Therefore, the system will be provided with the function to collect data concerned and store them.

4) Consideration for Introduction of the System

The following items for introduction of the system should be considered.

a) Flexibility of the Data Base

The common data base will be provided with the flexibility for enhanced services, and for the expansion of facilities of outside plant, switching and transmission systems.

b) CCITT Recommendation

CCITT is now studying to prescribe the recommendation for TMN (Telecommunication Management Network). The important item of CCITT's study now is the standard of architecture, interface and protocol of TMN. Therefore, the study work of CCITT should be taken into consideration in the introduction plan of the system.

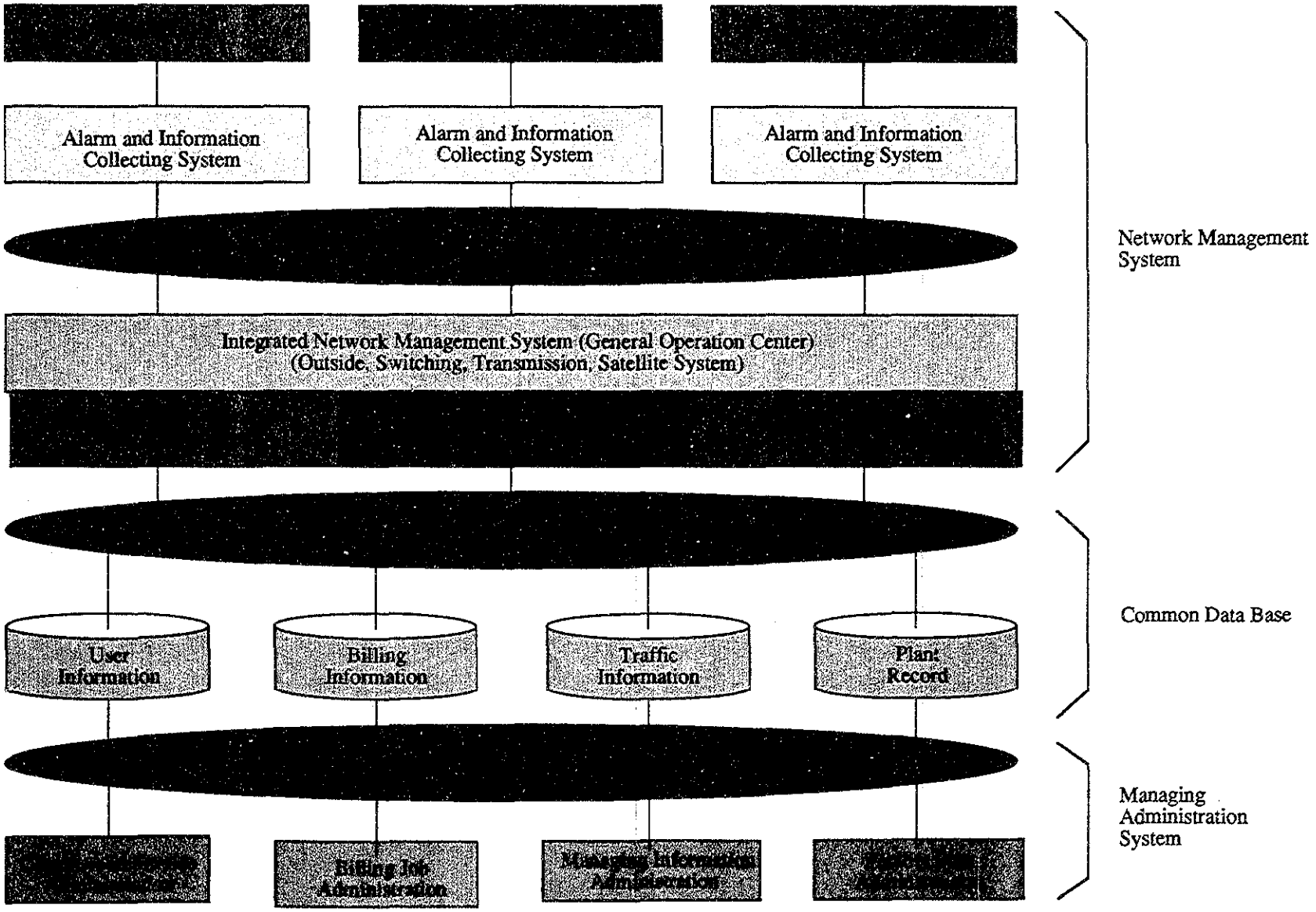


Figure 7.3.1 Integraged Network Operation System (Phase-3)

CHAPTER 8

TELECOMMUNICATION FACILITY EXPANSION PLAN

CHAPTER 8. TELECOMMUNICATION FACILITY EXPANSION PLAN

This chapter describes a future installation and expansion plan of telecommunication network in Thailand covering from 1993 until 2007. This plan includes following 6 kinds of major facilities:

a) Switching Facilities,
b) Transmission Facilities,
c) Local Cable Facilities,
d) Mobile Communication Facilities,
e) Leased Circuit and Data Communication Facilities,
f) Other Facilities.

8.1 Expansion Plan

8.1.1 Expansion Objectives and Design Principles

1) Expansion Objectives

The Expansion Plans are formulated in accordance with objectives and strategies described in Chapter 5, and on the basis of demand forecast described in Chapter 4 and traffic forecast described in Chapter 6, respectively.

2) Design Principles

i) The quantity of the facilities to be installed in this expansion plan were decided on the basis of the telephone subscription demand forecast described in Chapter 4.

ii) Design margin period for switching and cable capacities were set at 2 and 5 years after completion of the project, respectively.

iii) Building construction plan was formuleted on the basis of the switching plan.

8.1.2 Telephone Installation Schedule

1) Main Telephone Line for Whole Kingdom

Table 8.1.2-1 shows the demand forecast of the main telephone line for the metropolitan area and the provincial areas.

Table 8.1.2-1 The Demand Forecast of the Main Telephone

Year	Metro.Area	Provincial Area	Whole Kingdom
1992	1,467,000	1,060,000	2,527,000
1997	2,120,000	1,494,000	3,614,000
2002	2,769,000	2,037,000	4,806,000
2007	3,376,000	2,791,000	6,167,000

One of the main objectives of the Project is fulfillment of the telephone demand at the end of Phase-1, which is the end of fiscal year 1997. In order to accomplish this objective, TOT needs to install 1,792,000 main telephone lines during Phase-1 in addition to the present 5th and 6th ESDP's installation schedules. After Phase-1, another 1,192,000 lines and 1,361,000 lines need to be installed in Phase-2 and Phase-3 respectively in order to meet the telephone demand.

Figure 8.1.2-1 shows the number of main telephone lines to be installed by the Project and the existing lines in the whole Kingdom.

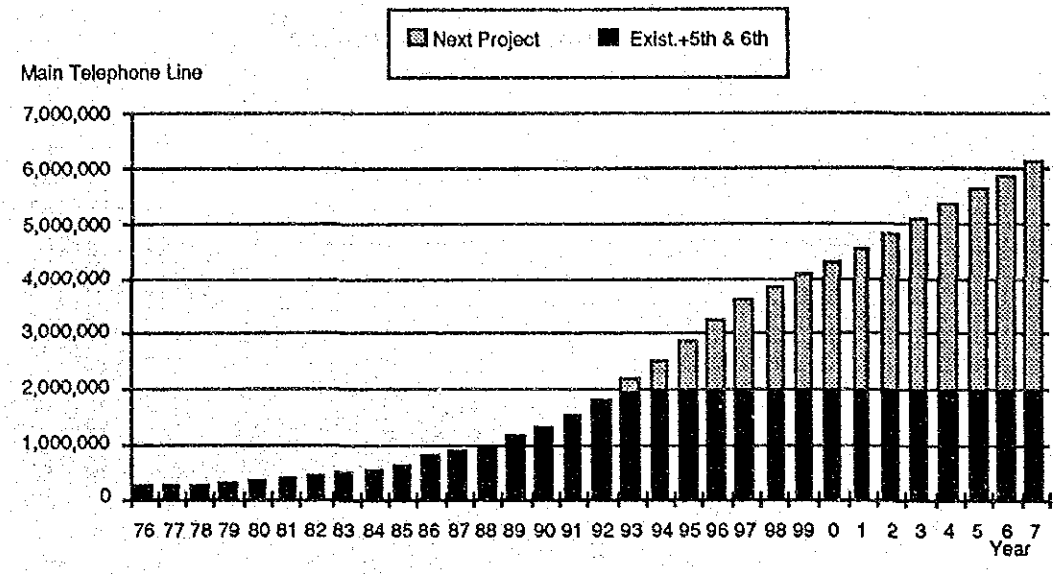


Figure 8.1.2-1 Estimated Number of Main Telephone Lines in the Whole Kingdom

Figure 8.1.2-2 shows the number of main telephone lines to be installed by the Project and the existing lines in the Metropolitan area.

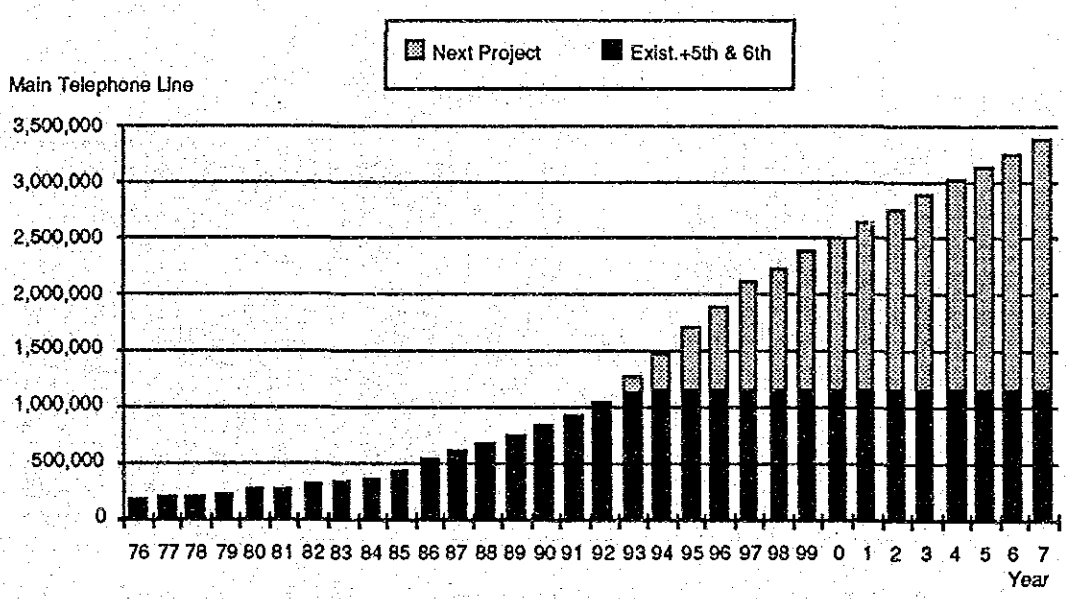


Figure 8.1.2-2 Estimated Number of Main Telephone Lines in Metro. Area

Figure 8.1.2-3 shows the number of main telephone lines installed by the project and existing lines in the provincial areas.

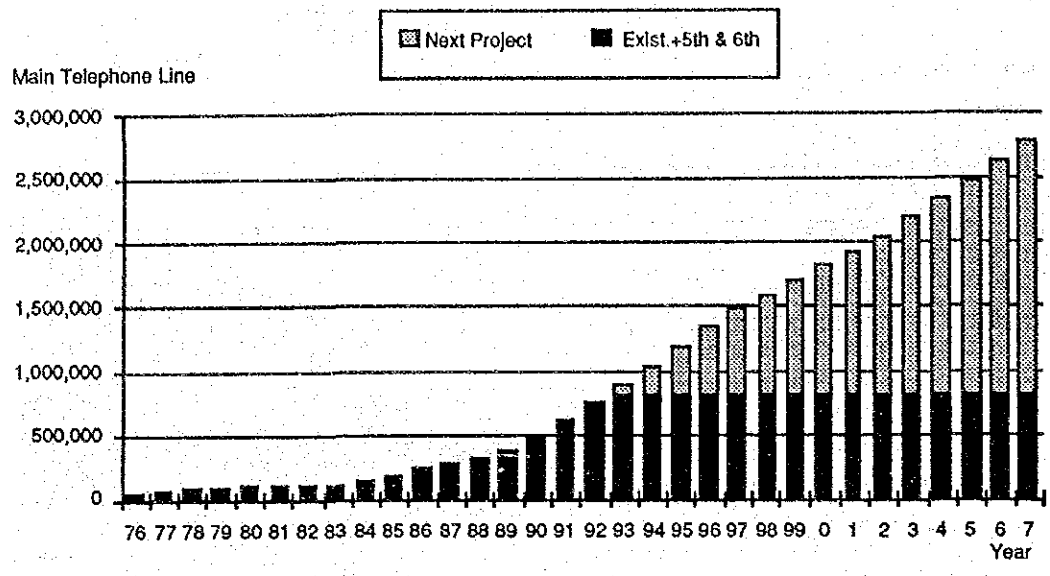


Figure 8.1.2-3 Estimated Number of Main Telephone Lines in Provincial Areas

Figure 8.1.2-4 shows the share of the main telephone lines in the metropolitan area and the provincial areas in the past and the future.

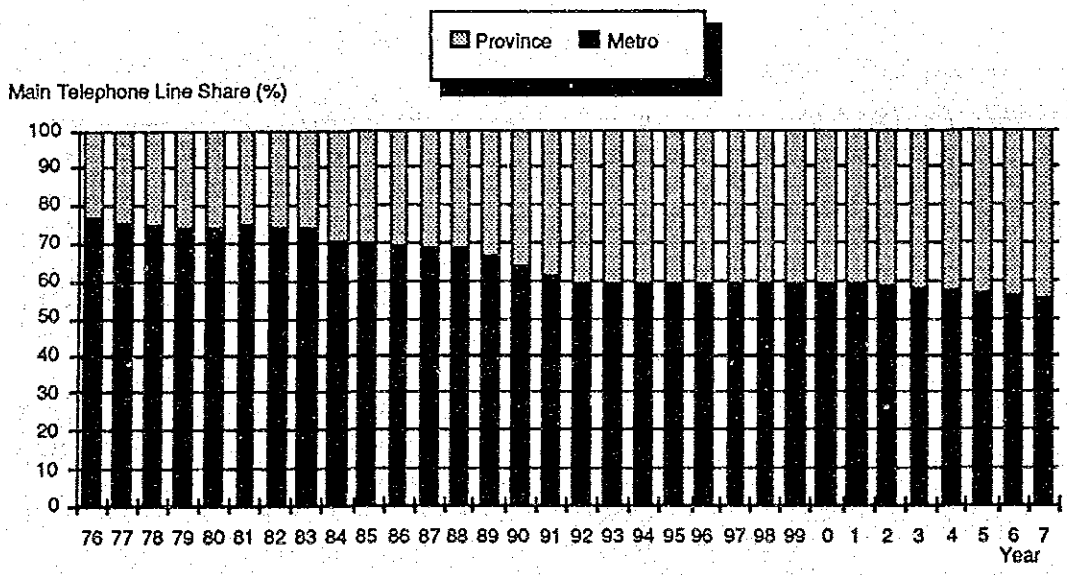


Figure 8.1.2-4 Estimated Number of Main Telephone Lines in Metro. & Prov.

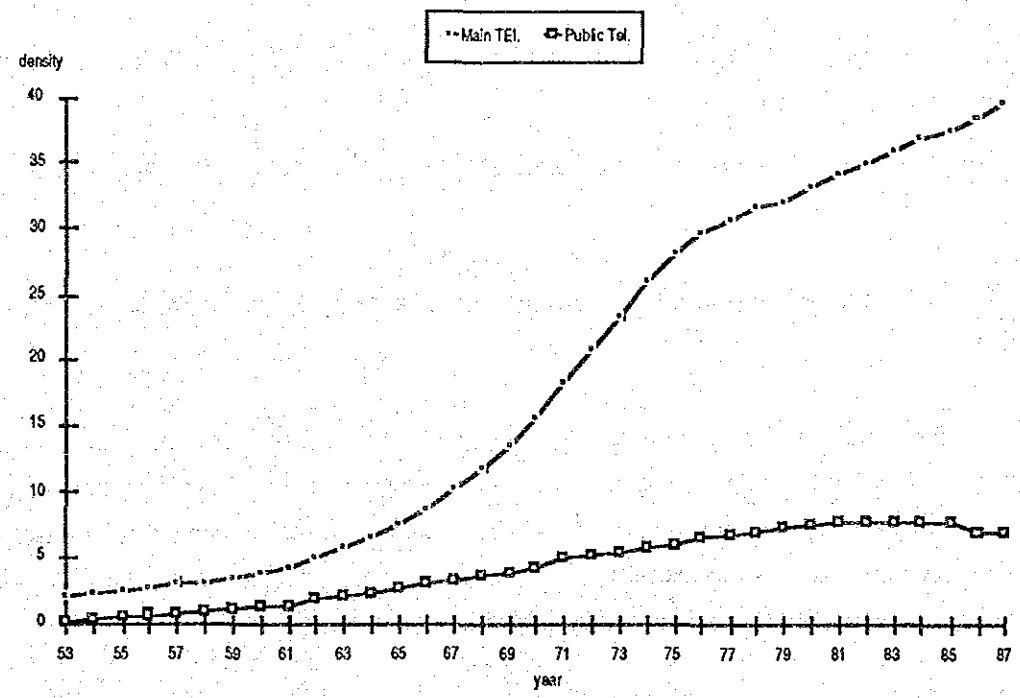
2) Public Telephone Expansion Plan

As regards the installation of public telephones, to decide the number of public telephone installation is not a matter of demand forecasting. Accordingly, it should be

carried out according to the installation strategy taking account of the benefit of general public.

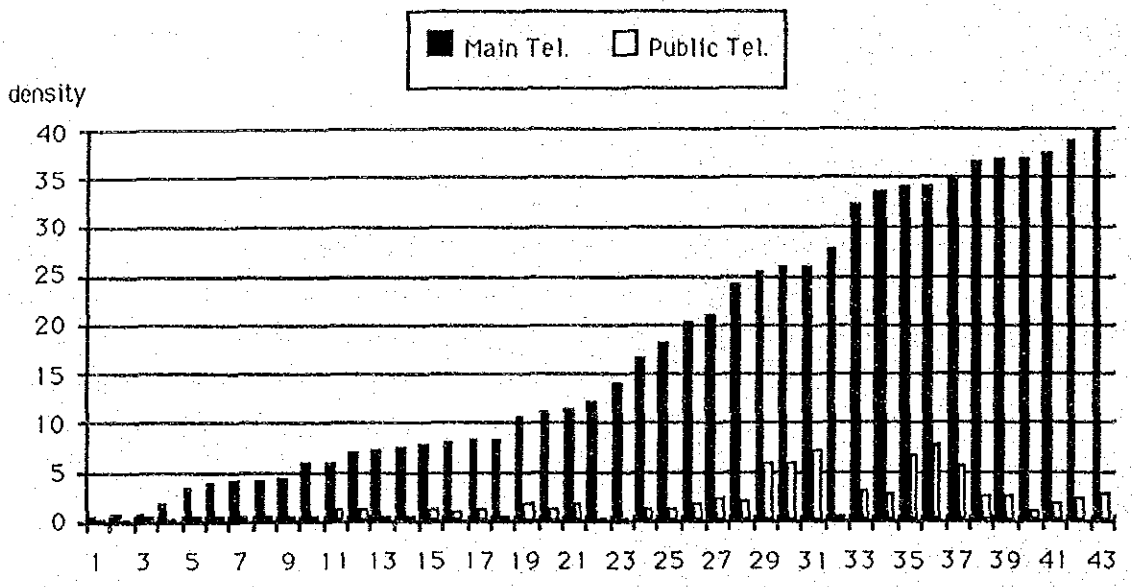
a) Number of Public Telephone

As one of the guidlines for installation of public telephones, the methodology can be given by estimating the number of public telephones in proportion to the population. Figure 8.1.2-5 shows the comparison between the main-telephone and the public telephone density in Japan. And Figure 8.1.2-6 shows those in some other countries(43 countries). Taking account of the above satistical data, the target of public telephone density is settled at 2.5 public telephones per 1000 persons at the end of 2007.



