

**A MASTER PLAN STUDY
ON
TELECOMMUNICATIONS DEVELOPMENT
IN
THE KINGDOM OF THAILAND
SUMMARY AND PROPOSALS**

DECEMBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

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

JICA sent to Thailand a survey team headed by Mr. Takao Iwashimizu, NTT International Corporation from October to December, 1988 and from March to June, 1989.

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

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

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

December, 1989



Kensuke Yanagiya

President

Japan International Cooperation Agency

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List of Abbreviations (in alphabetical order)

ASEAN	Association of South-East Asian Nations
ATM	Automatic Teller Machine
ATM	A synchronous Transfer Mode
B-ISDN	Broadband aspects of ISDN
BMA	Bangkok Metropolitan Telecommunication Area
BMR	Bangkok Metropolitan Region
BOI	Board of Investment
BPI	Bit Per Inch
b/s	bit per second
CAT	Communications Authority of Thailand
CATV	Cable Television
CCIR	Comité Consultatif International de Radio-Communications
CCITT	Comité Consultatif International de Télégraphique et Téléphonique
CCS	Common Channel Signalling System
CDAS	Computerized Directory Assistance System
CR	Calling Rate
DN	Destination Network Code
DSU	Digital Service Unit
DTI	Digital Transmission Interface
EGAT	Electricity Generating Authority of Thailand
EIRR	Economic Internal Rate of Return
ESDP	Economic and Social Development Plan
ESP	Eastern Seaboard Development Program
FAX	Facsimile
FD	Floppy Disk
FDM	Frequency Division Multiplex
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GDP	Gross Domestic Product
GNP	Gross National Product
GPP	Gross Provincial Product
GRP	Gross Region Product
IBRD	International Bank for Reconstruction and Development
ISD	International Subscriber Dialling

ISDN	Integrated Services Digital Network
ITSC	International Transit Switching Center
ITU	International Telecommunication Union
JICA	Japan International Cooperation Agency
LAN	Local Area Network
LE	Local Exchange
MHS	Message Handling Systems
MS	Mobile Station as Cellular Mobile System
MT	Magnetic Tape
MTX	Mobile Telephone Exchange
MUX	Multiplexer
NCC	New Common Carrier
NDC	National Destination Code
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plans
NIEs	Newly Industrializing Economies
NT	Network Termination
OA	Office Automation
OECF	The Overseas Economic Cooperation Fund
OJT	On the Job Training
OM	Operation and Maintenance
P(A)BX	Private (Automatic) Branch Exchange
PC	Primary Center
PCM	Pulse Code Modulation
PRD	Public Relations Department
PSTN	Public Switched Telephone Network
QC	Quality Control
RBS	Radio Base Station as Cellular Mobile System
RS(L)U	Remote Subscriber (Local) Unit
RT	Remote Terminal
SC	Secondary Center
SEP	Signal End Point
SPC	Stored Program Control
STD	Subscriber Trunk Dialling
STP	Signal Transfer Point
TA	Terminal Adaptor
TC	Tertiary Center

TDMA	Time Division Multiple Access
TE	Terminal Equipment
TOT	Telephone Organization of Thailand
XB	Crossbar

CHAPTER 1. INTRODUCTION

1.1 Composition of the Study Report

This report consists of three volumes as follows:

- Volume-I: Summary and Proposals
- Volume-II: Main Text,
- Volume-III: Appendix.

This part is the volume-I, Summary and Proposals, composed of summarization of the important descriptions, illustrations and some proposals extracted from the Main Text.

1.2 Purpose of the Study

This study was made by the Japan International Cooperation Agency (JICA) during the period from September 1988 to November 1989, aiming at formulating a long term telecommunication development plan for the period from FY 1993 to FY 2007 in Thailand (hereinafter referred to as "the Master Plan").

1.3 Main Features of the Study

Main features of the study are as follows:

- 1) Review and examination of the present circumstances of telecommunications and presenting perspectives of the future socio-economics and telecommunications,
- 2) Telephone subscription demand forecast by means of potential demand approach and expressed demand approach, with demand forecast of some other telecommunication services,
- 3) Setting forth of objectives and strategies for the Master Plan taking the matters in the previous items 1) and 2) into consideration,
- 4) Telecommunication traffic forecast of PC-PC traffic Matrix for the whole country and LE-LE traffic matrix for the Metropolitan area,
- 5) Making some suggestions on the future fundamental network plan and formulating facility expansion plan up to the year 2007 taking introduction of ISDN and some new services into consideration,

- 6) Performing financial and economic analysis to estimate FIRR and EIRR of the Master Plan and also to examine about the impact of the Master Plan on the socio-economic development in Thailand,
- 7) Diagnosis of present financial and human resource managements of TOT and some proposals for future improvement of the management,
- 8) Illustrating guidelines of implementation of the Master Plan, including some suggestions for upgrade of service qualities and traffic promotion activities.

Formulating procedure of the Mater Plan is illustrated in Figure 1.3.