Note: These density show the number of Main telephone per 100 population and the number of Public telephone per 1000 populations

Figure 8.1.2-5 Density of Main Telephone and Public Telephone in Japan



Note: These density show the number of Main telephone per 100 populations and the number of Public telephone per 1000 populations

Figure 8.1.2-6 Density of Main Telephone and Public Telephone in the World

On the basis of the above target, the installation plan is arranged as shown in Table 8.1.2-2.

As for rural public telephones, the target for the resolution of non-telephone communities is set up at tambom level by the end of Phase-2, and it will be continuously carried out to extend telecommunication service to the Muhbahn level after Phase-2, as described in Chapter 5. As the result, the goal of the ITU Kuala Lumpur Declaration will be achieved by the end of Phase-3 with expansion of local cable network.

Table 8.1.2-2 Public Telephone Installation Plan

Year	Result	Future Plan			
	1987	1992	1997	2002	2007
Population (x1000)	53,873	58,041	62,102	65,865	69,165
No. of Public Telephone	20,144	55,452	93,153	131,730	172,912
Public Tele/1000 persons	0.37	0.96	1.50	2.00	2.50
No. of Expansion	-	-	37,700	38,577	41,182
Ordinary Public(Metro)	-	-	24,470	25,153	25,102
Ordinary Public (Prov.)	-	-	6,900	7,094	7,080
Rural Public	-	-	6,330	6,330	9,000

b) For the Installation of Public Telephone

i) TOT has some type of public telephones such as local call, STD trunk call and coin type. Therefore, user must select a public telephone according to purpose. Now, TOT is going to introduce trunk services public telephone for the both of local and trunk call in order to improve users convenience. This type should be spreaded nationwide for users and TOT taking replacement of existing public telephone toward the future into consideration.

ii) There are some different type of coins in Thailand. This is also a big problem for users. Therefore, it will be efficient to introduce card-operated public telephone and furthermore, this will have an effect to save coin-collection work and to prevent coin-burglary from coin-box.

Figure 8.1.2-7, 8.1.2-8 and 8.1.2-9 show the number of public telephones and main telephone lines to be installed by the Project in the future for the whole Kingdom, Metropolitan area and Provincial areas. Figure 8.1.2-10 shows the share of public telephone lines in the metropolitan area and provincial areas.

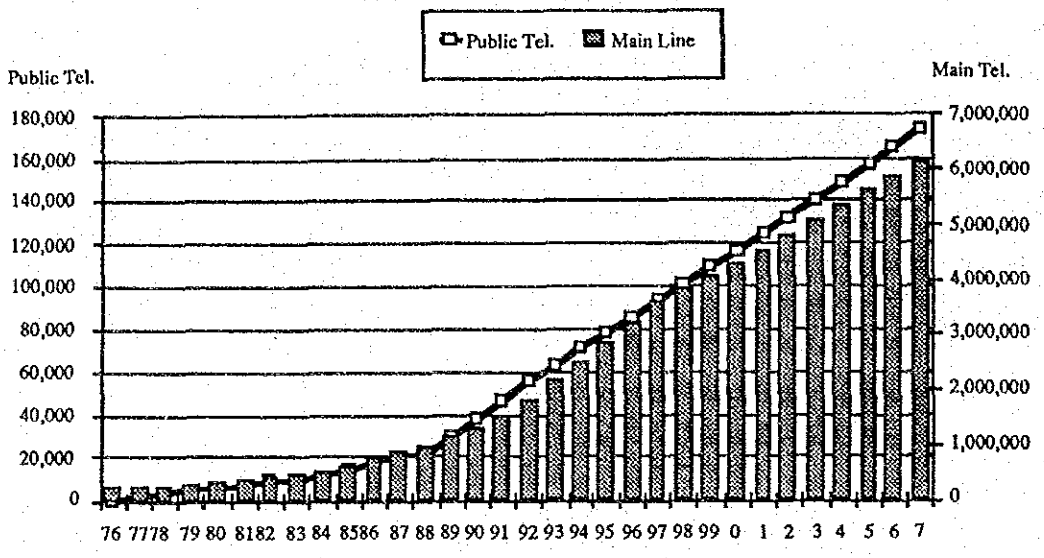


Figure 8.1.2-7 Public Telephone and Main Telephone Installation Plan in the Whole Kingdom

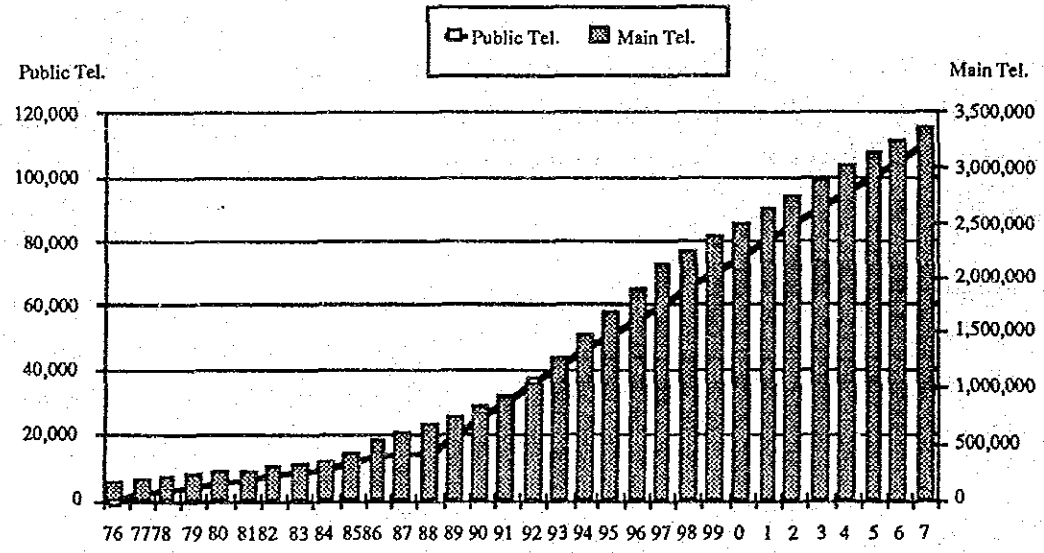


Figure 8.1.2-8 Public Telephone and Main Telephone Installation Plan in the Metropolitan Area

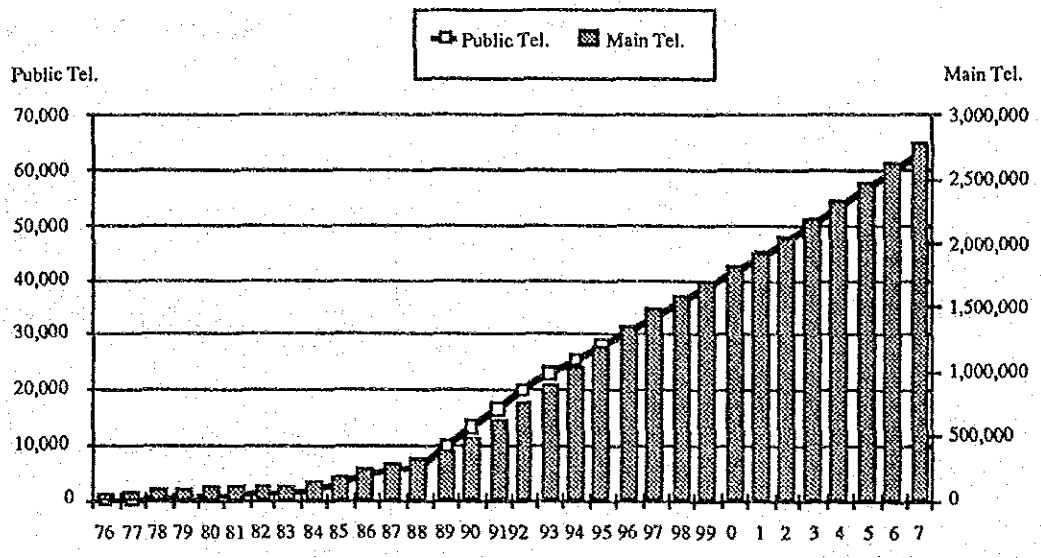


Figure 8.1.2-9 Public Telephone and Main Telephone Installation Plan in the Provincial Areas

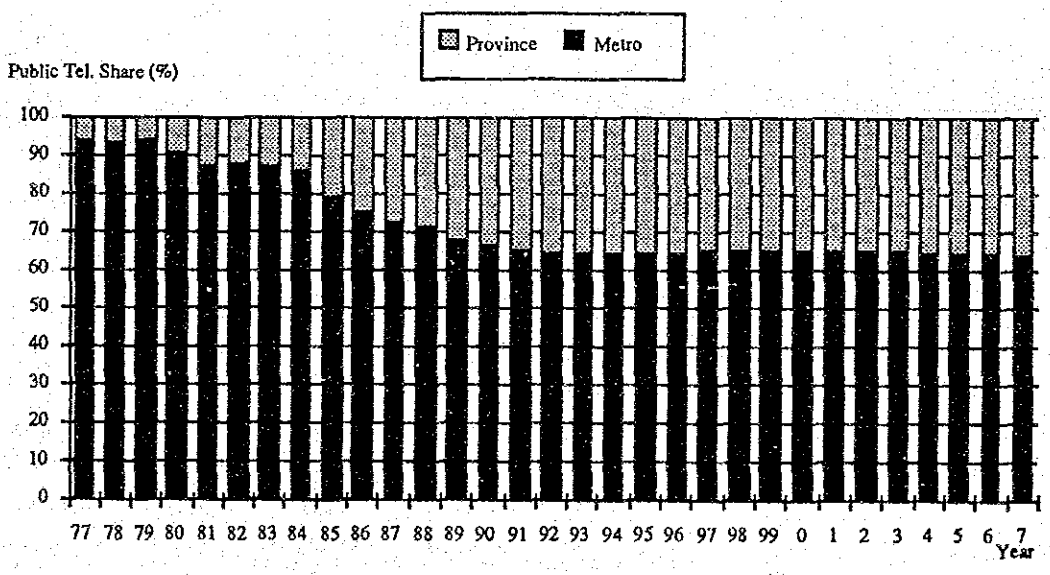


Figure 8.1.2-10 Share of Public Telephone Installation Plan in the Metropolitan and Provincial Areas

Table 8.1.2-3 to 8.1.2-6 show the detailed installation schedule.

Table 8.1.2-3 Estimated Number of Main Telephone Lines by Type of Subscribers in Metropolitan

Year	Business	Resi-dence	Total Priv.	Govt.	Prv.+Govn.	Public Tel.	TOT Tel.	TOTAL Tel. Line
1976								179,830
1977	76,488	102,052	178,540	13,013	191,553	2,057	1,613	195,223
1978	80,208	117,706	197,914	16,470	214,384	2,924	1,515	218,823
1979	86,301	133,328	219,629	17,922	237,551	4,362	1,694	243,607
1980	92,875	149,758	242,633	19,979	262,612	5,160	1,762	269,534
1981	96,368	160,980	257,348	22,004	279,352	5,950	1,788	287,090
1982	101,047	176,804	277,851	24,579	302,430	7,645	1,987	312,062
1983	105,610	196,683	302,293	26,906	329,199	8,176	2,135	339,510
1984	108,726	212,825	321,551	28,820	350,371	9,260	2,293	361,924
1985	123,732	263,328	387,060	31,972	419,032	11,298	3,187	433,517
1986	142,980	352,887	495,867	35,029	530,896	13,229	3,955	548,080
1987	155,521	403,191	558,712	36,962	595,674	14,435	4,598	614,707
1988	172,414	454,890	627,304	39,007	666,311	14,485	5,355	686,151
1989 e					741,145	19,726	5,462	766,333
1990 e					801,484	24,967	5,571	832,022
1991 e					907,471	30,208	5,683	943,362
1992 e					1,016,407	35,449	5,796	1,057,652
1993 e					1,232,607	40,343	5,912	1,278,862
1994 e					1,437,757	45,237	6,031	1,489,024
1995 e					1,642,904	50,131	6,151	1,699,186
1996 e					1,848,049	55,025	6,274	1,909,348
1997 e					2,053,192	59,919	6,400	2,119,510
1998 e					2,177,933	64,949	6,528	2,249,410
1999 e					2,302,671	69,980	6,658	2,379,309
2000 e					2,427,407	75,010	6,791	2,509,209
2001 e					2,552,140	80,041	6,927	2,639,108
2002 e					2,676,871	85,072	7,066	2,769,008
2003 e					2,793,183	90,092	7,207	2,890,482
2004 e					2,909,492	95,112	7,351	3,011,956
2005 e					3,025,798	100,133	7,498	3,133,429
2006 e					3,142,102	105,153	7,648	3,254,903
2007 e					3,258,402	110,174	7,801	3,376,377

Note: The figures from FY 1976 to 1988 are actual and from FY 1989 to 2007 are made by the study.

Table 8.1.2-4 Estimated Number of Main Telephone Lines by Type of Subscribers in Province

Year	Business	Resi-dence	Total Priv.	Govt.	Prv.+Govn.	Public	TOT	TOTAL
1976	38,084	11,636	49,720	5,874	55,594	132	1,262	56,988
1977	42,468	15,311	57,779	6,323	64,102	150	1,331	65,583
1978	47,914	20,189	68,103	7,093	75,196	230	1,385	76,811
1979	53,316	24,964	78,280	7,908	86,188	308	1,481	87,977
1980	56,879	28,348	85,227	8,844	94,071	598	1,691	96,360
1981	58,362	31,282	89,644	9,564	99,208	913	2,027	102,148
1982	61,504	38,479	99,983	10,373	110,356	1,076	2,185	113,617
1983	64,433	44,401	108,834	11,303	120,137	1,250	2,334	123,721
1984	71,878	68,616	140,494	12,757	153,251	1,626	2,690	157,567
1985	79,447	93,746	173,193	14,351	187,544	3,024	2,413	192,981
1986	90,645	135,892	226,537	16,469	243,006	4,491	3,335	250,832
1987	97,709	162,030	259,739	17,834	277,573	5,677	3,665	286,915
1988	104,127	185,753	289,880	19,583	309,463	6,151	4,107	319,721
1989 e					386,735	9,614	4,189	400,539
1990 e					468,499	13,077	4,273	485,850
1991 e					592,611	16,540	4,358	613,510
1992 e					739,771	20,003	4,446	764,220
1993 e					874,101	22,649	4,534	901,285
1994 e					1,019,477	25,295	4,625	1,049,398
1995 e					1,164,851	27,941	4,718	1,197,510
1996 e					1,310,224	30,587	4,812	1,345,623
1997 e					1,455,594	33,233	4,908	1,493,736
1998 e					1,561,532	35,918	5,006	1,602,457
1999 e					1,667,468	38,603	5,107	1,711,178
2000 e					1,773,402	41,288	5,209	1,819,899
2001 e					1,879,334	43,973	5,313	1,928,620
2002 e					1,985,264	46,657	5,419	2,037,341
2003 e					2,132,730	49,873	5,527	2,188,131
2004 e					2,280,193	53,089	5,638	2,338,920
2005 e					2,427,654	56,305	5,751	2,489,710
2006 e					2,575,112	59,521	5,866	2,640,499
2007 e					2,722,568	62,737	5,983	2,791,289

Table 8.1.2-5 Estimated Number of Main Telephone Lines by Type of Subscribers in Whole Kingdom.

Year	Business	Resi-dence	Total Priv.	Govt.	Prv.+Govn.	Public	TOT	TOTAL
1976								236,818
1977	118,956	117,363	236,319	19,336	255,655	2,207	2,944	260,806
1978	128,122	137,895	266,017	23,563	289,580	3,154	2,900	295,634
1979	139,617	158,292	297,909	25,830	323,739	4,670	3,175	331,584
1980	149,754	178,106	327,860	28,823	356,683	5,758	3,453	365,894
1981	154,730	192,262	346,992	31,568	378,560	6,863	3,815	389,238
1982	162,551	215,283	377,834	34,952	412,786	8,721	4,172	425,679
1983	170,043	241,084	411,127	38,209	449,336	9,426	4,469	463,231
1984	180,604	281,441	462,045	41,577	503,622	10,886	4,983	519,491
1985	203,179	357,074	560,253	46,323	606,576	14,322	5,600	626,498
1986	233,625	488,779	722,404	51,498	773,902	17,720	7,290	798,912
1987	253,230	565,221	818,451	54,796	873,247	20,112	8,263	901,622
1988	276,541	640,643	917,184	58,590	975,774	20,636	9,462	1,005,872
1989 e					1,127,881	29,340	9,651	1,166,872
1990 e					1,269,984	38,044	9,844	1,317,872
1991 e					1,500,083	46,748	10,041	1,556,872
1992 e					1,756,178	55,452	10,242	1,821,872
1993 e					2,106,708	62,992	10,447	2,180,147
1994 e					2,457,234	70,532	10,656	2,538,422
1995 e					2,807,756	78,072	10,869	2,896,696
1996 e					3,158,273	85,612	11,086	3,254,971
1997 e					3,508,786	93,152	11,308	3,613,246
1998 e					3,739,465	100,867	11,534	3,851,867
1999 e					3,970,140	108,583	11,765	4,090,487
2000 e					4,200,809	116,298	12,000	4,329,108
2001 e					4,431,475	124,014	12,240	4,567,728
2002 e					4,662,135	131,729	12,485	4,806,349
2003 e					4,925,912	139,965	12,735	5,078,612
2004 e					5,189,685	148,202	12,989	5,350,876
2005 e					5,453,452	156,438	13,249	5,623,139
2006 e					5,717,214	164,675	13,514	5,895,403
2007 e					5,980,971	172,911	13,784	6,167,666

Table 8.1.2-6 The Number of Installation per Year

Year	Actual	5th EDP Plan	6th EDP Plan	Total	Req. Instal.	Residual	The Project
1976							
1977	23,988						
1978	34,828						
1979	35,950						
1980	34,310						
1981	23,344						
1982	36,441						
1983	37,552						
1984	56,260						
1985	107,007						
1986	172,414						
1987	102,710	93000		93,000			
1988	104,250	117,000		104,250			
1989 e		161,000		161,000			
1990 e		151,000		151,000			
1991 e		189,000	50,000	239,000			
1992 e		150,000	115,000	265,000			
1993 e		80,000	26,400	106,400	358,275	-251,875	251,875
1994 e		20,000	0	20,000	358,275	-338,275	338,275
1995 e					358,275		358,275
1996 e					358,275		358,275
1997 e					358,275		358,275
1998 e					238,621		238,621
1999 e					238,621		238,621
2000 e					238,621		238,621
2001 e					238,621		238,621
2002 e					238,621		238,621
2003 e					272,263		272,263
2004 e					272,263		272,263
2005 e					272,263		272,263
2006 e					272,263		272,263
2007 e					272,263		272,263

8.1.3 Outline of the Expansion Plan

The concept of the Expansion Plans are as follows.

1) Main Telephone

The main telephone lines will be increased 1,792,000 lines during Phase-1, 1,192,000 lines during Phase-2, 1,361,000 lines during Phase-3 and total 4,345,000 lines to meet the telephone demand.

As the results of this expansion plan, the supply of main telephone can be expected to reach all the demand by the end of Phase-1.

2) Public Telephone

The expansion of public telephone is proposed 37,700 sets during Phase-1, 38,600 sets during Phase-2, 41,200 sets during Phase-3 and total 117,500 sets. Rural public telephone will be installed 21,660 sets in order to dissolve non-telephone communities.

As the results, the density of public telephone will become 2.5 per 1000 persons in 2007.

3) Switching Facilities

The expansion plan of switching capacity is proposed 1,897,000 lines during Phase-1, 1,248,000 lines during Phase-2, 1,346,000 lines during Phase-3 and total 4,491,000 lines. Replacement of analog exchange will be proposed in order to change to a large capacity of SPC exchange.

4) Transmission Facilities

a) Long Distance Transmission System

Proposed Plan of long distance system are as follows.

Phase-1 ; To link all PCs by digital transmission systems, and to connect a big SC(Chiang Mai) to Bangkok with duplicated transmission routes.

Phase-2 ; To enhance reliability of the telecommunication network by connecting all SCs with duplicated routes.

Phase-3 ; To link all TCs, SCs and PCs with duplicated routes.

The number of these expansion systems are 50 systems during Phase-1, 68 systems during Phase-2, 87systems during Phase-3 and total 205 systems.

b) Metropolitan Junction Transmission System

The number of optical fiber systems to be installed are 63 systems during Phase-1, 63 systems during Phase-2, 63 systems during Phase-3 and total 189 systems.

c) Spur Route Transmission Systems

The number of optical fiber and radio systems to be installed are 177 systems during Phase-1, 178 systems during Phase-2, 156 systems during Phase-3 and total 511 systems,

d) Satellite Communication System

The local earth station of satellite communication systems will be installed 17 earth stations during Phase-1, 5 earth stations during Phase-2 and 4 earth stations during Phase-3.

5) Outside Plant Facilities

a) Local Cable

The expansion of local cable are proposed 3,770,000 pairs during Phase-1, 2,003,000 pairs during Phase-2, 2,315,000 pairs during Phase-3 and total 8,088,000 pairs.

b) Rehabilitation Plan

About 4.1 billion baths will be required as the investment cost for the rehabilitation of outside plants during the period of 1993 to 2007. As the execution results of this rehabilitation plan, the fault ratio can be expected 1.3 per 100 subscribers per month at the end of Phase-3.

6) Mobile Communication Facilities

a) Cellular Mobile Facilities

The cellular mobile communication facilities are planned the expansion of 62,000 line units during Phase-1, 138,000 line units during Phase-2, 154,000 line units during Phase-3 and total 354,000 line units.

b) Paging Facilities

The paging facilities are planned 35,000 line units during Phase-1, 45,000 line units during Phase-2, 60,000 line units during Phase-3, total 140,000 line units.

7) Leased Circuit and Data Communication Facilities

a) Leased Circuit

The leased circuit facilities are planned 54,000 lines during Phase-1, 76,900 lines during Phase-2, 64,700 lines during Phase-3 and total 195,600 lines.

b) Data Communication Facilities

Packet switching facilities as one of the data communication facilities are planned 10,000 lines during Phase-1, 23,000 lines during Phase-2, 50,000 lines during Phase-3 and total 83,000 lines.

8) Investment cost

The investment cost of this expansion plan is required 69.7 billion Bahts during Phase-1, 55.8 billion Bahts during Phase-2, 60.3 billion Bahts during Phase-3 and total 185.8 billion Bahts.

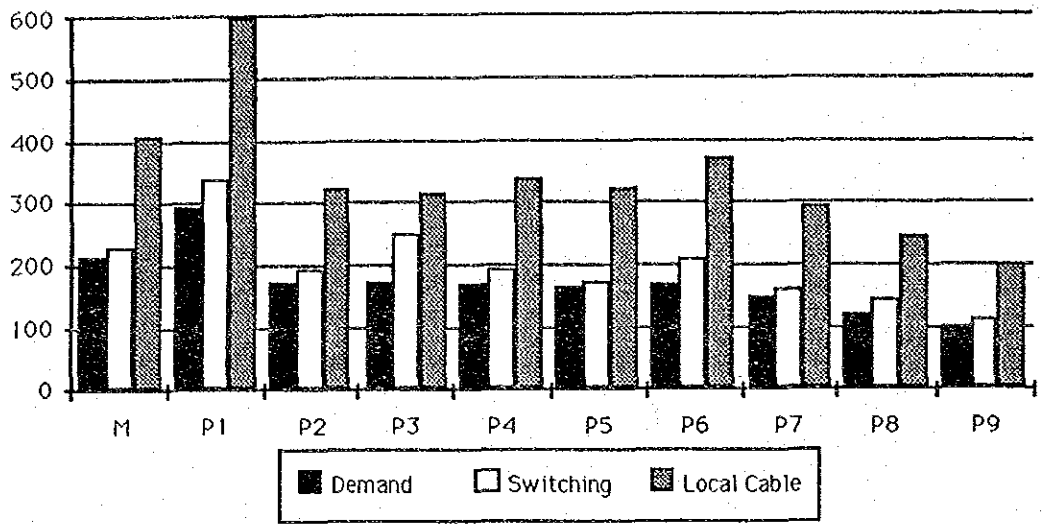
Table 8.1.3 shows the outline of the Expansion Plan.

8.1.4 Local Cable and Switching Facilities

Local cable and switching facilities to be expanded at the end of each phase are shown in Figure 8.1.4-1 to 8.1.4-3.

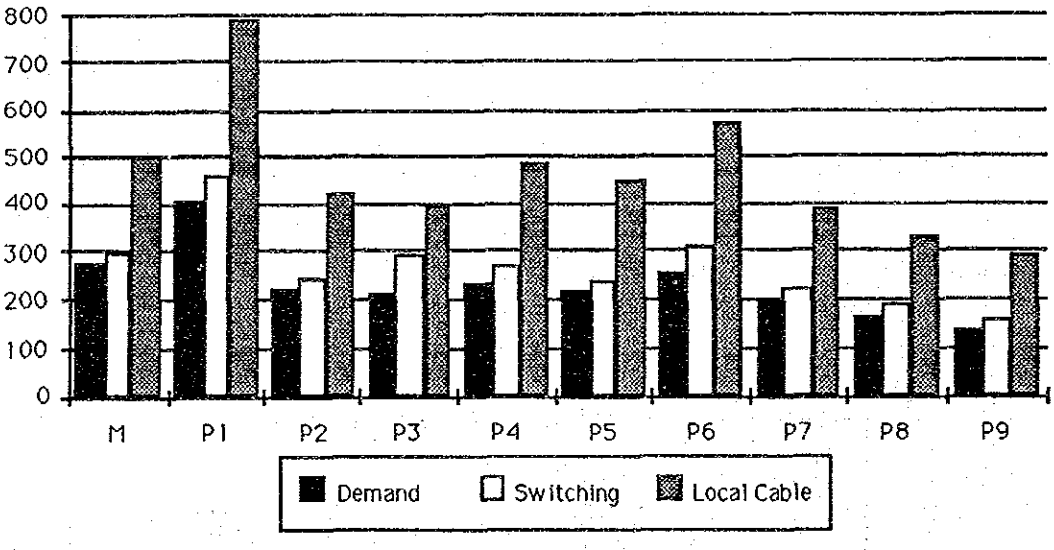
Table 8.1.3 Outline of the Expansion Plan

Facility		Phase-1	Phase-2	Phase-3	Total
Telephone	Main Telephone (line)	1,792,000	1,192,000	1,361,000	4,345,000
	Public Telephone (set)	37,700	38,600	41,200	117,500
Switching Facility	Capacity (line)	1,897,000	1,248,000	1,346,000	4,491,000
	(Metropolitan) (line)	(974,000)	(633,000)	(616,000)	(2,223,000)
	(Provincial) (line)	(923,000)	(615,000)	(730,000)	(2,268,000)
	Replacement of XB (line)	127,000	177,000	94,000	398,000
	Replacement of SPC (line)	217,000	773,000	528,000	1,518,000
Transmission Facility	Long Distance Transmission				
	Number of System	50	68	87	205
	Number of Mux.	213	263	214	690
	Junction Transmission				
	Number of System	63	63	63	189
	Number of Mux.	115	115	119	349
	Spur Transmission				
	Number of System	177	178	156	511
	Number of Mux.	732	732	736	2,200
	Satellite Communication				
	Number of Station	17	5	4	26
Outside Plant Facility	Pair Cable (pair)	3,770,000	2,003,000	2,315,000	8,088,000
	(Metropolitan) (pair)	(1,908,000)	(894,000)	(983,000)	(3,785,000)
	(Provincial) (pair)	(1,862,000)	(1,109,000)	(1,332,000)	(4,303,000)
Building		19	23	34	76
Mobile Services	Cellular Mobile (line unit)	62,000	138,000	154,000	354,000
	Paging (line unit)	35,000	45,000	60,000	140,000
Investment Cost	(Baht)	69.7 Billion Baht	55.8 Billion Baht	60.3 Billion Baht	185.8 Billion Baht



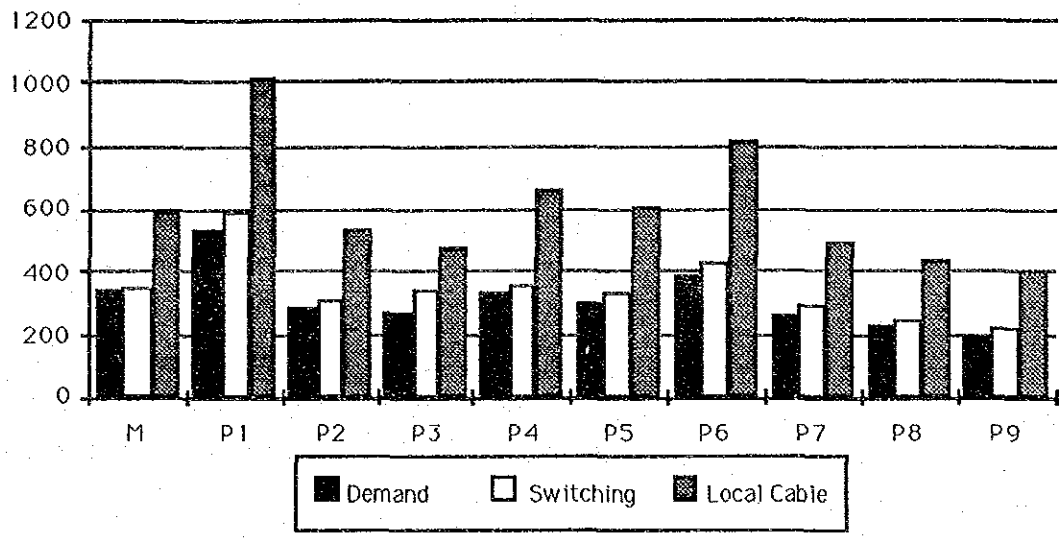
Unit; Metropolitan :10,000 Provincial :1,000

Figure 8.1.4-1 Comparison of Demand, Switching and Local Cable Capacity (Phase-1)



Unit; Metropolitan : 10,000 Provincial : 1,000

Figure 8.1.4-2 Comparison of Demand, Switching and Local Cable Capacity (Phase-2)



Unit; Metropolitan : 10,000 Provincial : 1,000

Figure 8.1.4-3 Comparison of Demand, Switching and Local Cable Capacity (Phase-3)

8.2 Switching Facilites

The summary of switching long term plan is shown in Figure 8.2.

8.2.1 Expansion Plan

In order to estimate the number of new exchanges, the following procedure as shown in Figure 8.2.1-1 is applied because the demand forecast was estimated for about each Changwat at this time.

Therefore, when the detailed study based on Amphoe or Tambon level is carried out, the number of exchanges may increase more than that of this study. For calculation of the number of circuits, the traffic forecast data in Appendix, the routing plan in Chapter 7 and Erlang-B formula were applied.

i) The exchange office installed one RSL is juxtaposed one more RSL. After that, one RSU is installed to replace the RSLs. Next expansion method is as same method as ii).

ii) The exchange office installed one RSU is juxtaposed one more RSU. After that, the exchange becomes LE and RSUs are removed.

iii) The LE is iextended until 40,000 line capacity and when the capacity excceds 40,000 lines, new unit is juxtaposed.

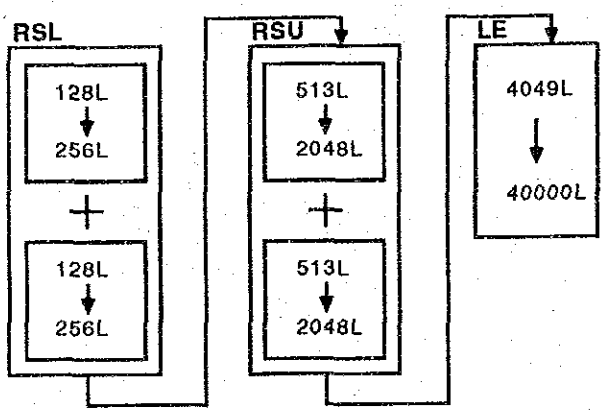


Figure 8.2.1-1 Procedure of Exchange Number Estimation

The switching capacity to be expanded up to 2007 is shown in Table 8.2.1-1 and total switching capacity is shown in Table 8.2.1-2. And about each Changwat of these are published in Appendix.

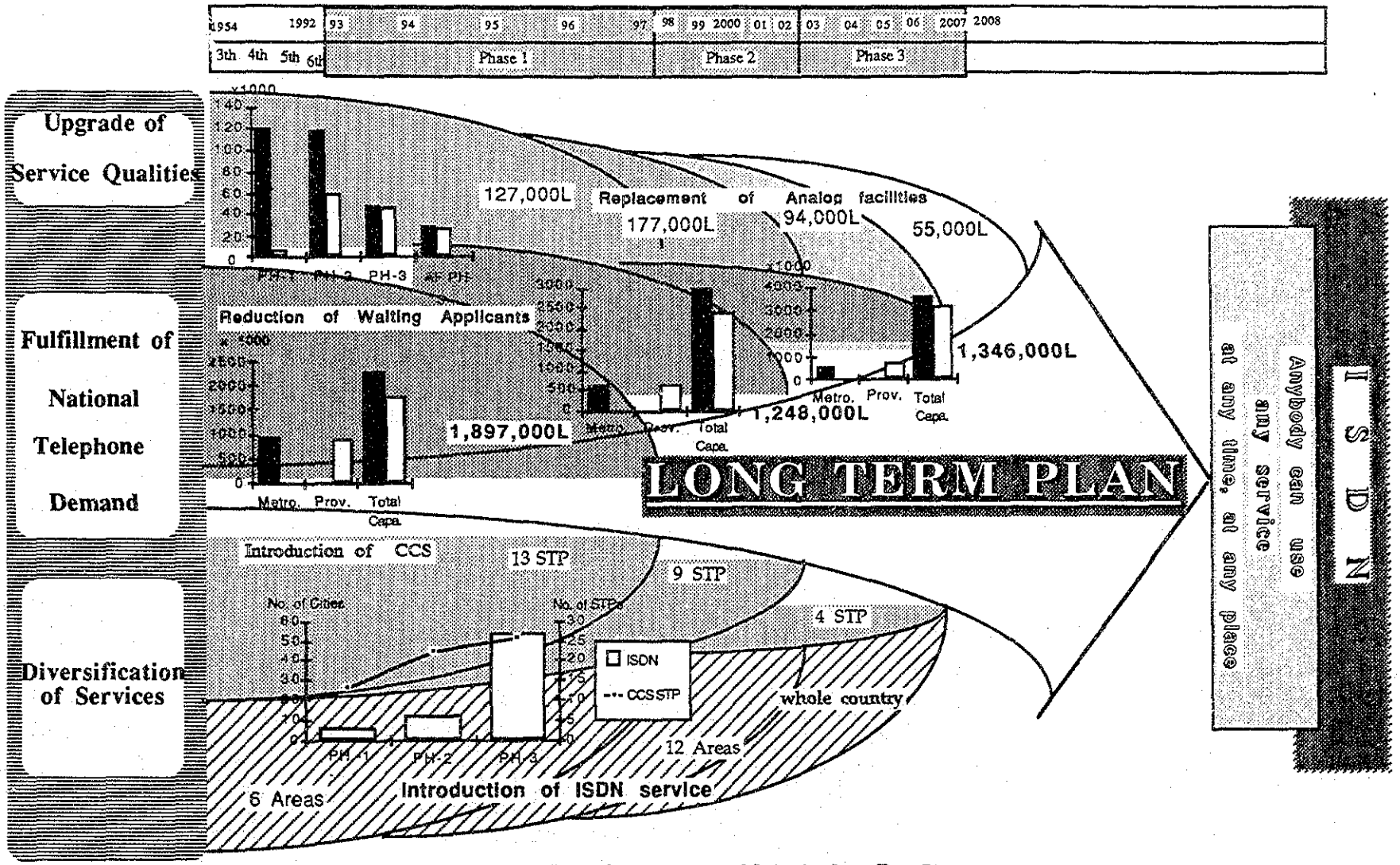


Figure 8.2 Summary of Switching Long Term Plan

Table 8.2.1-1 Switching Capacity to be Increased

Term	Phase-1	Phase-2	Phase-3	Total
Increasing Capacity	1,897,000	1,248,000	1,346,000	4,491,000
Metropolitan Area	974,000	633,000	616,000	2,223,000
Provincial Area	923,000	615,000	730,000	2,268,000
Area 1	209,000	119,000	126,000	454,000
Area 2	103,000	54,000	62,000	219,000
Area 3	149,000	46,000	50,000	245,000
Area 4	103,000	77,000	92,000	272,000
Area 5	59,000	67,000	89,000	215,000
Area 6	110,000	98,000	126,000	334,000
Area 7	71,000	60,000	70,000	201,000
Area 8	73,000	45,000	56,000	174,000
Area 9	46,000	49,000	59,000	154,000

As shown in Table 8 2.1-1, there are considerable differences among the three Phases. It is because that this expansion plan follows a strategy of the Master Plan, placing emphasis on reduction of waiting applicants in Phase-1.

Table 8.2.1-2 Total Switching Capacity

Term	1992	Phase-1	Phase-2	Phase-3
Total Capacity	2,177,000	4,074,000	5,321,000	6,667,000
Metropolitan Area	1,336,000	2,310,000	2,942,000	3,558,000
Provincial Area	841,000	1,764,000	2,379,000	3,109,000
Area 1	129,000	338,000	457,000	583,000
Area 2	88,000	191,000	245,000	307,000
Area 3	97,000	246,000	292,000	342,000
Area 4	90,000	193,000	270,000	362,000
Area 5	115,000	174,000	241,000	330,000
Area 6	98,000	208,000	306,000	432,000
Area 7	88,000	159,000	219,000	289,000
Area 8	71,000	144,000	189,000	245,000
Area 9	65,000	111,000	160,000	219,000

8.2.2 Economic Comparison of Installing RSU in Metropolitan Area

In case of decision about switching system, the following matters should be taken into consideration:

- The subscriber number of the last period, more than 10 years later, at the accommodation area,
- Hierarchical position of facility,
- Operation & maintenance,
- Economic consideration etc.