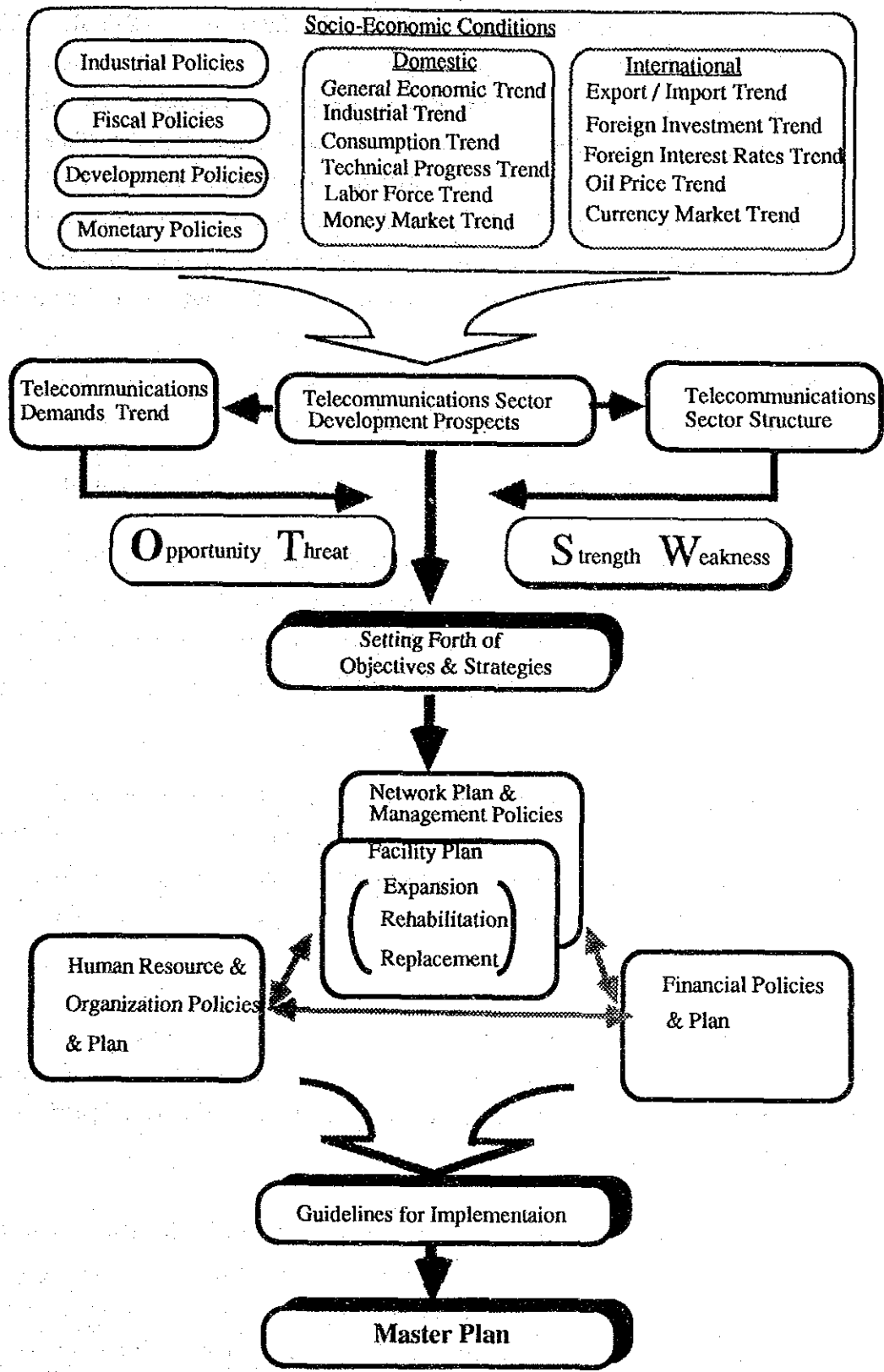


Figure 1.3 Formulating Procedure of The Master Plan

CHAPTER 2. PRESENT STATE OF TELECOMMUNICATIONS IN THAILAND

Section 2.1 outlines and discusses the socio-economic situations and problems during the periods of the past six National Economic and Social Development Plans (NESDP) as reference materials to analyze "Opportunities and Threats for development" discussed in Chapter 3. Sections 2.2, 2.3, 2.4 and 2.5 will analyze the present situations of telecommunications facilities, services and management of the operating entity, and telecommunication areas of Thailand to point out "Strength and Weakness" of the telecommunications sector.

2.1 Past and Present Socio-Economic Situations

The major socio-economic trends and issues are summarized as follows:

- 1) Economic development of Thailand started in the later part of the 1960's and reached a nation-wide and sector-wide development phase in the 1970's. Production expansion in the agricultural sector led the development at first, and then gradual and rapid industrialization followed in the 1970's. The manufacturing sector took over the leading role of development in the 1980's.
- 2) However, the change of the industrial structure caused little structural change in the labor market. The agricultural sector grew not by increase in land productivity but by expansion of farming land and product diversification. This caused little employment structural change. More than 70% of the labor force were still employed in the agricultural sector in the 1980's.
- 3) The forest area shrunk to only 30% of the country because of expansion of farming land. Rapid expansion of farming land and delayed efforts to maintain the forest area caused frequent floods and other environment problems and prevented land productivity from being improved.
- 4) Export items were primarily agricultural products in the 1960's and the 1970's. Thailand exported mainly just rice and rubber in the 1960's but succeeded in diversifying the export products such as maize, cassava, sugar cane, and pineapples. Thailand started to export more and more manufactured products in the late 1970's. Manufactured exports shared more than 50% of all exports in 1985. Major manufactured exports are textile and apparel, canned and processed food, light manufactured products such as jewelries and integrated circuits.

5) Although consumption goods, especially non-durable consumption goods, were major import items in the 1960's, imports of raw materials and capital goods increased while the import share of non-durable consumption goods increased as the policy change from the import substitute strategy to export oriented strategy was emphasized more.

6) In the early 80's, imbalances of three macro-economic factors, i.e., investment and savings, government revenue and expenditure, and import and export, became serious. The Thai government took a conservative fiscal position in order to restrain the speed of development. As a result, in 1984, the Thai economy experienced a severe recession. Although the accumulation of external debt was avoided, advancement of industrialization was slowed down due to decrease of both public and private investment. The development strategies in Thailand has been formulated to promote further industrialization within a given level of external debt ceiling since then.

7) After the Plaza Agreement in September 1985, several favorable external conditions such as depreciation of US dollars, fall of oil price and interest rates, and rising manufacturing costs in Japan and the Asian Newly Industrializing Economies (NIEs) emerged and helped the Thai manufactured exports. The trade imbalance has been improved and the fiscal deficit has been narrowed.

8) Thailand seems to have been going through major economic structural changes. The recent trend in the surge of manufactured exports and the stagnation of the traditional agricultural sector pictures the manufacturing sector as the present major force behind the future economic development. The recent economic success has created an impression that Thailand may be on the verge to be the fifth Asian Newly Industrializing Economy.

9) Industrialization in Thailand started for the purpose of import substitution of consumption goods in the 1960's. This created a mass concentration of industries in infrastructure rich and consumer concentrated Bangkok as a market of mass consumption. As a result, disparities of growth rates and income levels among regions and sectors became serious problems.

10) These disparities will widen more in the future because the traditional agricultural sector located in the outside of the Bangkok Metropolitan Region (BMR) is and will be in stagnation and the economically successful non-agricultural sectors are mainly located in the BMR although the government has been trying to relocate factories in Bangkok to provincial areas.

11) To solve the problems emerged during the Fifth NESDP period, the Sixth NESDP was started in 1987. The Eastern Seaboard Development Program is one of the highest priority development project. The effort to develop the Eastern Seaboard indicates a strategy of development of the surrounding areas of the BMR and decentralization of industries.