In the metropolitan area, however, the environment conditions such as construction delay of new building, outside plant, transmission system, and installation limit of MDF, sometimes cause special case to need RSU installation as a relief measure.

As the RSU construction is easy and the installation period is shorter, it is effective way for above mentioned. Though it is provisional way, the following matter is examined:

- The appropriation duration,
- The setting place.

1) Appropriation Duration

The point to be considered when the switching system is to be decided is already described. In conclusion, the most suitable system is selected corresponding to the purpose. Therefore, the selected switching system should have, at least, the line capacity and the traffic handling capability for last appropriation period of the accommodation area.

Table 8.2.2-1 shows the situation of RSU up to 1988 in metropolitan area. The table gives some information that the appropriation duration is quite short (average duration is 4.8 years) and the replacement time is after full accommodation of subscriber. This means that the setting purpose of RSU is different from provincial area and it has been used for provisional way to cope with keen demand of the metropolitan area.

This study examined about the relation with the duration and economies. The object RSU is 512L, 1024L, 1536L and 2048L. Interest for economic comparison was selected at 12%. The installation plan was set at 4 years, 5 years and 6 years based on the past result. Table 8.2.2-2 to 5 and Figure 8.2.2-1 to 4 show the result.

From this result, the following matters become clear:

- The profit is yielded one or two years after reaching full accommodation,
- In order to get more profit (excess interest), it needs to use one or two years more than the above mentioned,
- The type of 512L is seemed to be not suitable system for tentative way.

In this conclusion, the economies of RSUs installed for short duration is recognized if these RSUs (except the type of 512L) will be operation at least 5 years. The economies, however, will be influenced greatly by the telephone installation plan and if the profit is to be raised more and more,the RSU should be placed at the same place at least during 10 years.

2) Installation Place

The RSU will be replaced some years later, and then, the redistribution of outside plant will be needed. As the cost of outside plant occupied a considerable ratio in investment cost of the telecommunication network, the place should be selected very carefully. The estimation as mentioned in item a) did not include the costs relating to the installation place because the condition is changed depending on the environment.

3) Time of Installation and State of Host Exchange

When a RSU is installed for some reason, the problem will occur that the XB cannot accommodate the RSU if the exchange, which was already placed for LE in the same accommodation area, is XB. In this case, other SPC placed in the near accommodation area should be connected to this RSU instead of the XB.

After a few years, when new SPC is installed at the same building as XB, the changing of accommodation of the RSU is not necessary unless any problems such as numbering plan, utility for subscriber, maintenance aspect and etc will happen.

If the number of such RSUs becomes larger, however, it is supposed that the telephone network planning will be confused. Therefore, that situation should be avoided as far as possible. In order to do so, the basic long term plan (refer to Chapter 8.2.5) and replacement plan of analog facility (refer to Chapter 8.2.3) should be made definitely.

Table 8.2.2-1 RSU in Metropolitan Area

Office Name	Inauguration Date	System	Capacity	Number of Lines Connected and Replacement Schedule										Jaxtapositing Exchange 1988	
				1983	1984	1985	1986	1987	1988	1989	1990	1991	1992		
Bang Phli-Bang Bo	1985	M-NEAX61	600			30	190	367	584						
Bang Phli	1985	NEAX61	1000			742	1000	*							
Bang Poo	1984	NEAX61	1000			758	907	943	N.A	*					
Lad Krabang	1984	NEAX61	1000			873	1000	*							
Nong Chok	1984	NEAX61	1000			663	797	854	916						
Ma Bun Khrong	1986	R-NEAX	1000				373	438	614						
Pravet Khrong	1984	NEAX61	1000						945						
Ammarin Plaza	1986	R-NEAX	1000				435	495	625						
Asok-Din Daeng	1986	M-NEAX	1000					818	*					XB	SPC
Sukhumwit	1987	M-NEAX	1000					898	*						
Song Serm Nakhon	1983	NEAX61	600	190	503	573	*								
Thaiwa Tower	1985	NEAX61	512			213	472		471						
Thanontok	1985	NEAX61	1000				863	921	973	*				XB	
Thungmahamek	1985	NEAX61	2000			4	1343	1959	1977					XB	SPC
Pha Nu Rangsi	1983	NEAX61	600	306	527	531	546	552	566						
Phom Phrachool	1984	NEAX61	1000			738	786	802	940						
Chaiyaphruk	1987	R-NEAX	2000					896	1740					XB	
Phruksachat	1986	R-NEAX	2000				1749	1741	1753	*					
Laem Thong	1985	R-NEAX	2000				1478	1567	1740						
Bang Bua Thong	1984	NEAX61	1000				903		926	*					
Phuthamonthon	1985	R-NEAX	1000				407	509	663						
Thon Buri	1983	NEAX61	1000	N.A	N.A	903	651	551	*					XB	
Bang Ken	1985	NEAX61	1000			12	840	950	987		*			XB	SPC
Central Plaza	1985	NEAX61	600			323	460	658	688						
Donmuang	1983	NEAX61	2000	N.A	N.A	920	75	1460	1989	*				XB	SPC
Inthamara	1985 1985	NEAX61 M-NEAX	1000 1000				916	938	1000 769		* *			XB	SPC
Lak Si	1985	NEAX61	1000			2	N.A	953	*					XB	SPC
Lat Phrao	1985	M-NEAX	1000				909	984	999					XB	
Nonthaburi	1984 1983	NEAX61 M-NEAX	1000x2 1000	N.A	N.A	922	2606	1842 913	1947 952		* *			XB	
Phathum Thani	1985	NEAX61	1000x2			948	1570	1882	1964		*				
Rang Sit	1983	NEAX61	1000x2	396	412	337	1375	1728	1951		*				
Thanyaburi	1984	NEAX61	1000			677	795	893	917		*				
Vibhavadee Rang Sit	1983	NEAX61	1000	88	436	539	N.A	*							
Mung Ek	1986	R-NEAX	1000				32	336	452						
Thungsikan	1986	R-NEAX	2000				1365	1819	1891						
Daokhanong	1987	R-NEAX	1000					622	849						
Muban Setkakit	1984	R-NEAX	2000					1913	1960	*					

* Replacement Date

Table 8.2.2-2 (1/3) Economic Comparison of RSU (512 L) Case A (sell out within 5 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	17,910,460	358,209	18,268,669	698,343	-17,570,326		2,082	4,536	3,500	102	102	75
1993		358,209	358,209	1,375,368	1,017,159	-0.942	2,108	4,473	3,500	102	204	75
1994		358,209	358,209	2,045,355	1,687,146	-0.660	2,133	4,413	3,500	102	306	75
1995		358,209	358,209	2,704,632	2,346,423	-0.404	2,166	4,335	3,500	102	408	75
1996		358,209	358,209	3,372,860	3,014,651	-0.226	2,191	4,275	3,500	104	512	75
1997		358,209	358,209	3,334,656	2,976,447	-0.122	2,211	4,227			512	75
1998		358,209	358,209	3,325,952	2,967,743	-0.054	2,224	4,197			512	75
1999		358,209	358,209	3,319,808	2,961,599	-0.008	2,233	4,176			512	75
2000		358,209	358,209	3,314,688	2,956,479	0.026	2,241	4,158			512	75
2001		358,209	358,209	3,308,544	2,950,335	0.050	2,247	4,140			512	75

Table 8.2.2-2 (2/3) Economic Comparison of RSU (512 L) Case B (sell out within 6 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	17,910,460	358,209	18,268,669	581,953	-17,686,717		2,082	4,536	3,500	85	85	75
1993		358,209	358,209	1,146,140	787,931	-0.955	2,108	4,473	3,500	85	170	75
1994		358,209	358,209	1,704,463	1,346,254	-0.701	2,133	4,413	3,500	85	255	75
1995		358,209	358,209	2,253,860	1,895,651	-0.455	2,166	4,335	3,500	85	340	75
1996		358,209	358,209	2,799,433	2,441,224	-0.278	2,191	4,275	3,500	85	425	75
1997		358,209	358,209	3,355,841	2,997,632	-0.155	2,211	4,227	3,500	87	512	75
1998		358,209	358,209	3,325,952	2,967,743	-0.079	2,224	4,197			512	75
1999		358,209	358,209	3,319,808	2,961,599	-0.029	2,233	4,176			512	75
2000		358,209	358,209	3,314,688	2,956,479	0.007	2,241	4,158			512	75
2001		358,209	358,209	3,308,544	2,950,335	0.033	2,247	4,140			512	75

Table 8.2.2-2 (3/3) Economic Comparison of RSU (512 L) Case C (sell out within 4 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	17910460	358,209	18,268,669	876,352	-17,392,317		2,082	4,536	3,500	128	128	75
1993		358,209	358,209	1,725,952	1,367,743	-0.921	2,108	4,473	3,500	128	256	75
1994		358,209	358,209	2,566,720	2,208,511	-0.602	2,133	4,413	3,500	128	384	75
1995		358,209	358,209	3,394,048	3,035,839	-0.335	2,166	4,335	3,500	128	512	75
1996		358,209	358,209	3,348,992	2,990,783	-0.185	2,191	4,275			512	75
1997		358,209	358,209	3,334,656	2,976,447	-0.091	2,211	4,227			512	75
1998		358,209	358,209	3,325,952	2,967,743	-0.029	2,224	4,197			512	75
1999		358,209	358,209	3,319,808	2,961,599	0.015	2,233	4,176			512	75
2000		358,209	358,209	3,314,688	2,956,479	0.045	2,241	4,158			512	75
2001		358,209	358,209	3,308,544	2,950,335	0.068	2,247	4,140			512	75

Table 8.2.2-3 (1/3) Economic Comparison of RSU (1024 L) Case A (sell out within 5 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	27,209,110	544,182	27,753,292	1,369,300	-26,383,992		2,082	4,536	3,500	200	200	75
1993		544,182	544,182	2,696,800	2,152,618	-0.918	2,108	4,473	3,500	200	400	75
1994		544,182	544,182	4,010,500	3,466,318	-0.594	2,133	4,413	3,500	200	600	75
1995		544,182	544,182	5,303,200	4,759,018	-0.326	2,166	4,335	3,500	200	800	75
1996		544,182	544,182	6,854,392	6,310,210	-0.142	2,191	4,275	3,500	254	1,024	75
1997		544,182	544,182	6,669,312	6,125,130	-0.041	2,211	4,227			1,024	75
1998		544,182	544,182	6,651,904	6,107,722	0.023	2,224	4,197			1,024	75
1999		544,182	544,182	6,639,616	6,095,434	0.066	2,233	4,176			1,024	75
2000		544,182	544,182	6,629,376	6,085,194	0.096	2,241	4,158			1,024	75
2001		544,182	544,182	6,617,088	6,072,906	0.117	2,247	4,140			1,024	75

Table 8.2.2-3 (2/3) Economic Comparison of RSU (1024 L) Case B (sell out within 6 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	27,209,110	544,182	27,753,292	1,163,905	-26,589,387		2,082	4,536	3,500	170	170	75
1993		544,182	544,182	2,292,280	1,748,098	-0.934	2,108	4,473	3,500	170	340	75
1994		544,182	544,182	3,408,925	2,864,743	-0.637	2,133	4,413	3,500	170	510	75
1995		544,182	544,182	4,507,720	3,963,538	-0.377	2,166	4,335	3,500	170	680	75
1996		544,182	544,182	5,598,865	5,054,683	-0.199	2,191	4,275	3,500	170	850	75
1997		544,182	544,182	6,711,681	6,167,499	-0.078	2,211	4,227	3,500	174	1,024	75
1998		544,182	544,182	6,651,904	6,107,722	-0.006	2,224	4,197			1,024	75
1999		544,182	544,182	6,639,616	6,095,434	0.041	2,233	4,176			1,024	75
2000		544,182	544,182	6,629,376	6,085,194	0.074	2,241	4,158			1,024	75
2001		544,182	544,182	6,617,088	6,072,906	0.097	2,247	4,140			1,024	75

Table 8.2.2-3 (3/3) Economic Comparison of RSU (1024 L) Case C (sell out within 4 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	27,209,110	544,182	27,753,292	1,711,625	-26,041,667		2,082	4,536	3,500	250	250	75
1993		544,182	544,182	3,371,000	2,826,818	-0.891	2,108	4,473	3,500	250	500	75
1994		544,182	544,182	5,013,125	4,468,943	-0.528	2,133	4,413	3,500	250	750	75
1995		544,182	544,182	6,791,912	6,247,730	-0.244	2,166	4,335	3,500	274	1,024	75
1996		544,182	544,182	6,697,984	6,153,802	-0.093	2,191	4,275			1,024	75
1997		544,182	544,182	6,669,312	6,125,130	-0.003	2,211	4,227			1,024	75
1998		544,182	544,182	6,651,904	6,107,722	0.056	2,224	4,197			1,024	75
1999		544,182	544,182	6,639,616	6,095,434	0.095	2,233	4,176			1,024	75
2000		544,182	544,182	6,629,376	6,085,194	0.122	2,241	4,158			1,024	75
2001		544,182	544,182	6,617,088	6,072,906	0.141	2,247	4,140			1,024	75

Table 8.2.2-4 (1/3) Economic Comparison of RSU (1536 L) Case A (sell out within 5 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	40,662,955	813,259	41,476,214	2,101,876	-39,374,339		2,082	4,536	3,500	307	307	75
1993		813,259	813,259	4,139,588	3,326,329	-0.916	2,108	4,473	3,500	307	614	75
1994		813,259	813,259	6,156,118	5,342,858	-0.587	2,133	4,413	3,500	307	921	75
1995		813,259	813,259	8,140,412	7,327,153	-0.317	2,166	4,335	3,500	307	1,228	75
1996		813,259	813,259	10,117,662	9,304,403	-0.138	2,191	4,275	3,500	308	1,536	75
1997		813,259	813,259	10,003,968	9,190,709	-0.037	2,211	4,227			1,536	75
1998		813,259	813,259	9,977,856	9,164,597	0.026	2,224	4,197			1,536	75
1999		813,259	813,259	9,959,424	9,146,165	0.069	2,233	4,176			1,536	75
2000		813,259	813,259	9,944,064	9,130,805	0.099	2,241	4,158			1,536	75
2001		813,259	813,259	9,925,632	9,112,373	0.120	2,247	4,140			1,536	75

Table 8.2.2-4 (2/3) Economic Comparison of RSU (1536 L) Case B (sell out within 6 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	40,662,955	813,259	41,476,214	1,752,704	-39,723,510		2,082	4,536	3,500	256	256	75
1993		813,259	813,259	3,451,904	2,638,645	-0.934	2,108	4,473	3,500	256	512	75
1994		813,259	813,259	5,133,440	4,320,181	-0.635	2,133	4,413	3,500	256	768	75
1995		813,259	813,259	6,788,096	5,974,837	-0.375	2,166	4,335	3,500	256	1,024	75
1996		813,259	813,259	8,431,232	7,617,973	-0.196	2,191	4,275	3,500	256	1,280	75
1997		813,259	813,259	10,066,304	9,253,045	-0.076	2,211	4,227	3,500	256	1,536	75
1998		813,259	813,259	9,977,856	9,164,597	-0.005	2,224	4,197			1,536	75
1999		813,259	813,259	9,959,424	9,146,165	0.042	2,233	4,176			1,536	75
2000		813,259	813,259	9,944,064	9,130,805	0.075	2,241	4,158			1,536	75
2001		813,259	813,259	9,925,632	9,112,373	0.098	2,247	4,140			1,536	75

Table 8.2.2-4 (3/3) Economic Comparison of RSU (1536 L) Case C (sell out within 4 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	40,662,955	813,259	41,476,214	2,629,056	-38,847,158		2,082	4,536	3,500	384	384	75
1993		813,259	813,259	5,177,856	4,364,597	-0.888	2,108	4,473	3,500	384	768	75
1994		813,259	813,259	7,700,160	6,886,901	-0.519	2,133	4,413	3,500	384	1,152	75
1995		813,259	813,259	10,192,144	9,368,885	-0.239	2,166	4,335	3,500	384	1,536	75
1996		813,259	813,259	10,046,976	9,233,717	-0.089	2,191	4,275			1,536	75
1997		813,259	813,259	10,003,968	9,190,709	-0.002	2,211	4,227			1,536	75
1998		813,259	813,259	9,977,856	9,164,597	0.059	2,224	4,197			1,536	75
1999		813,259	813,259	9,959,424	9,146,165	0.098	2,233	4,176			1,536	75
2000		813,259	813,259	9,944,064	9,130,805	0.125	2,241	4,158			1,536	75
2001		813,259	813,259	9,925,632	9,112,373	0.144	2,247	4,140			1,536	75

Table 8.2.2-5 (1/3) Economic Comparison of RSU (2048 L) Case A (sell out within 5 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	51,266,904	1,025,338	52,292,242	2,807,065	-49,485,177		2,082	4,536	3,500	410	410	75
1993		1,025,338	1,025,338	5,528,440	4,503,102	-0.909	2,108	4,473	3,500	410	820	75
1994		1,025,338	1,025,338	8,221,525	7,196,187	-0.570	2,133	4,413	3,500	410	1,230	75
1995		1,025,338	1,025,338	10,871,560	9,846,222	-0.298	2,166	4,335	3,500	410	1,640	75
1996		1,025,338	1,025,338	13,489,604	12,464,266	-0.119	2,191	4,275	3,500	408	2,048	75
1997		1,025,338	1,025,338	13,338,624	12,313,286	-0.019	2,211	4,227			2,048	75
1998		1,025,338	1,025,338	13,303,808	12,278,470	0.044	2,224	4,197			2,048	75
1999		1,025,338	1,025,338	13,279,232	12,253,894	0.086	2,233	4,176			2,048	75
2000		1,025,338	1,025,338	13,258,752	12,233,414	0.114	2,241	4,158			2,048	75
2001		1,025,338	1,025,338	13,234,176	12,208,838	0.135	2,247	4,140			2,048	75

Table 8.2.2-5 (2/3) Economic Comparison of RSU (2048 L) Case B (sell out within 6 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	51,266,904	1,025,338	52,292,242	2,334,810	-49,957,432		2,082	4,536	3,500	342	340	75
1993		1,025,338	1,025,338	4,598,216	3,572,878	-0.928	2,108	4,473	3,500	342	682	75
1994		1,025,338	1,025,338	6,844,713	5,819,375	-0.621	2,133	4,413	3,500	342	1,024	75
1995		1,025,338	1,025,338	9,055,320	8,029,982	-0.358	2,166	4,335	3,500	342	1,366	75
1996		1,025,338	1,025,338	11,250,517	10,225,179	-0.179	2,191	4,275	3,500	342	1,708	75
1997		1,025,338	1,025,338	13,421,414	12,396,076	-0.060	2,211	4,227	3,500	340	2,048	75
1998		1,025,338	1,025,338	13,303,808	12,278,470	0.011	2,224	4,197			2,048	75
1999		1,025,338	1,025,338	13,279,232	12,253,894	0.058	2,233	4,176			2,048	75
2000		1,025,338	1,025,338	13,258,752	12,233,414	0.089	2,241	4,158			2,048	75
2001		1,025,338	1,025,338	13,234,176	12,208,838	0.112	2,247	4,140			2,048	75

Table 8.2.2-5 (3/3) Economic Comparison of RSU (2048 L) Case C (sell out within 4 years)