12) There are already several industrial parks in Thailand. Most of them are, however, located in the BMR. There are several plans for development of industrial parks in the provincial areas.

13) The most important problem for the future economic expansion is the state of infrastructure. After several years of cutbacks in public investment programs, the present state of infrastructure is not adequate to support the recent unexpected rapid economic expansion caused by increased manufactured exports and direct foreign investments. Bottlenecks are emerging in ports, energy, industrial water supply, transportation, and telecommunications.

14) The Thai economy faces many problems such as rise of protectionism in developed countries, low labor workers employment capability of the manufacturing sector, shortage of skilled workers, professionals, and engineers.

15) Advancement of industrialization may be halted because of entry barriers into markets of developed countries.

16) The overall labor supply situation in Thailand appears to be quickly heading toward a shortage, especially for skilled workers and professionals, perhaps within several years if the current pattern of economic growth continues. Labor shortage will not only stifle economic growth but also increase labor price and cause inflation.

17) In order for Thailand to continue its rapid growth, the government has to promote policies to establish higher autonomy and stronger sustainability in the Thai economy. To do so, it may have to consider increasing flexibility and competitiveness and at the same time reducing some major constraints which have hindered the economic growth in the past. The following are some urgently necessary policies:

- To increase technological capabilities of the Thai manufacturers through public efforts on research and development, encouraging people to take science and engineering education, and technical transfer.

- To develop a wide range of efficient and reliable subcontractors and supporting industries which can supply Thai-made parts and intermediate materials for export orienting foreign and domestic firms.
- To develop rural industries which can spread the benefits of economic development to rural areas and to expand the size of the domestic market.
- To develop industries with comparative advantages in international industrial specialization and with competitive advantages in international markets.
- To develop desirable industries for the socio-economic development of Thailand.
- To develop infrastructure, to raise the operating efficiency and the quality of services of the state enterprises under the constraint of keeping conservative fiscal stance not to create inflationary pressure.
- To review the tax system to increase the tax revenue and improve the fiscal condition.
- To promote financial liberalization to increase private savings and to efficiently utilize foreign capital.
- To simplify import tariff, to reduce corporate tax rates, to create export incentives, to legislate local contents regulations on usage of Thai made parts and intermediate materials.
- To develop human resources and to improve compensation systems for workers.

2.2 Present State of Telecommunication Services in Thailand

At present, the telecommunication services in Thailand are provided by TOT and CAT. The existing classification of each service is shown in Table 2.2-1. This table describes just the present state and does not prescribe the future state of telecommunication services.

Table 2.2-1 Structure and Territory of Telecommunication Services in Aug.1989

Telecommunication Services			Domestic		International	
			TOT	CAT	TOT	CAT
Telephone (Voice) Communication	Ordinary Telephone	Call Service	S		S	S
		Network Service	S			
		Terminal Connection e.g. Facsimile Terminal, Data Terminal etc.	S			
	Public Telephone	Coin (Local)	S			
		Coin (STD)	S			
		Pre-paid Card	P			
	Radio & Mobile Telephone	Radio Telephone	S	S		
		Radio Mobile Telephone	S	S		
		Cellular Mobile Tel.	S	S		
		Train Telephone	P	S		
Maritime Telephone		P	S			
	Airplane Telephone	P	P			
	Paging Station	P	S			
Leased Circuit	Voice Grade		S	S		S
	Telex Access Line as Local Cable		S	S		
	Teletype & Telegraph		S	S		S
	Broadcast Program Transmission		S	S		S
	Data Transmission		S	S		S
Data Communication	DATEL (Specified Data Transmission)					S
	IDAR (International Database Access)					S
	Packet Switched Data Network			S		S
	MHS (Message Handling Systems)			S		S
Recorded Communication	Telegram			S		S
	Telex			S		S
	Teletex (Super Telex)			S		S
	Photo-Telegraph			S		S
	Bureau Facsimile			S		S
Video Communication	Videotex		P			
	Video Conference		P			

Legend: **S**: In service
P: Planning (Under study)

Note: This table describes the present state as of Aug. 1989 and does not prescribe the future state of telecommunication services.

Among the whole telecommunication services, the telephone service is the most fundamental service. The annual development of the ordinary telephone service is shown in Table 2.2-2 and Figure 2.2.

Table 2.2-2 Telephone Service Development

Year	1972	1975	1978	1981	1984	1987
Number of Main Telephones	156,839	208,851	295,631	389,238	519,491	901,622
Metropolitan	124,099	161,951	218,820	287,090	361,924	614,707
Provincial	32,740	46,900	76,811	102,148	157,567	286,915
Population (Thousand)	38,359	42,391	45,222	47,875	50,583	53,873
Metropolitan	4,740	5,417	6,030	6,625	6,660	7,338
Provincial	33,619	36,974	39,192	41,250	43,923	46,535
Main Telephones /100 Persons	0.41	0.49	0.65	0.81	1.03	1.67
Metropolitan	2.62	2.99	3.63	4.33	5.43	8.38
Provincial	0.10	0.13	0.20	0.25	0.36	0.62