Year	Investment Costs	Maintenance Costs	Expense	Revenue	Balance	IRR	Trunk Charge	Local Charge	Subscription Fee	New Subscriber	Total Subscriber	Monthly Fee
1992	51,266,904	1,025,338	52,292,242	3,505,408	-48,786,834		2,082	4,536	3,500	512	512	75
1993		1,025,338	1,025,338	6,903,808	5,878,470	-0.880	2,108	4,473	3,500	512	1,024	75
1994		1,025,338	1,025,338	10,266,880	9,241,542	-0.500	2,133	4,413	3,500	512	1,536	75
1995		1,025,338	1,025,338	13,576,192	12,550,854	-0.217	2,166	4,335	3,500	512	2,048	75
1996		1,025,338	1,025,338	13,395,968	12,370,630	-0.068	2,191	4,275			2,048	75
1997		1,025,338	1,025,338	13,338,624	12,313,286	0.022	2,211	4,227			2,048	75
1998		1,025,338	1,025,338	13,303,808	12,278,470	0.078	2,224	4,197			2,048	75
1999		1,025,338	1,025,338	13,279,232	12,253,894	0.116	2,233	4,176			2,048	75
2000		1,025,338	1,025,338	13,258,752	12,233,414	0.142	2,241	4,158			2,048	75
2001		1,025,338	1,025,338	13,234,176	12,208,838	0.161	2,247	4,140			2,048	75

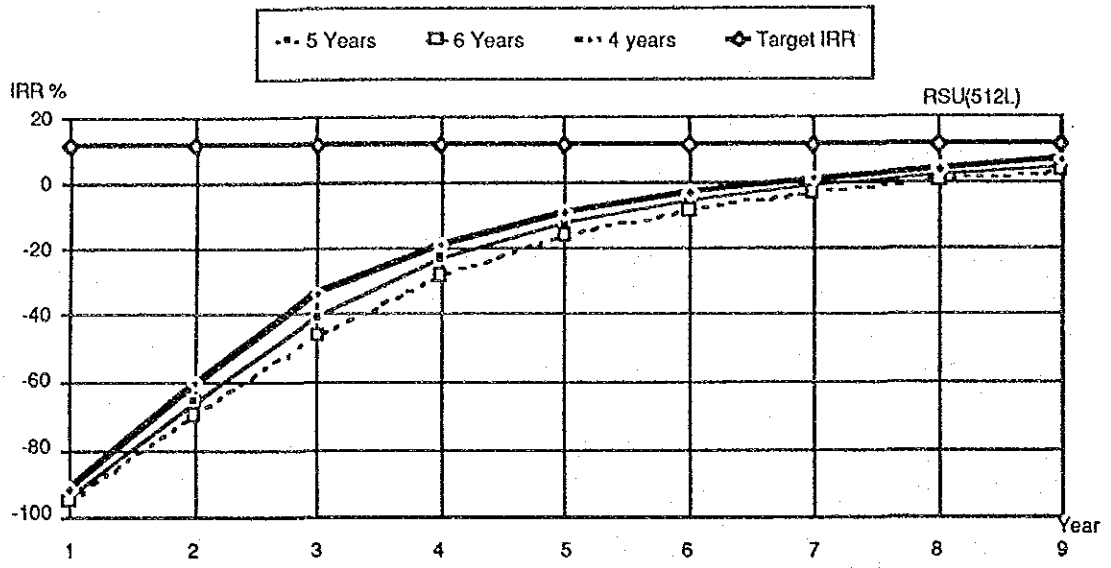


Figure 8.2.2-1 Economic Comparison of RSU (512L)

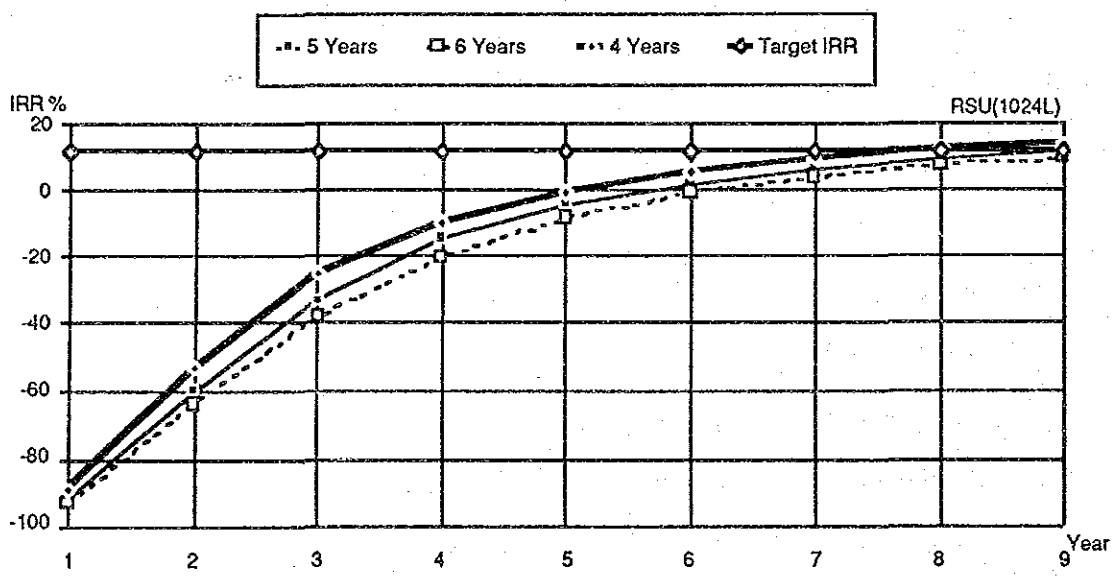


Figure 8.2.2-2 Economic Comparison of RSU (1024L)

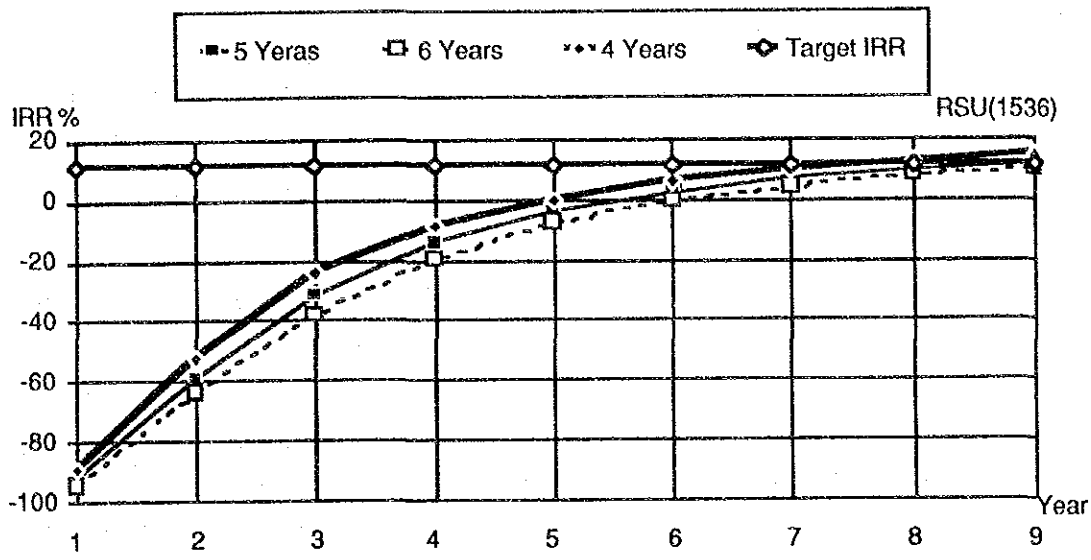


Figure 8.2.2-3 Economic Comparison of RSU (1536L)

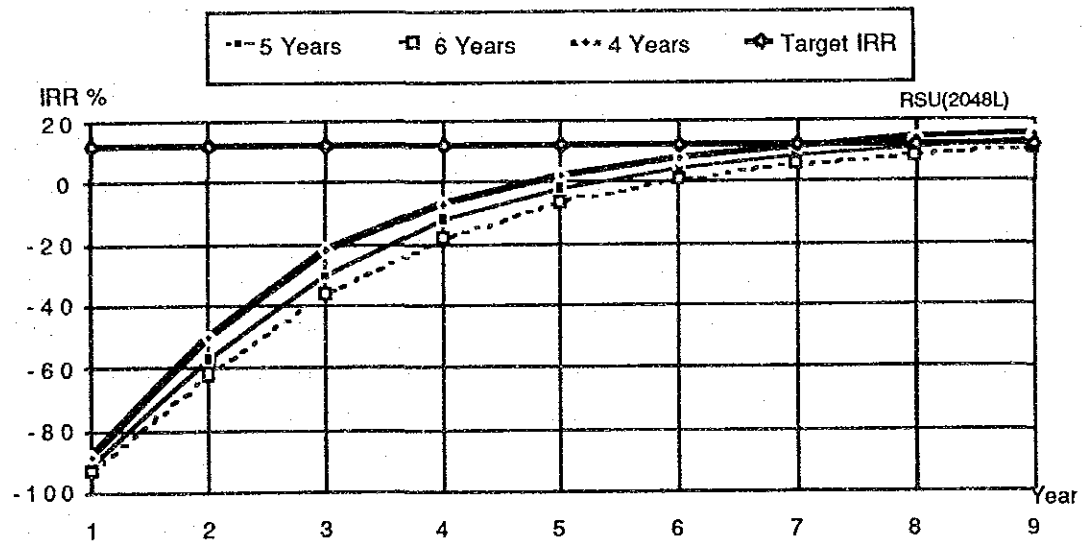


Figure 8.2.2-4 Economic Comparison of RSU (2048L)

8.2.3 Replacement Plan of Analog Facility

Recently, TOT has carried out many projects to introduce of a large number of SPC and also to replace XB, however, many XB is still working especially in metropolitan area. Table 8.2.3-2 shows the number of XB lines as of FY 1988. The points to be considered on replacement of XB are described in this section.

1) Supply of Parts for Repair

TOT has already restrained extension of XB system. But the repair parts should be kept to supply until all the XB system in the whole country is replaced. Besides, though the number of subscriber accommodated to the XB will be settled, the traffic volume will increase. Therefore, the common equipment extension is needed for keeping service quality.

In order to keep supplying repair parts, it is suitable way to reuse some removed XB. That way is called **S&B** (Scrap & Build). By using this way, the extension of XB can be continue as far as possible and it will give a triger to increase SPC in metropolitan area.

2) Time of Replacement

Table 8.2.3-2 gives clear data that the end of service life concentrates at specific year. If all XBs still continue to work, it will threaten that the time when XB become superannuated may come up at the same time. This means that great amount of investment cost is needed for it and it will threaten effective construction plan. Therefore, it is better to replace XB with appropriate plan. The plan is described in Table 8.2.3-3 and Figure 8.2.3-1 to 4. According to this schedule, metropolitan area is given highest priority because the area was placed as the most important area in this study. Table 8.2.3-1 shows the principle of XB replacement plan and about SPC replacement plan was made from point of life duration.

Table 8.2.3-1 Principle of XB Replacement Plan

	Ph-1	Ph-2	Ph-3	After Ph-3
Metro.1	(1)*100%	(2)*100%	0	0
Metro.2	(1)*40%	(1)*60%+(2)*40%	(2)*60%	(3)*100%
Metro.3	(1)*50%	(1)*50%+(2)*50%	(2)*50%	(3)*100%
Metro.4	(1)*50%	(1)*50%+(2)*50%	(2)*50%	(3)*100%
Prov.1-9	(1)*10%	(1)*90%+(2)*10%	(2)*90%	(3)*100%

Note (1): The number of exchange line capacities installed during FY1960~1967 and the end of life duration comes up by FY1992.

(2): The number of exchange line capacities installed during FY1968~1972 and the end of life duration comes up by FY1997.

(3): The number of exchange line capacities installed during FY1973~1977 and the end of life duration comes up by FY2002.

(4): The number of exchange line capacities installed during FY1978~1980 and the end of life duration comes up by FY2005.

Table 8.2.3-2 Situation of XB

Year		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
No. of Lines	Metro.	5	6							10	9	95	77					37		25	50	12
	Prov.		14	5	4	18	8	1		3		3	1	4	5	7	18		10	8	26	
Total		5	20	5	4	18	8	1	0	13	9	98	78	4	5	7	18	37	10	33	76	12

After 25 years

Year		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
No. of Lines	Metro	5	6							10	9	95	77					37		25	50	12
	Prov.		14	5	4	18	8	1		3		3	1	4	5	7	18		10	8	26	
Total		5	20	5	4	18	8	1	0	13	9	98	78	4	5	7	18	37	10	33	76	12

Table 8.2.3-3 Implementation Plan of Replacement

		Phase-1		Phase-2		Phase-3		After Execution	Total Lines
		Lines	Execution	Lines	Execution	Lines	Execu-tion		
Metro.1	X B	52,000	52,000	31,100	31,100	0	0	0	83,100
	SPC	132,634	53,054	10,240	83,676	0	6,144	0	142,874
Metro.2	X B	71,310	35,655	20,000	45,655	36,000	28,000	18,000	127,310
	SPC	271,873	54,375	68,536	129,310	0	129,310	27,414	340,409
Metro.3	X B	28,000	14,000	11,000	19,500	10,000	10,500	5,000	49,000
	SPC	157,859	31,572	56,272	80,025	0	80,025	22,509	214,131
Metro.4	X B	38,730	19,365	6,000	22,365	11,300	8,650	5,650	56,030
	SPC	203,144	40,629	103,304	112,249	0	112,249	41,322	306,448
Total	X B	190,040	121,020	68,100	118,620	57,300	47,150	28,650	315,440
	SPC	765,510	179,629	238,352	405,260	0	327,728	91,245	1,003,862
	Total	955,550	300,649	306,452	523,880	57,300	374,878	119,895	1,319,302
Prov. 1	X B	3,000	300	9,600	3,660	3,000	8,940	2,700	15,600
	SPC	56,272	5,627	60,544	56,699	0	36,326	18,163	116,816
Prov. 2	X B	12,300	1,230	2,912	11,361	1,000	2,721	900	16,212
	SPC	35,392	3,539	32,528	35,106	0	19,517	9,758	67,920
Prov. 3	X B	14,393	1,439	600	13,014	4,800	1,020	4,320	19,793
	SPC	37,480	3,748	39,080	37,640	0	23,448	11,724	76,560
Prov. 4	X B	4,600	460	6,000	4,740	1,500	5,550	1,350	12,100
	SPC	56,160	5,616	25,320	53,076	0	15,192	7,596	81,480
Prov. 5	X B	8,000	800	3,000	7,500	1,000	2,800	900	12,000
	SPC	57,692	5,769	38,264	55,749	0	22,958	11,479	95,956
Prov. 6	X B	5,000	500	7,896	5,290	3,600	7,466	3,240	16,496
	SPC	67,264	6,726	21,264	62,664	0	12,758	6,379	88,528
Prov. 7	X B	2,000	200	4,000	2,200	3,000	3,900	2,700	9,000
	SPC	26,168	2,617	51,284	28,680	0	30,770	15385	77,452
Prov. 8	X B	7,000	700	5,600	6,860	4,800	5,520	4,320	17,400
	SPC	16,624	1,662	36,814	18,643	0	22,088	11,044	53,438
Prov. 9	X B	3,048	305	8,626	3,606	7,000	8,463	6,300	18,674
	SPC	18,160	1,816	29,248	19,269	0	17,549	8,744	47,408
Total	X B	59,341	5,934	48,234	58,230	29,700	46,381	26,730	137,275
	SPC	371,212	37,121	334,346	367,525	0	200,608	100,304	705,558
	Total	430,553	43,055	382,580	425,756	29,700	246,988	127,034	842,833
Whole Country	X B	249,381	126,954	116,334	176,850	87,000	93,531	55,380	452,715
	SPC	1,136,722	216,750	572,698	772,786	0	528,336	191,549	1,709,420
	Total	1,386,103	343,704	689,032	949,636	87,000	621,866	246,929	2,162,135

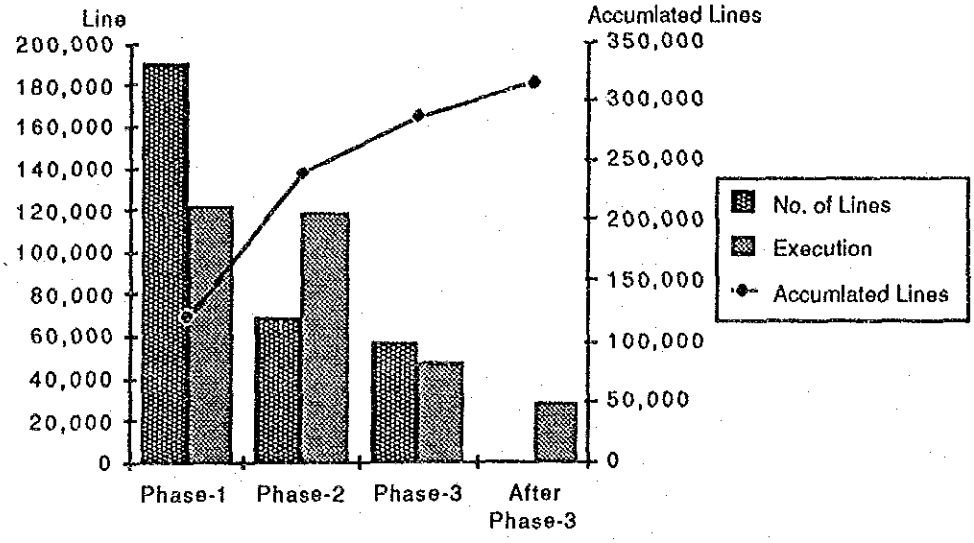


Figure 8.2.3-1 Implemetation of XB for Metropolitan Area

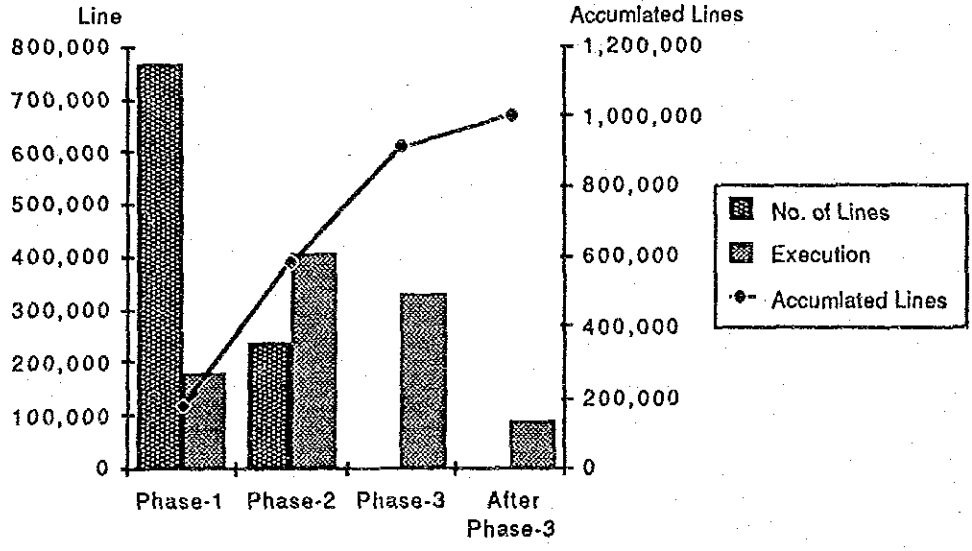


Figure 8.2.3-2 Implemetation of SPC for Metropolitan Area

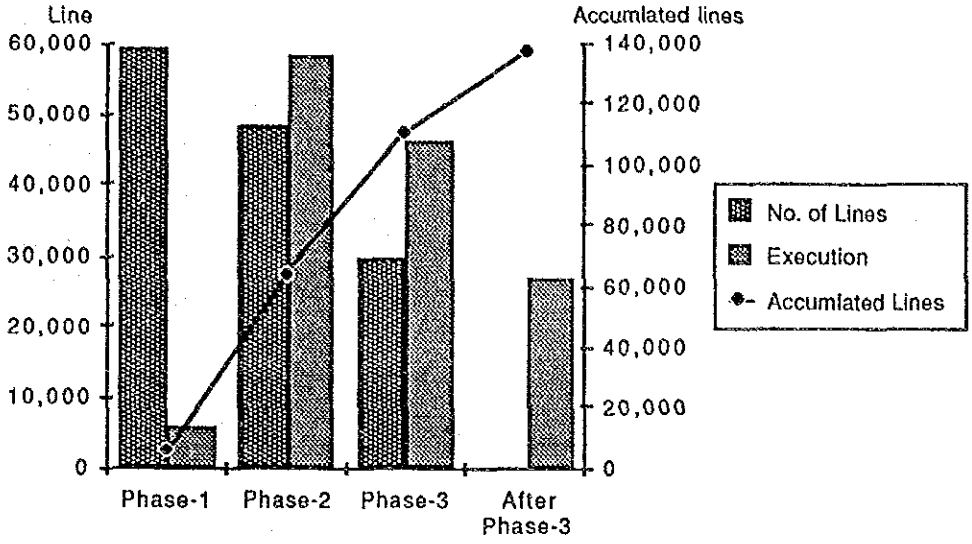


Figure 8.2.3-3 Implemetation of XB for Provincial Area

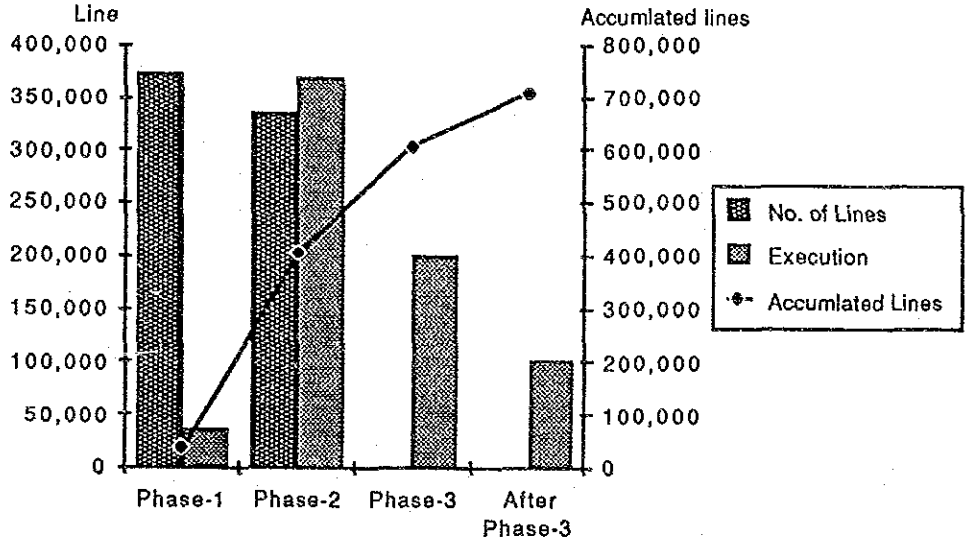


Figure 8.2.3-4 Implemetation of SPC for Provincial Area

8.2.4 Replacement Plan of Existing SPC

In case of SPC, it can be supposed that the time of replacement will come up at specific time as same as XB. Besides, relating to ISDN service, some existing SPC shall be modified with the function. If it is difficult to be modified, the SPC shall be changed to other exchanges having ISDN function. In order to resolve that problem, further detailed study will be requested.

Figure 8.2.4-1 expresses the exchange classified about the function and Table 8.2.3-2 and Table 8.2.3-4 show the replacement plan of existing SPC based on service life.

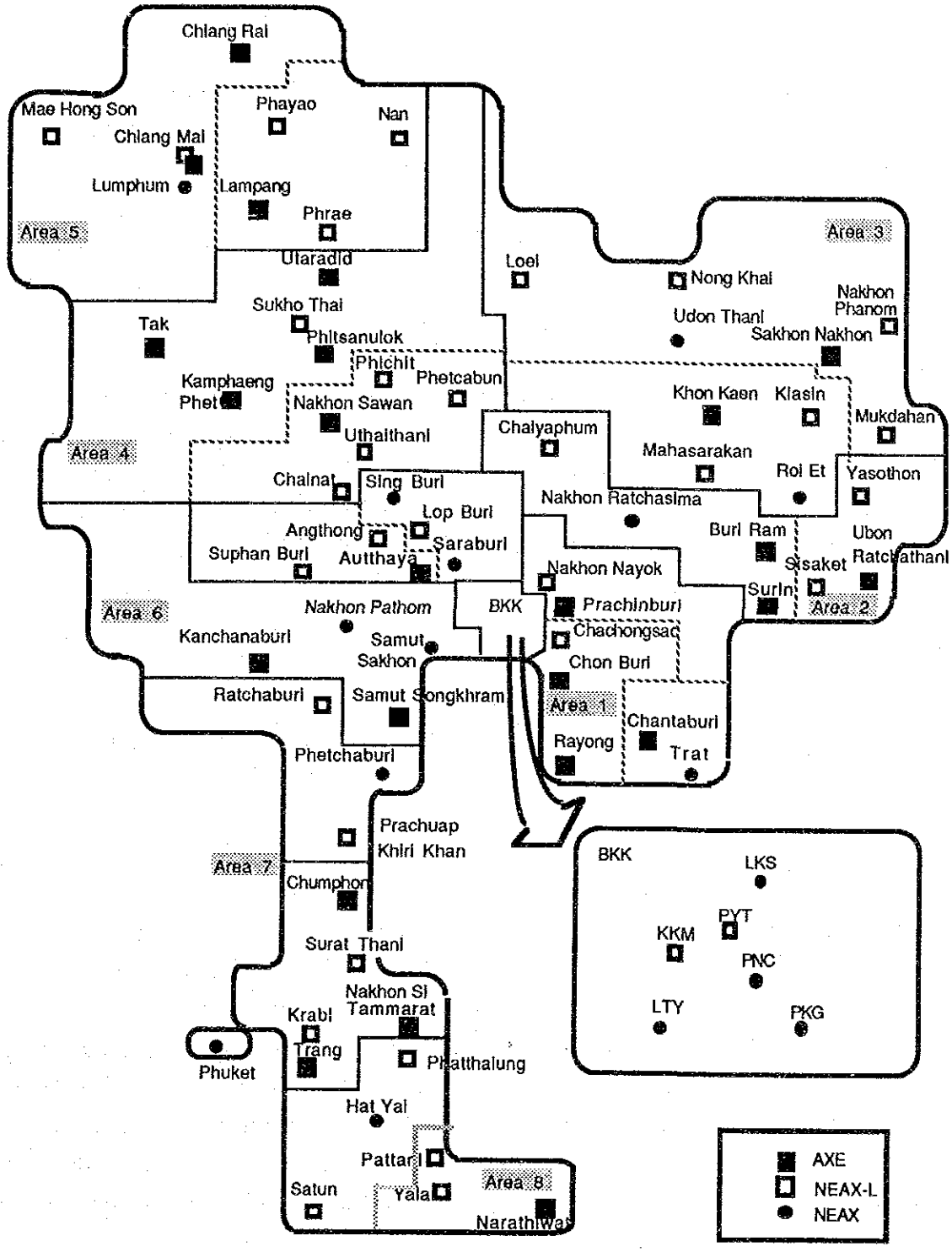


Figure 8.2.4-1 State of Exchange

8.2.5 Management of Floor Plan for Exchange

In future, many new kinds of equipment for introducing new services, not to mention ordinary telephone switching equipment for meeting ever-increasing demand, will be installed much more than present state in every exchanges.

Therefore, the present floor occupation condition must always be grasped to be able to make up a precise future floor plan of building for exchange at any time, so that unreasonable investment can be avoided as much as possible.

As a measure for floor space shortage of exchange room, to construct a new building may rather be a straightforward way. It will, however, need a large amount of investment cost and management expenses for the building and additional workers. Besides, a problem of excessive fixed property will occur because an exchange will be improved to a smaller size for the same capacity, and maintenance method of exchange will be concentrated. Even if many buildings seem to be needed, each case should be re-examined to minimize new building construction.

TOT has planned to replace XB with SPC at Paholyotin telephone office in the fifth ESDP, and there may be the other similar situations as this case especially in Bangkok metropolitan area.

In this section, a management procedure to carry out effective facility plan, avoiding new building construction as much as possible, is described. Figure 8.2.5-1 shows the procedure of floor plan followed in TOT up to now, and new procedure to be proposed is shown in Figure 8.2.5-2.

By TOT's method, the shortage of floor space can be found out only during the project design period completion. Therefore, if the problem occurs, it is usually difficult to take an appropriate measure because of time shortage. New method, however, improves this point and try to review the floor occupation condition annually on the basis of demand and traffic forecast issued by Engineering Planning Division regardless whether the exchange office is under execution of a project.

In order to grasp the floor occupation condition, this method uses a example as described below.

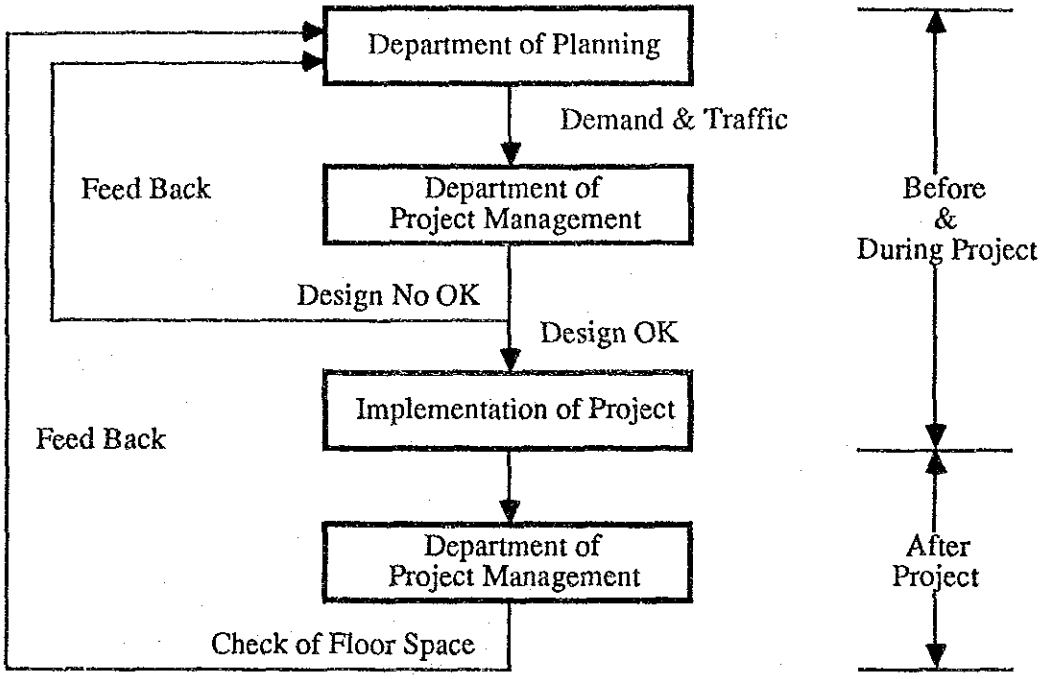


Figure 8.2.5-1 Flow Chart of TOT's Present Procedure

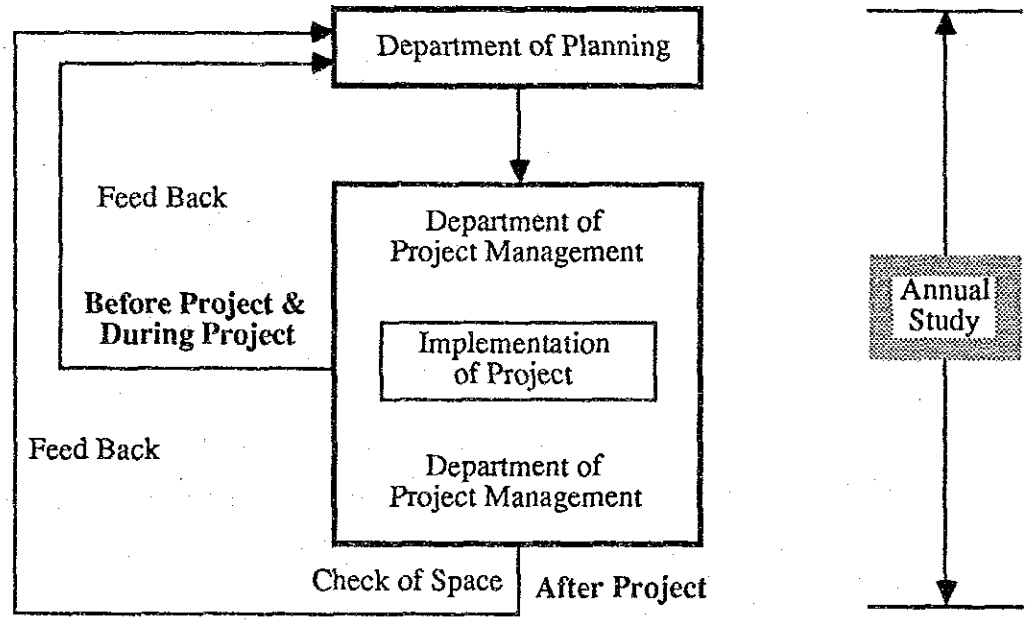


Figure 8.2.5-2 Flow Chart of New Procedure

A telephone office (installed XB and SPC exchanges)

Precondition

- Service life ----------	XB 25 years	SPC 10 years
- Open date ----------	XB Y1979	SPC Y1984
- ISDN function ----------	No	
- Exchange room capacity ----------	XB 10,000	SPC 30,000
- Present line capacity ----------	XB 10,000	SPC 14,000
- MDF capacity ----------	45,000	
- Location of office ----------	Metropolitan area 1	

Figure 8.2.5-3 indicates the transitional situation according to above conditions and demand forecast and Figure 8.2.5-4 also expresses the floor occupation condition. These figures give clear information to be examined as follows;

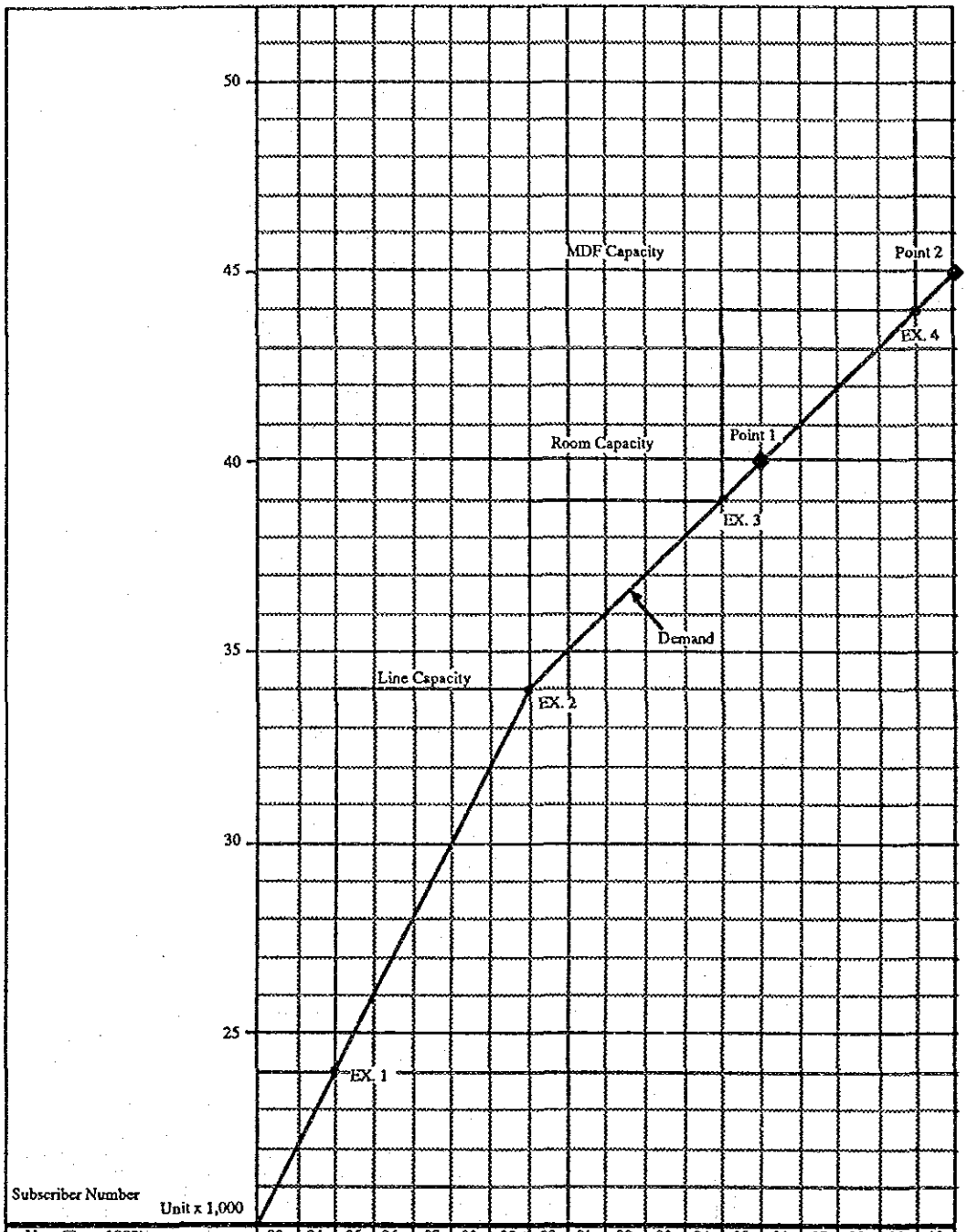
- The shortages of exchange room and MDF capacity will occur about on FY 2004 and FY 2010 (point 1 and point 2 in Figure 8.2.5-3),
- The service life of both exchanges passes on FY 1994 (SPC) and FY 2004 (XB),
- SPC should be given ISDN function at latest on FY 1997 for the full-scale introduction of ISDN service.

Accordingly, when the planner of the project makes a facility plan of switching, he should consider, and make decision on the following matters.

- Replacement of the existing XB exchange (10,000T) with extension of present SPC needs room space in existing SPC room. (If the XB is replaced with RSU, additional room space is not necessary. Which way is more economical is explained in Chapter 8.2.3). Therefore, the provision of extension for existing SPC in FY 1994, will not become 10,000 lines to cope with the demand on the end of seventh project, but less than 6,000 lines.

- For the relief of MDF shortage which will occur in FY 2010, the following matters should be examined, 1) preparation of expansion space, 2) introduction of high density of MDF, 3) possibility of expansion of duct.

How to offer ISDN service because this SPC does not have the function.