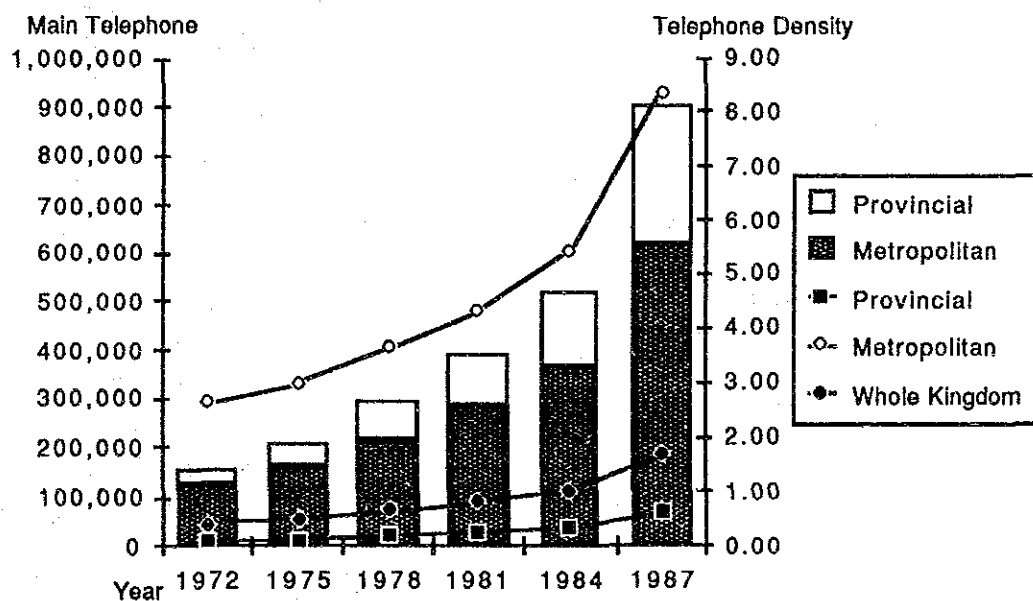


Figure 2.2 Telephone Service Development

2.3 Present State of Telecommunication Facilities

The domestic telecommunication services, in Thailand, are offered through the telecommunication network composed with the network hierarchy and the number of exchanges are as follows;

Tertiary Center	(TC)	7 Exchanges,
Secondary Center	(SC)	17 Exchanges,
Tandem Exchange	(TDM)	10 Exchanges,
Primary Center	(PC)	54 Exchanges,
Local Exchange	(LE)	285 Exchanges.

Note: The figures are at the end of 5 th project

Figure 2.3-1 sows the network hierarchy, and the location of the exchange and the area code is shown in figure 2.3-2. Figure 2.3-3 also shows long digital layout.

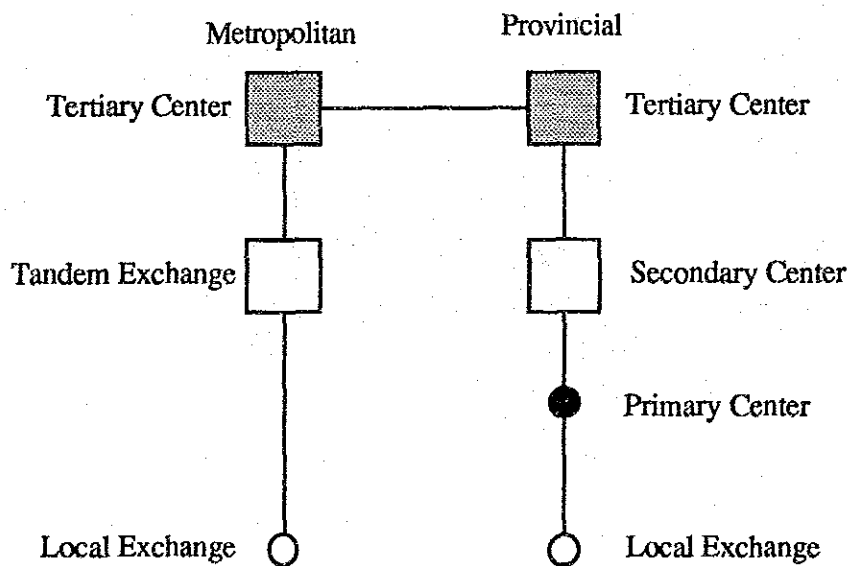


Figure 2.3-1 Exchange Hierarchy

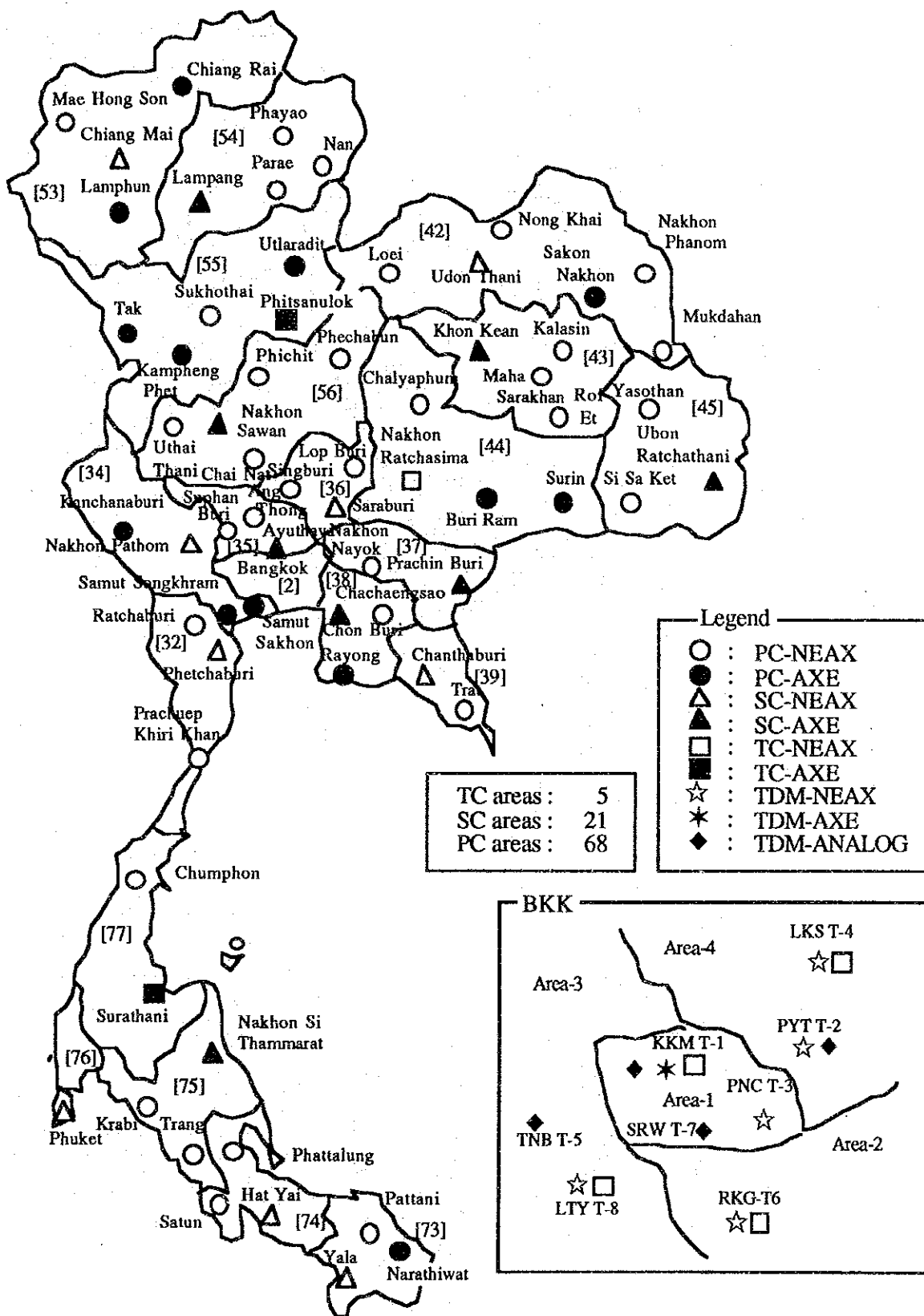


Figure 2.3-2 Location of Exchange and Area Code(FY1992)