Year (From 1993)		93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Demand	x 1,000	22	24	26	28	30	32	34	35	36	37	38	39	40	41	42	43	44	45
ISDN Demand	x 100	1	1	2	3	3	4	4	5	7	9	11	13	15	17	21	23	23	25
Line Capacity	XB	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	SPC	14	24	24	24	24	24	29	29	29	29	34	34	34	34	34	34	39	39
	Expansion		10					5					5					5	
	Total	24	24	34	34	34	34	34	39	39	39	39	39	44	44	44	44	44	49
Expansion Schedule			—					—					—					—	
Project Schedule		7th Project					8th Project					9th Project					10th Project		
Renew Point			SPC					XB											

Figure 8.2.5-3 Demand Forecast and Outside Condition - 1

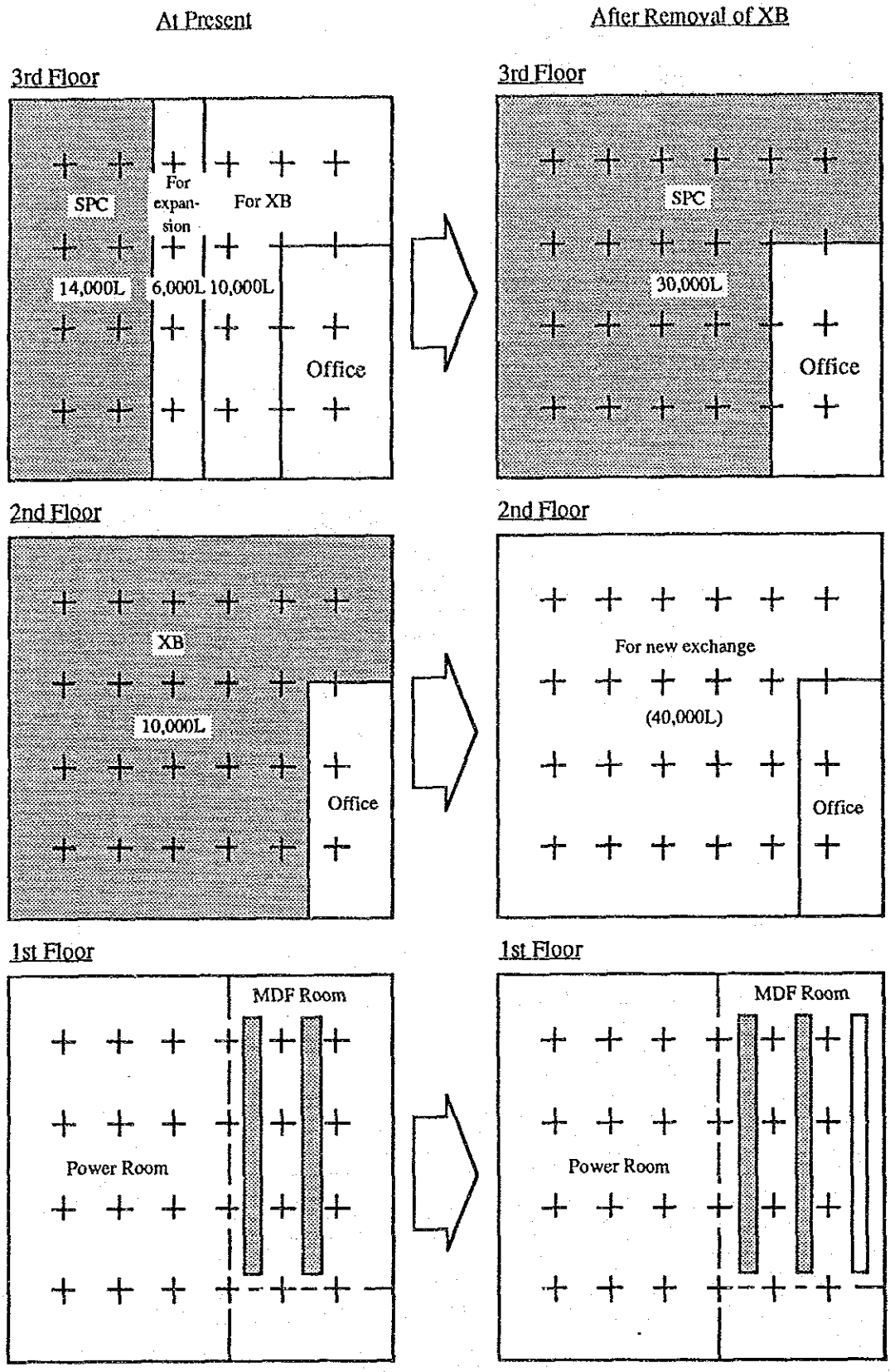


Figure 8.2.5-4 Floor Occupation Condition

Some problems and the resolutions mentioned above are summarized as a time series in Table 8.2.5-1. From this table, the long term plan of A office can be made though it is roughly. Therefore, Figure 8.2.5-3 will be changed to Figure 8.2.5-5 according to Table 8.2.5-1.

The description of up to here, however, is one example of the cases. There seem to be various floor occupation conditions which will be found out by studying whole Kingdom.

In this chapter, only the examination method is described because this study aims at macroscopic plan. The following matters are the points deserving of attention in order to make middle or long term plan;

- Room capacity of exchange, power facility and MDF, and duct capacity,
- Traffic volume of trunking call especially Toll switching system,
- Consumption and Supply of electric power,
- External factor (i.e. ISDN service, replacement plan).

TOT has been examining about replacement plan of exchanges based on service life. In this process, the above points should be taken into consideration.

The planner can estimate the provision and other processes about exchanges by adopting this management method. Besides, if planner keeps a close connection to other division concerned especially procurement division, the project plan will be able to have more flexibility.

Table 8.2.5-1 Situation Summary

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Demand Unit x 1,000	24	24	26	28	30	32	34	35	36	37	38	39	40	41	42	43	44	45
Replace of XB				✦			✧ —											
Replace of SPC		✧ —									✦ —							
Shortage of Room Capacity													✇					
Available Capacity of Exchange Room for SPC					✇													
Shortage of MDF Capacity																		✇
1st Expansion Unit x 1,000		10 (6) ❖																
2nd Expansion Unit x 1,000					(4) ❖		5 ❖											
3rd Expansion Unit x 1,000							(5) ❖					5 ❖						
4th Expansion Unit x 1,000											(5) ❖						5 ❖	
Project Duration	7th Project					8th Project					9th Project					Next Project		

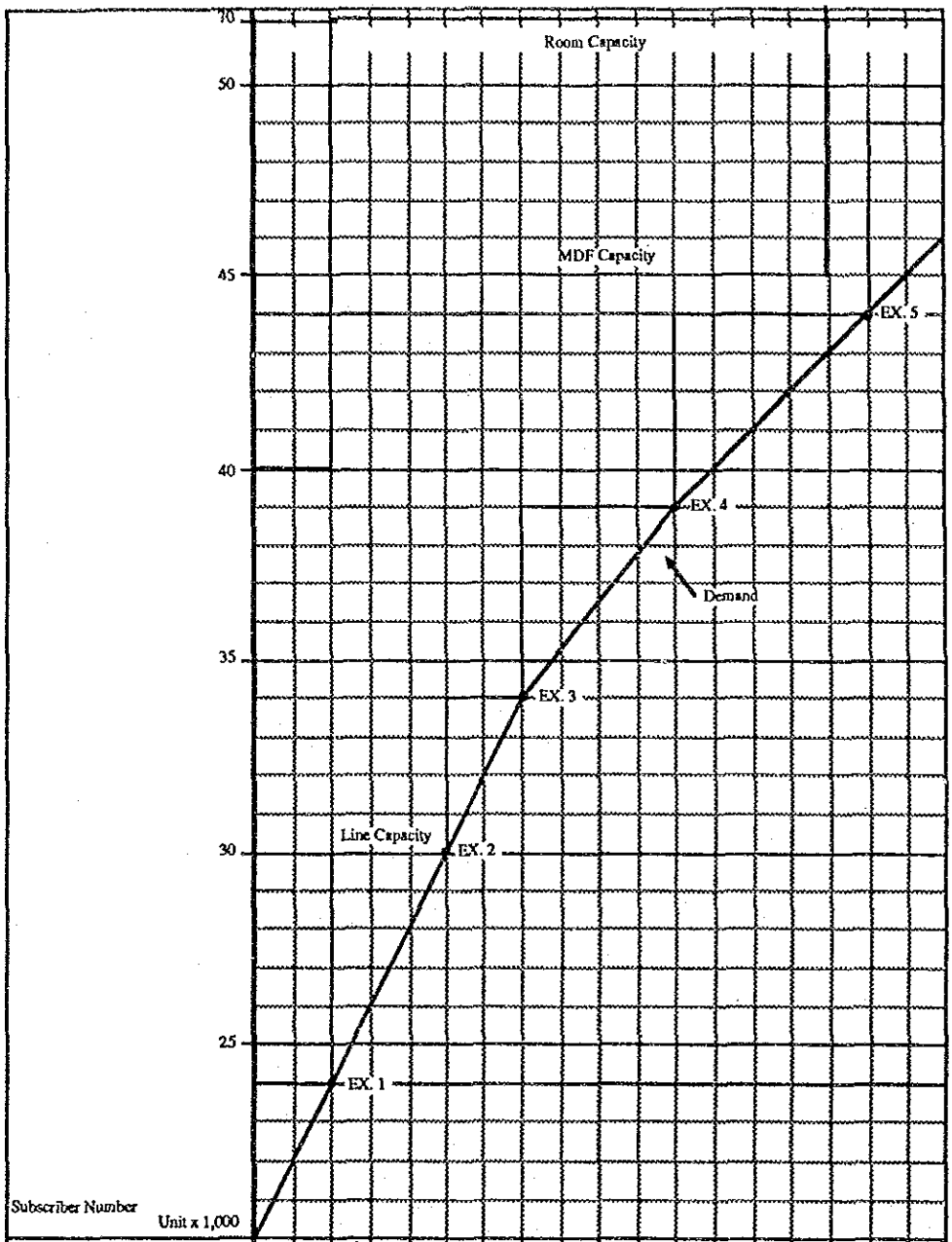
✧ : The beginning time when the exchange can be renewed.

✦ : Execution of replacement

✇ : The occurrence time of shortage

❖ : The time of expansion to be needed. (The design margin period is set at 2 years after completion of the project.)

( ) : After changed schedule



Year (From 1993)		93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Demand	x 1,000	22	24	26	28	30	32	34	35	36	37	38	39	40	41	42	43	44	45
ISDN Demand	x 100	1	1	2	3	3	4	4	5	7	9	11	13	15	17	19	21	23	25
Line Capacity	XB	10	10	10	0														
	Expansion XB				10														
	SPC-1	14	20	20	30	30	30	30	30	30	30	0							
	Expansion SPC-1		6		10							30							
	SPC-2					34	34	39	39	39	39	40	40	40	40	40	40	40	40
	Expansion SPC-2					4		5				1							
	SPC-3					6	6	6	6	9	9	4	4	4	4	4	8	8	8
	Expansion SPC-3					6				3		4						5	
	Total	24	30	30	30	34	34	39	39	39	39	44	44	44	44	44	44	49	49
Expansion Schedule			—		—			—				—						—	
Project Schedule		7th Project					8th Project					9th Project					10th Project		
Replacement Point			XB									SPC							

Figure 8.2.5-5 Demand Forecast and Outside Condition - 2

8.2.6 Network Services

1) Non-ringing Service

a) Summary of Service

This service is for remote inspection of meters such as electricity, gas and water service. Through this service, these meters can be read with the subscriber's line from computer center which is placed at the remote area from the subscriber's house, without ringing the subscriber's telephone.

b) Required Equipments

i) Originating Side

-Exchange	SPC
-Inspection Center	Computer and NCU (Network Control Unit)

ii) Terminating Side

-Exchange	SPC and XB having NRT (Non-ringing Trunk)
-Subscriber	NCU (Network Control Unit)

c) System Configuration

The system configuration is shown in Figure 8.2.6-1.

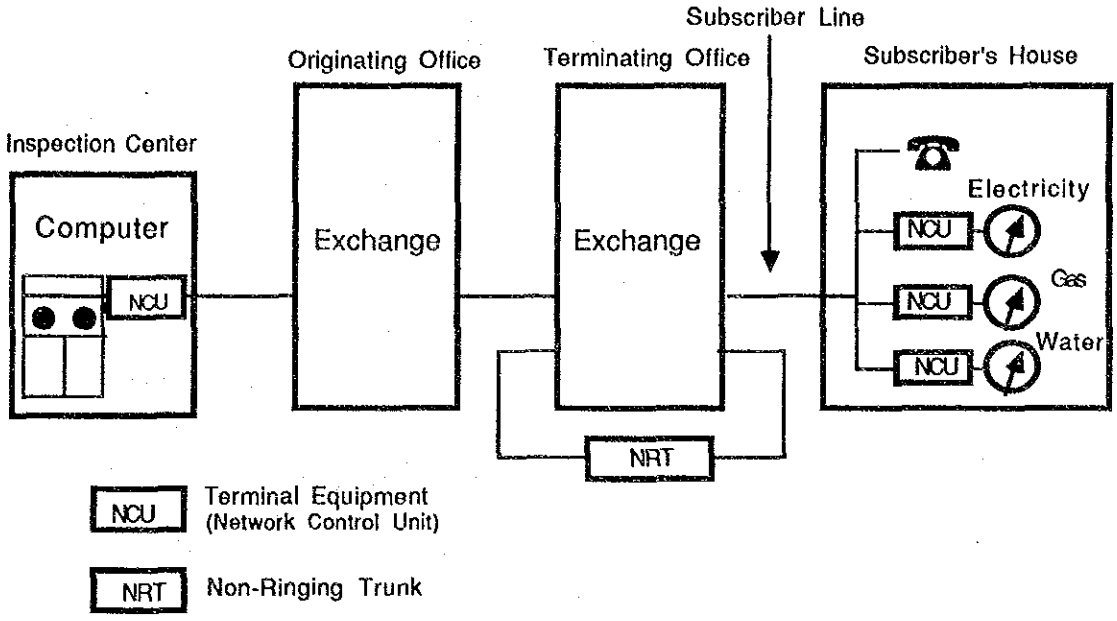


Figure 8.2.6-1 System Configuration for Non-ringing Service

2) Credit Call Service

a) Summary of Service

This service offers to connect to called party without charging meter of the originating telephone. In order to use this service, the subscriber registers the telephone number and secret number to telephone exchange in advance. The charge is put on the registered telephone number. It is convinient for long distance call or when business people are going to call their company from outside.

b) Required Equipments

-Exchange SPC and XB

c) System Configuration

The system configuration is shown in Figure 8.2.6-2.

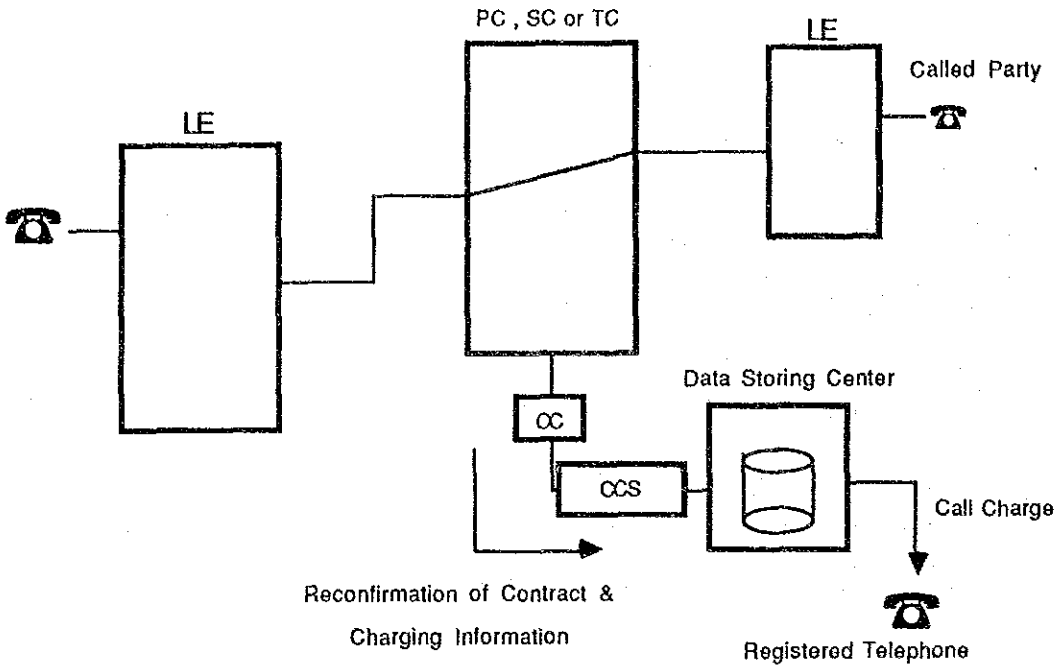


Figure 8.2.6-2 System Configuration for Credit Call Service

8.3 Transmission Facilities

8.3.1 General

Terrestrial transmission systems, which compose the domestic telecommunication network, are classified as follows :

- Long distance transmission system: Terrestrial transmission systems to link PC-PC, PC-SC, PC-TC, SC-SC and TC-TC.
- Spur route transmission system: Terrestrial transmission systems to link a switching facility to the other facilities in PC area except Metropolitan area.
- Metropolitan junction transmission system: Terrestrial transmission systems to link a switching facility to the other switching facilities in Metropolitan area.

For satellite communication system, introduction and expansion plans are also included in this transmission facility plan, from the viewpoints of network reliability enhancement and diversification of services.

These plans were formulated on the basis of the strategies described in Chapter 5 as shown in Figure 8.3.1.

8.3.2 Long Distance Transmission System

Proposed plans of long distance transmission systems for the telephones in the period from 1993 to 2007 are shown in Figure 8.3.2-1, Figure 8.3.2-2 and Figure 8.3.2-3. Detail configuration of long distance transmission network is shown in Appendix.
The main objectives of these plans are as follows ;

Phase-1: To link all PCs by digital transmission systems, and to connect a big SC(Chiang Mai) to Bangkok with duplicated transmission routes.

Phase-2: To enhance reliability of the telecommunication network, by connecting all SCs with duplicated routes.

Phase-3: To link all TCs, SCs, and PCs with duplicated routes.