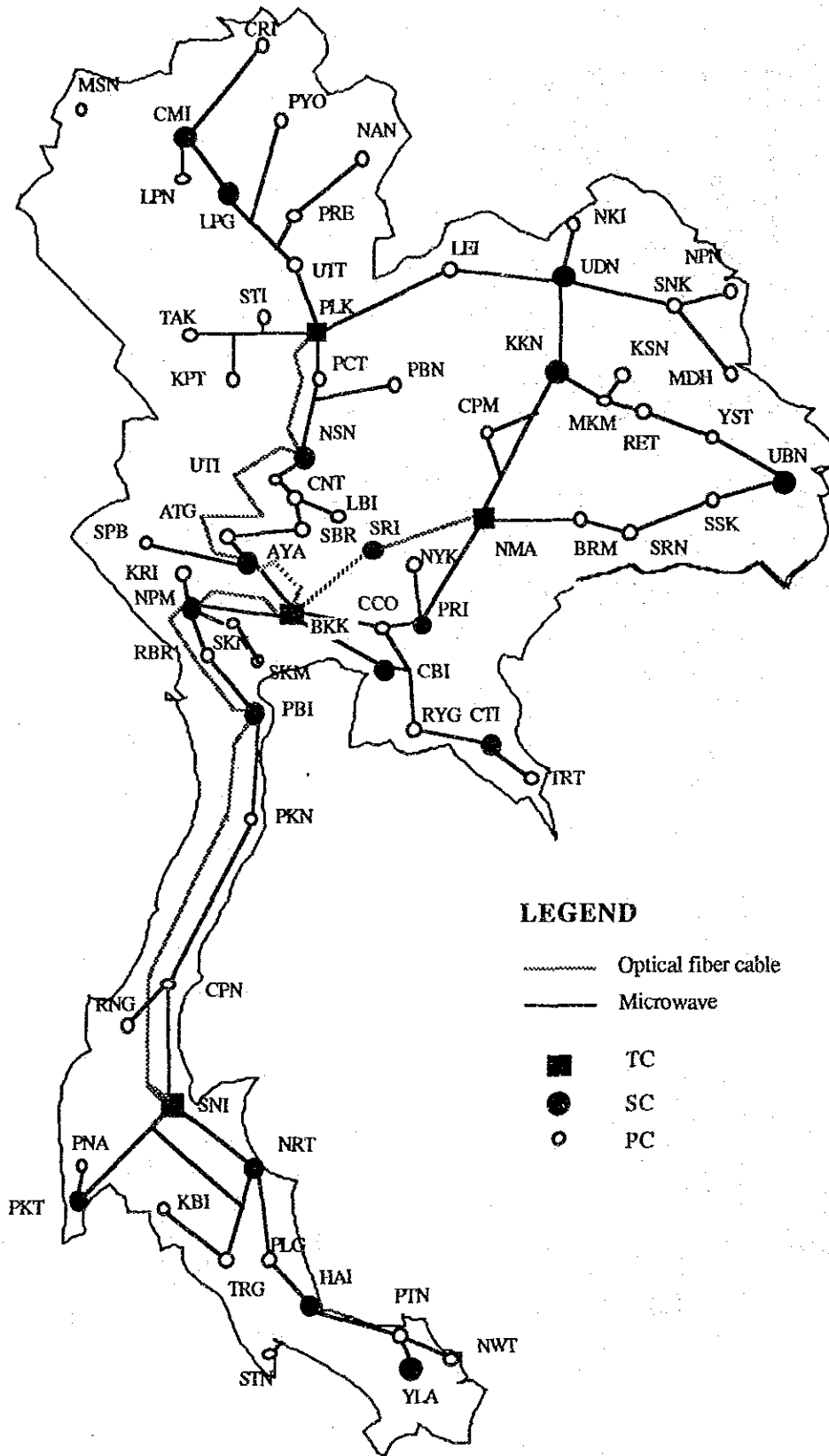


Figure 2.3-3 Long Distance Digital Layout (FY1992)

The development of the number of exchanges for the past five years is shown in Figure 2.3-4, and the development of the number of line capacities is shown in Figure 2.3-5.

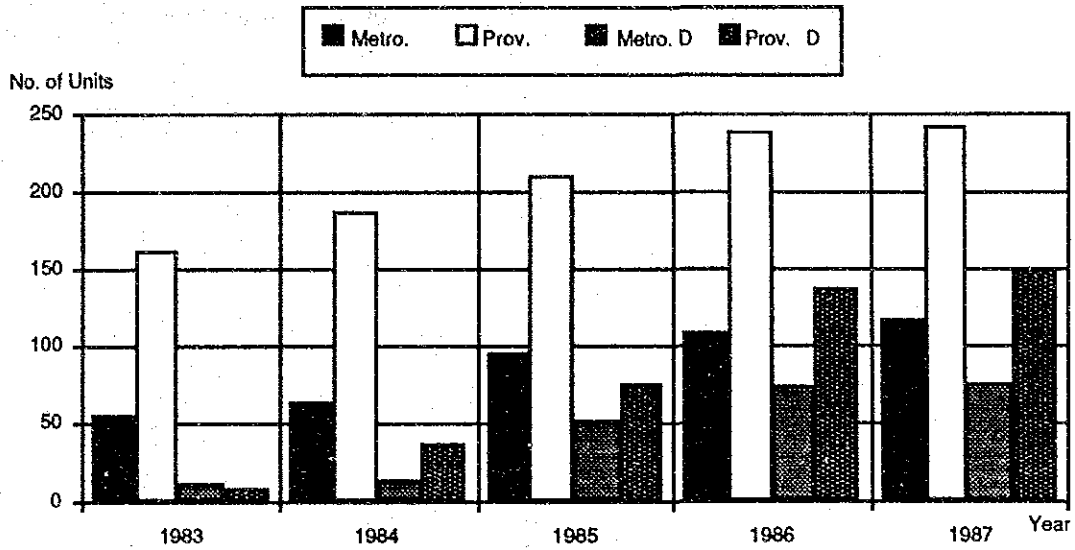


Figure 2.3-4 Annual Development of Number of Exchanges

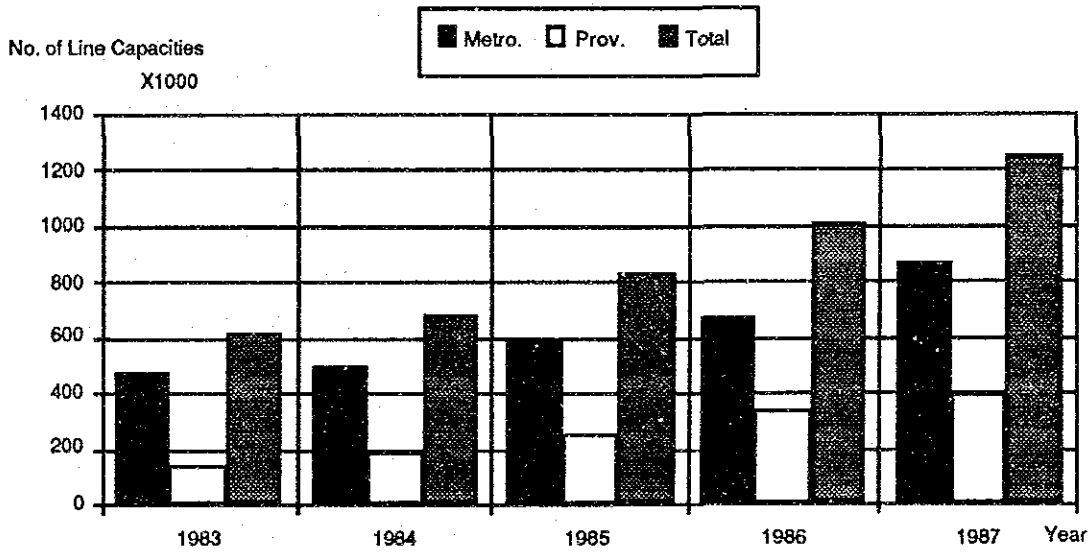


Figure 2.3-5 Annual Development of Number of Line Capacities

2.4 Analysis on Present Situation of Each Telecommunication Area in TOT

In this section, some comparative analyses were attempted on telecommunication areas in TOT with respect to the following figures and the result is shown in Figure 2.4-1 and 2.4-2.

- 1) Revenue (local call revenue, trunk call revenue, total revenue),
- 2) Switching and cable capacity,
- 3) Fault ratio,
- 4) Waiting applicants.