Contents of expansion facilities mentioned above are shown in Table 8.3.2-1 and the detail of them are as follows ;

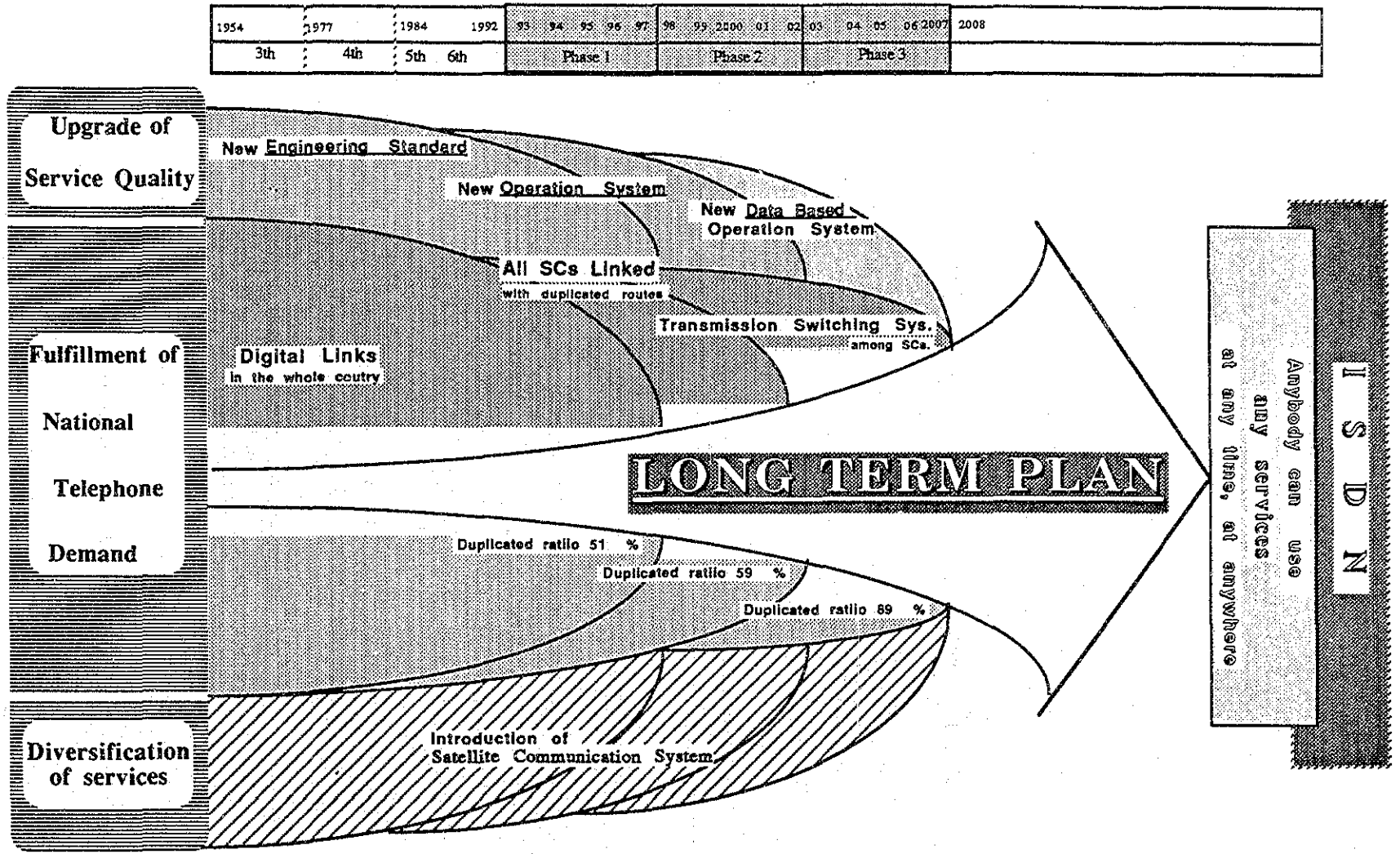


Figure 8.3.1 Summary of Expansion Plan

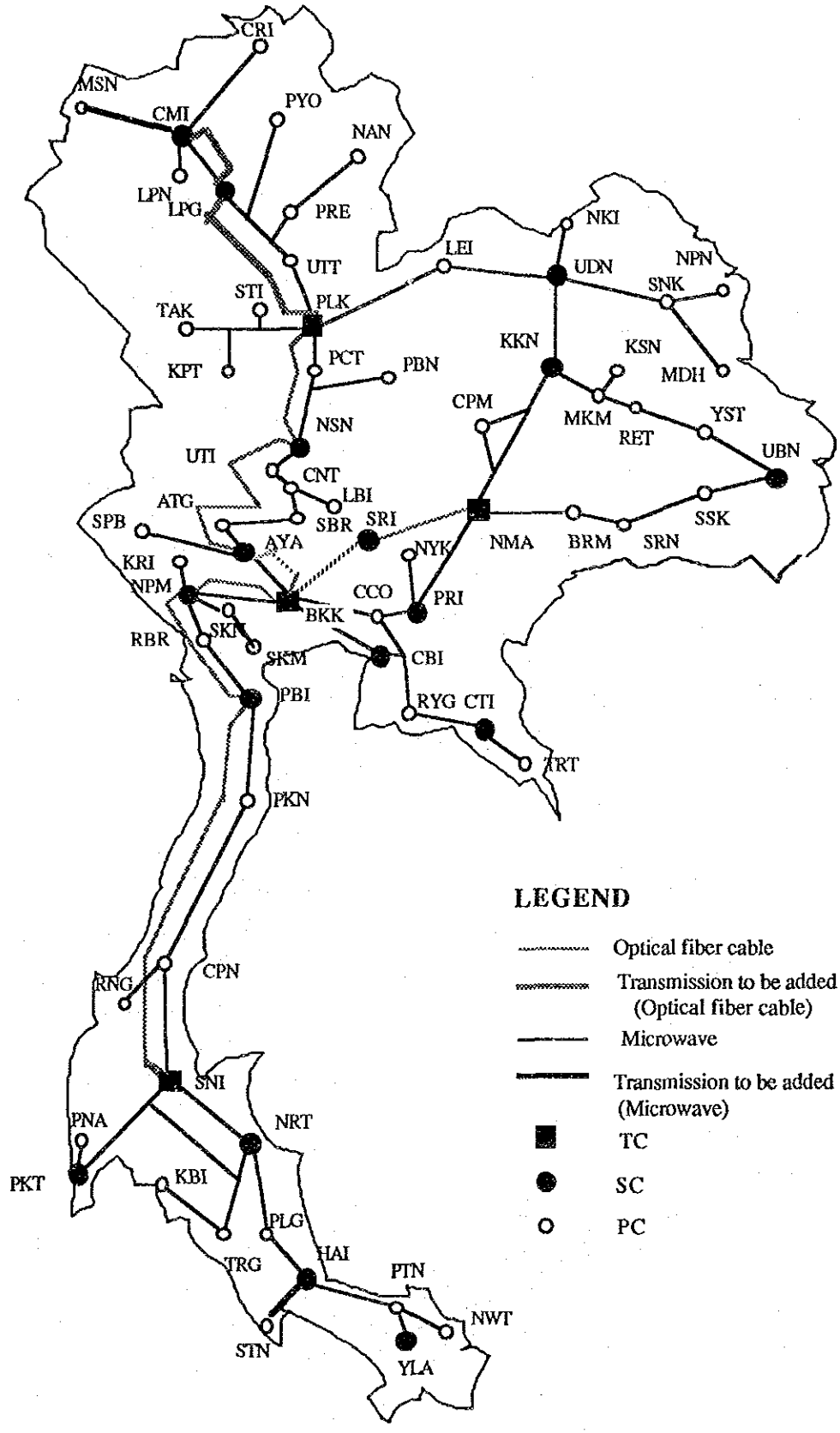


Figure 8.3.2-1 Long Distance Digital Transmission Layout (End of 1997)

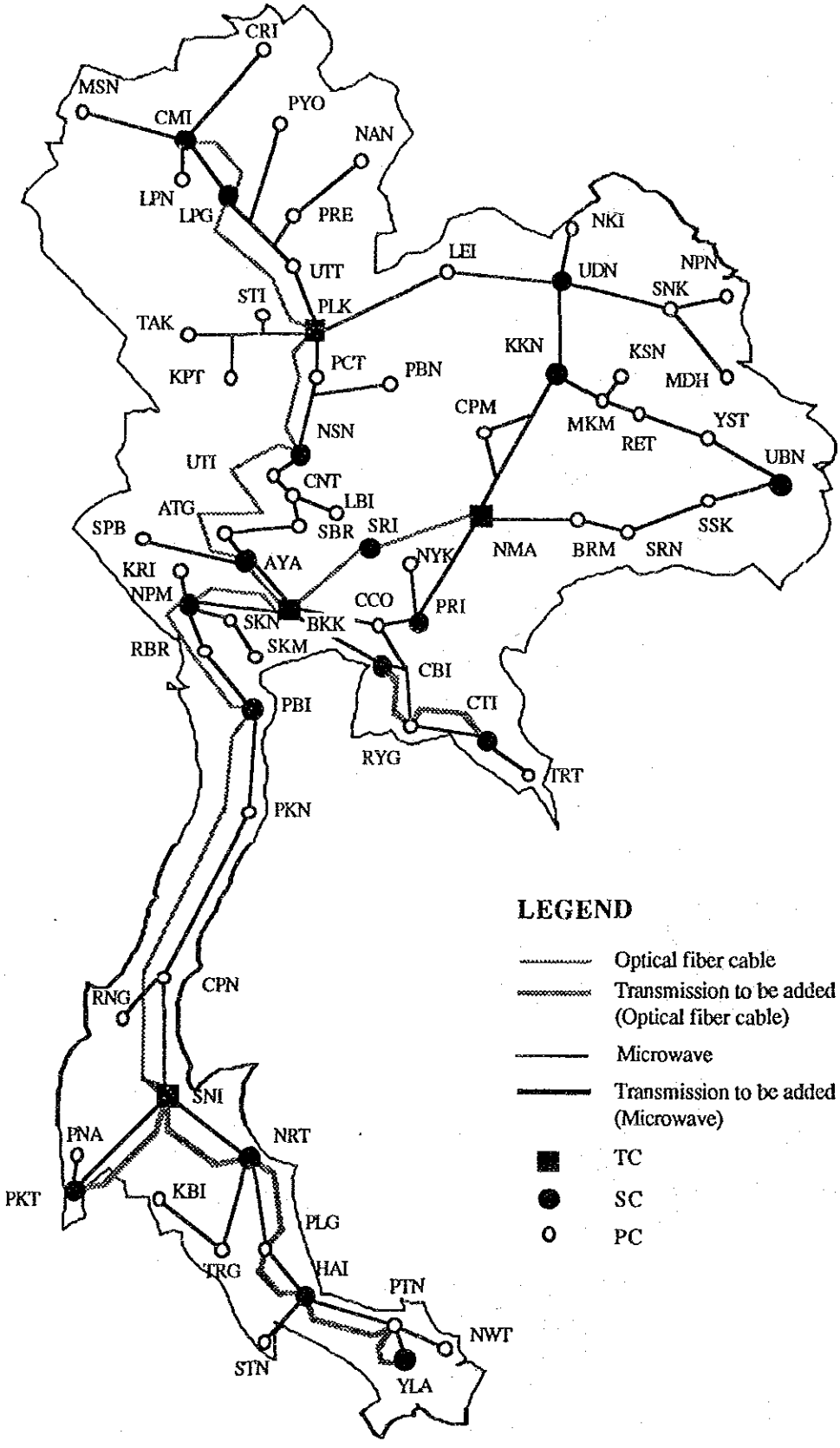


Figure 8.3.2-2 Long Distance Digital Transmission Layout (End of 2002)

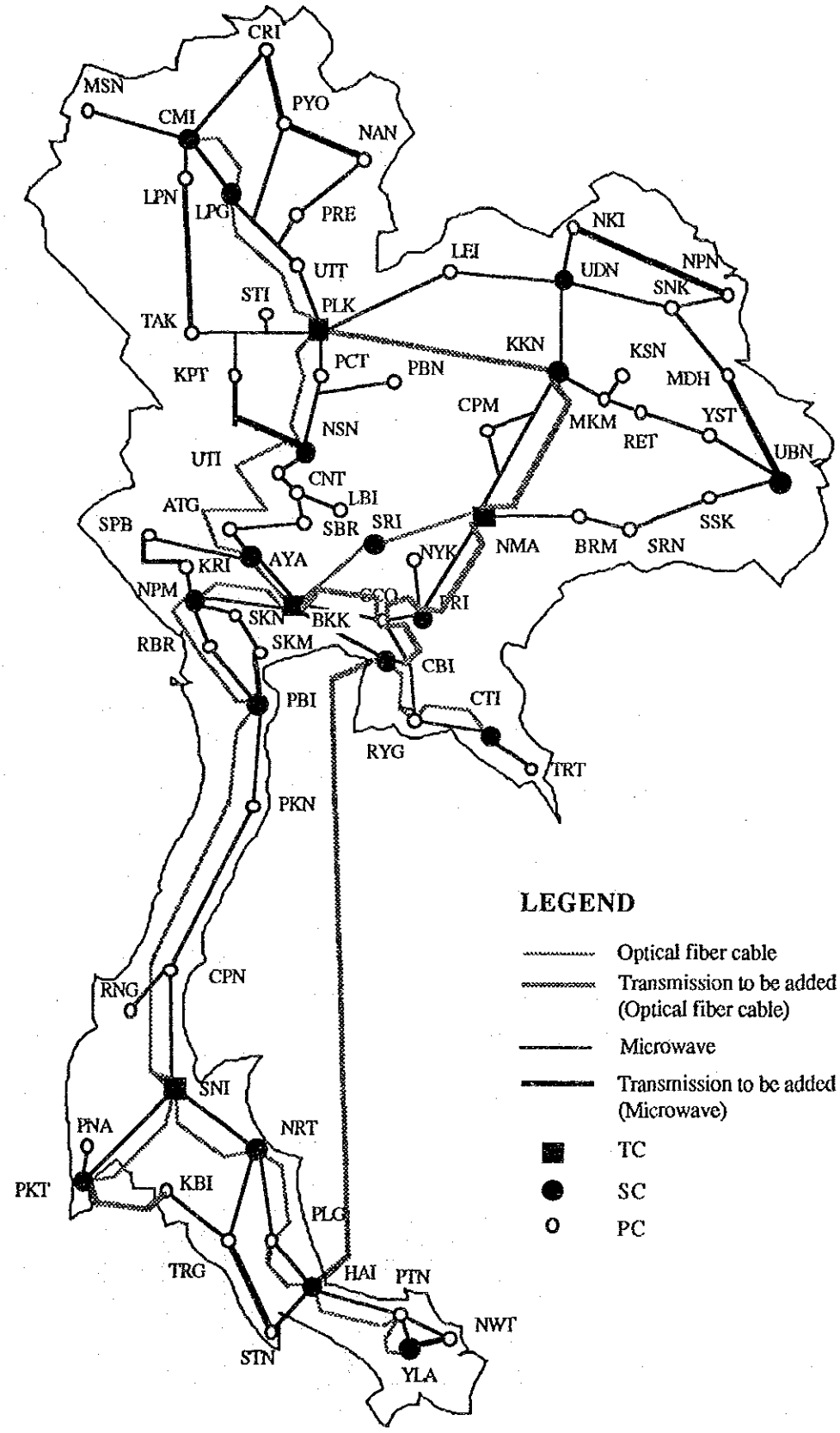


Figure 8.3.2-3 Digital Transmission Layout (End of 2007)

Table 8.3.2-1 Long Distance Transmission Facilities Expansion Plan

System	Installation or Expansion	Capacity (Mb/s)	Number of Span	Number of Systems (Unit)				Number of Repeater	Distance (km)
				Phase-1	Phase-2	Phase-3	Total		
Radio	Installation	140	1			2	2	2	84
Radio	Installation	68	4	2		6	8	15	493
Radio	Installation	34	6	4		8	12	14	698
Sub Total			11	6		16	22	31	1,275
Radio	Expansion	140	34	29	34		63	150	3,739
Radio	Expansion	68	10	8	8	2	18	41	867
Radio	Expansion	34	7			7	7	21	725
Sub Total			51	37	42	9	88	212	5,331
Total			62	43	42	25	110	243	6,606
Fiber	Installation	565	13	4	10	12	26	63	1,815
Fiber	Installation	280	1			2	2		650
Fiber	Installation	140	1		2		2	6	159
Fiber	Installation	68	1			2	2	5	60
Sub Total			16	4	12	16	32	74	2,684
Fiber	Expansion	565	14		14		14	41	1,194
Sub Total			14		14		14	41	1,194
Total			30	4	26	16	46	115	3,878
Grand Total			92	47	68	41	156	358	10,484
Multiplexer	Expansion	140		79	25	54	108		
		34		40	39	40	119		
		8		44	53	44	141		

1) To Link All PCs by Digital Transmission Systems

Two PCs, which are Mae Hong Son and Satun, are still linked to other PCs by analog transmission systems at the end of 1992. For this, digital microwave routes will be planned to connect all PCs with digital transmission systems in Phase-1. The contents of installation routes are shown in Table 8.3.2-2.

Table 8.3.2-2 The Installation Routes

Section	Distance (km)	System	Capacity (Mb/s)	No. of Systems
HYI-STN	67.0	Microwave	34	2
CMI-MSN	156.8	Microwave	34	2
PLK-LPG	203.5	Fiber	565	2
LPG-CMI	100.8	Fiber	565	2
Total	528.1			8

2) To Enhance Reliability of the Network

a) To Connect a Big City to Bangkok with Double Routes

The second digital transmission systems will be installed to connect Chiang Mai to Bangkok in Phase-1 as shown in Figure 8.3.2-1. It is an optical fiber cable system from Phitsanulok to Chiang Mai via Lampang. The content is shown in Table 8.3.2-2.

b) To Enhance Reliability of the Network Link among All of the SCs & TCs

First of all, the transmission systems will be installed for completing looped or duplicated transmission routes among all of the SCs and TCs. In addition to this program, the digital transmission switching system will be introduced to relieve the circuits connecting among the SCs and TCs. They are planned in Phase-2.

For this, many routes are planned as shown in Figure 8.3.2-2, and the contents are shown in Table 8.3.2-3

Table 8.3.2-3 The Installation Routes

Section	Distance (Km)	System	Capacity (Mb/s)	No. of Systems
CBI-RYG	60.2	Fiber	565	2
RYG-CTI	102.0	Fiber	565	2
SNI-PKT	159.0	Fiber	140	2
SNI-NRT	142.0	Fiber	565	2
NRT-HYI	190.0	Fiber	565	2
HYI-YLA	128.0	Fiber	565	2
Total	781.2			12

c) To Enhance Reliability of Telecommunication Network Link among All of PCs

The transmission systems will be installed for completing looped or duplicated transmission route among all PCs in Phase-3. The contents of this plan is shown in Table 8.3.2-4.

Table 8.3.2-4 The Installation Routes

Span	Distance (Km)	System	Capacity (Mb/s)	No. of Systems
LPN-TAK	182.0	Microwave	68	2
PKT-KBI	60.0	Fiber	68	2
PYO-NAN	150.0	Microwave	140	2
CRI-PYO	84.5	Microwave	140	2
KPT-NSN	105.5	Microwave	68	2
SPB-KRI	55.0	Microwave	68	2
NKI-NPN	297.0	Microwave	34	2
TRG-STN	136.0	Microwave	34	2
YLA-NWT	80.0	Microwave	34	2
SKM-PBI	28.0	Microwave	34	2
MDH-UBN	150.0	Microwave	68	2
Total	1328.0			22

Circuits connecting 8 PCs, which are impossible to connect the other PCs through looped or duplicated routes in this plan, are to be relieved by the transportable satellite stations, which will be located at each TC as described in the section 8.3.5.

8.3.3 Spur Route Transmission Systems

At the end of 1992, there are several hundred switching facilities in the country, which are connected to the other switching facilities in the same PC area with PCM-30 systems, optical fiber systems and radio links.

They will increase with about 6 million subscribers by the year of 2007. Therefore, expansion plan of spur route transmission system should be also expanded in according to number of subscribers. The contents of expansion facilities for the plan are shown in Table 8.3.3-1.

Table 8.3.3-1 Spur Route Transmission Facilities Expansion Plan

Optical Fiber	140 Mb/s	30 span	30 system
	34 Mb/s	70 span	70 system
Radio	34 Mb/s	70 span	70 system
Mutiplexer	140 Mb/s		60 units
	34 Mb/s		140 units
	8 Mb/s		2,000 units