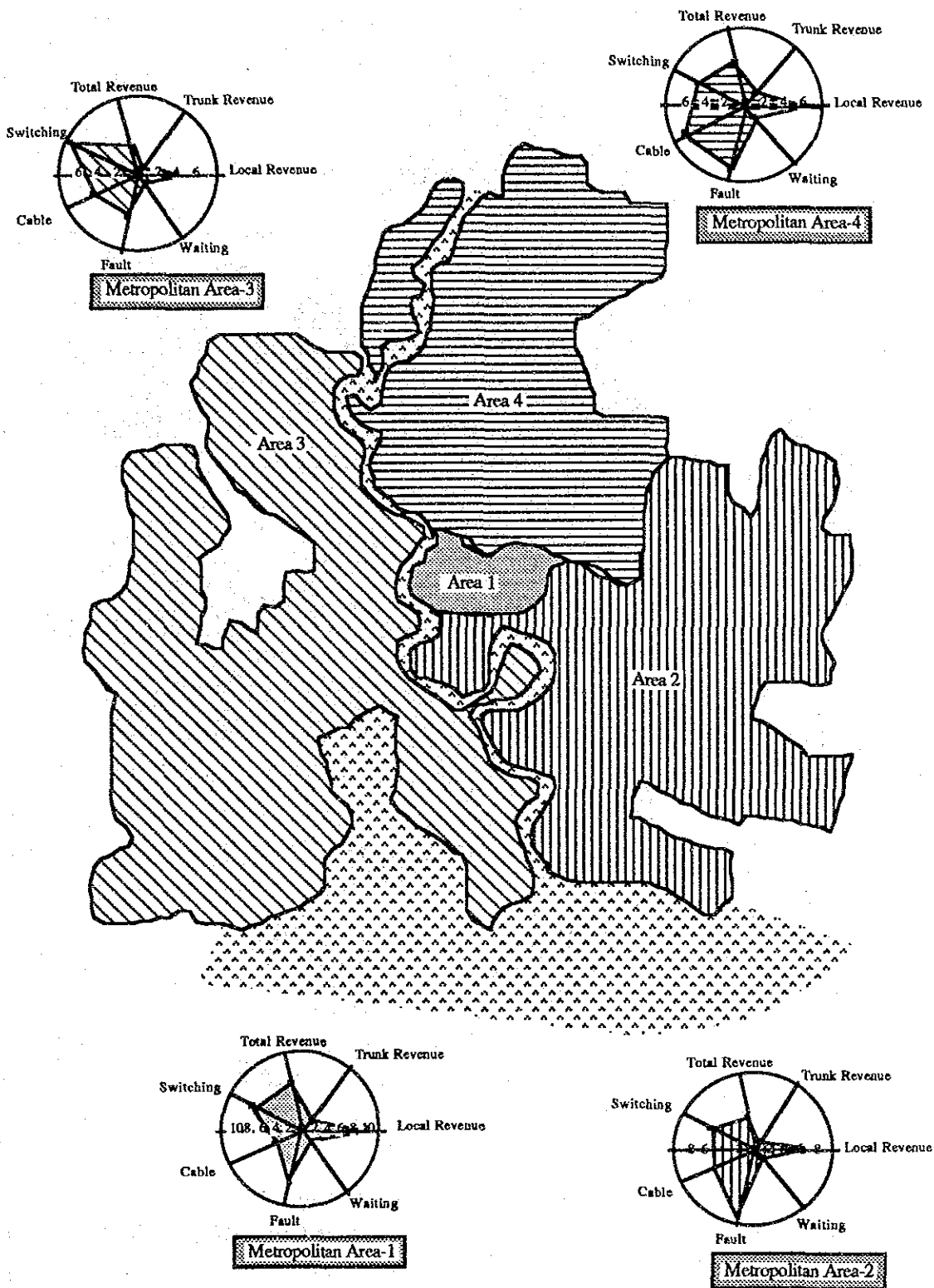


Figure 2.4-1 Present Situation in Metropolitan Areas

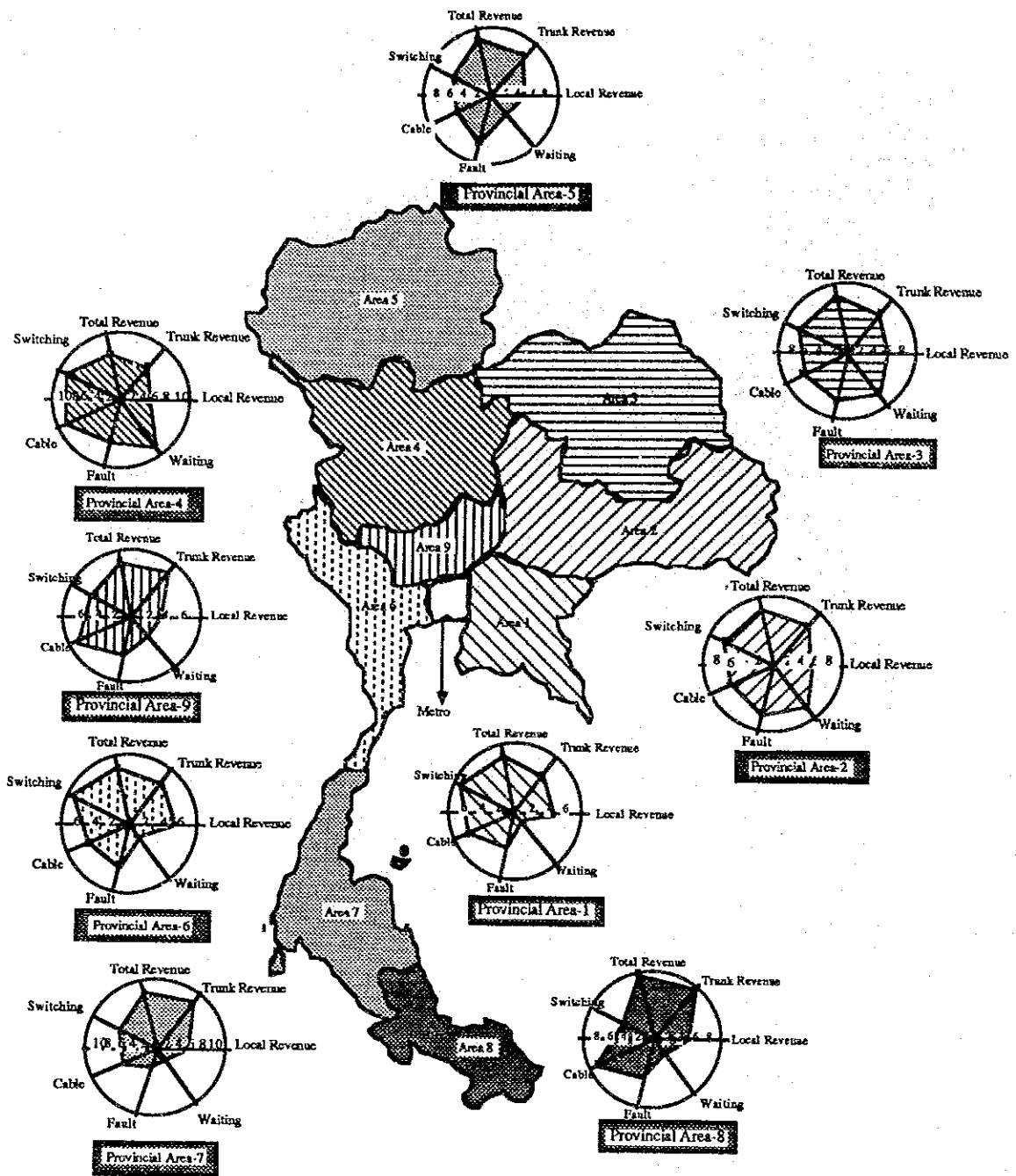


Figure 2.4-2 Present Situation in Provincial Areas

CHAPTER 3. PROSPECTS OF SOCIO-ECONOMIC DEVELOPMENT AND THE ROLES OF TELECOMMUNICATIONS

3.1 Prospects of Socio-Economic Development in Thailand

Section 3.1 examines prospects of socio-economic development in Thailand from viewpoints of future opportunities and threats for the telecommunications sector development. The examination of opportunities and threats will help creating scenarios of demand forecasts in Chapter 4 on who will demand, where they demand, what they demand, and how much they demand for the telecommunications services and will provide reference materials with the analysis of the telecommunications sector weakness and strength for formulating development objectives and strategies of the Master Plan in Chapter 5.

Future success of Thailand depends on developing industrial areas which generate the maximum benefits of economic development in the middle and short terms along with developing industrial areas which diversify and deepen the Thai industrial structures in the long term, implementing adequate industrial policies and continuation of favorable external conditions. Major external factors are magnitudes of external demands for Thai products, terms of trade, exchange rates of major currencies, oil price, amount of foreign direct investment, and foreign interest rates on Thailand's external borrowings.

A scenario which looks the most plausible in light of currently pursued government policies is given as follows:

- 1) The external conditions will stay largely unchanged. Industrial and regional developments will progress in a moderate speed. The Thai economy can expect real average annual GDP growth rate of 6% for the next 20 years. The government will increase public sector investment from 5.8% of GDP in 1988 and to 7.2% in 1989 and maintain that level thereafter. The real effective exchange rate will be kept unchanged.
- 2) The BMR will continue to grow into the three direction illustrated in Figure 3.1-1 and remain the leading center of Thai industries. At the same time, with improvement in basic infrastructure outside Bangkok and regional development efforts in the first ranked cities for development in the Sixth ESDP, the Eastern Seaboard area, and the Southern Seaboard area, a mild trend of decentralization will emerge. Disparities of growth rates and income levels among regions and industrial sectors will be slightly narrowed.

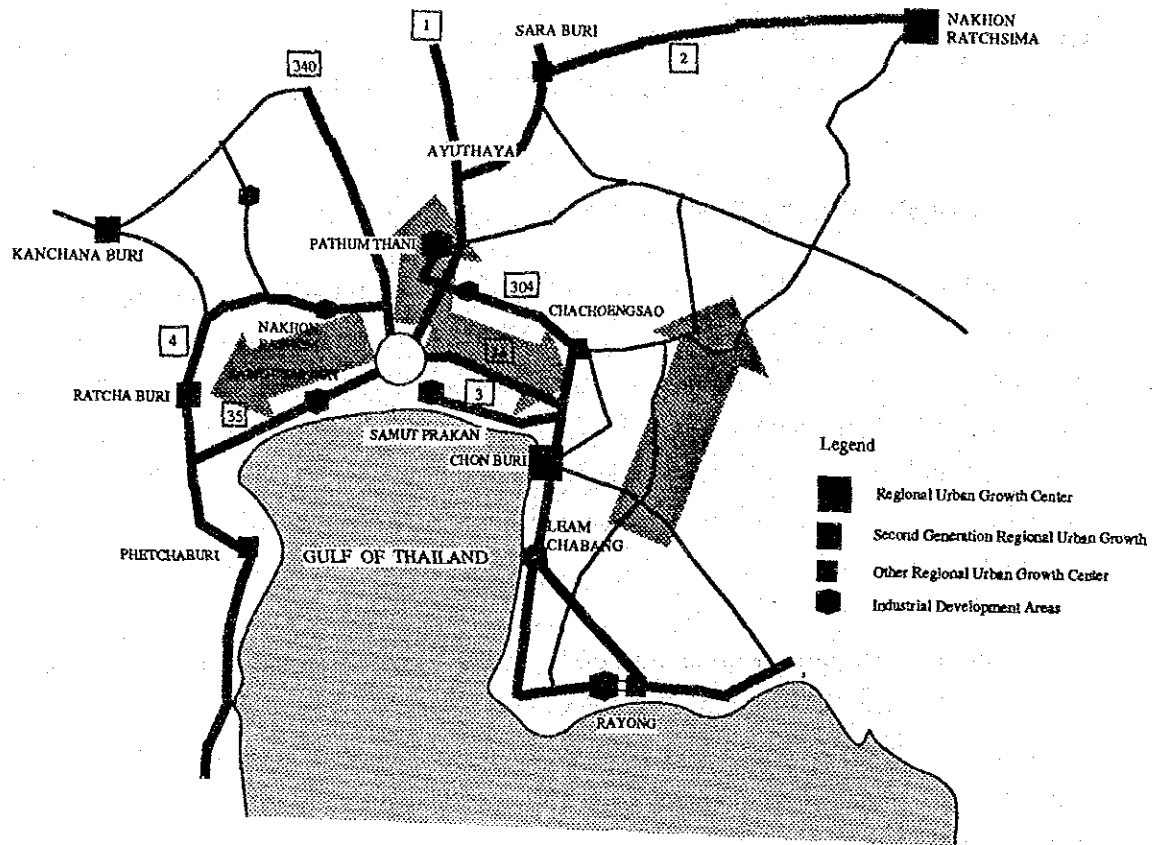


Figure 3.1-1 Future Development Directions in the BMR

3) Thailand possesses many advantages as a country to establish export bases of both foreign and domestic export oriented firms for North American, European, Japanese, the Asian NIEs, Australia-New Zealand, and Middle Eastern markets. The BMR, the Eastern Seaboard area and its surrounding areas up to Nakhon Ratchasima, and the Southern Seaboard area around Songkla-Hat Yai will grow into major industrial areas developed around export bases. Growth of these industrial areas will be expected to generate the following development benefits:

- a) To promote development of parts and components, and intermediate industrial materials manufacturing industries for export oriented industries.
- b) To promote development of a wide range of subcontracting and supporting industries.
- c) To promote industrial diversification.
- d) To promote decentralization of the presently concentrated industries in the BMR, to spread the benefits of economic development to the provincial areas and to expand the size of the domestic market.

- d) To promote decentralization of the presently concentrated industries in the BMR, to spread the benefits of economic development to the provincial areas and to expand the size of the domestic market.
 - e) To promote employment capability of the manufacturing sector.
 - f) To promote technical transfer.
- 4) The Northern Region around Chiang Mai will not develop so fast and widely as the Central, Southern, and even Northeastern Regions. High-technology industries which greatly use air-transportation, knowledge and technology intensive industries related to computer software development and basic research activities may be developed to take an advantage of the natural and cultural environment of the area. This area is regarded as a gateway to the Myanmar market, but the prospects of the Myanmar market do not seem good for at least another ten years.
- 5) The political and economic significance of Thailand will increase as a major gateway to Laos, Kampuchea, and Viet Nam.
- 6) Figure 3.1-2 illustrates regional development prospects and major cities as regional growth centers listed in the Sixth ESDP.
- 7) Agro-industries and labor intensive industries will be further developed to exploit the advantage of the availability of inexpensive, but good quality labor workers and richly endowed agro-resources.
- 8) The short supply of skilled and experienced workers will become a major problem, especially in Bangkok. Firms in Bangkok will start looking for qualified professionals seriously.
- 9) Table 3.1-1 and Table 3.1-2 show the forecasted figures of population, GRP, and GDP up to the year 2007.

Table 3.1-1 Population Projection

(Unit: Thousand)

Year	1987	1992	1997	2002	2007
Bangkok Metropolitan Telecom. Area	7,338	8,496	9,467	10,357	11,284
Provincial Telecom. Areas	46,535	49,545	52,635	55,508	57,881
Whole Kingdom	53,873	58,041	62,102	65,865	69,165

3.2 Roles and Significance of Telecommunications for Socio-Economic Development in Thailand

Significance and roles of telecommunications for social and economic development have been increasing not only in developed countries but also in developing countries since increasing importance of information is universal. This, however, does not mean that significance and roles of telecommunications are exactly the same in all countries. The development pattern and stage of one country is greatly different from those of other countries. Hence, to discuss how significant telecommunications are and what roles they play for social and economic development of a country, the following two issues must be clarified:

- 1) Significance and roles of telecommunications along with development stages.
- 2) The present situation and the future prospects of the development of the country.

Figure 3.2 illustrates social development stages and the relationship between development stages and the roles of telecommunications.

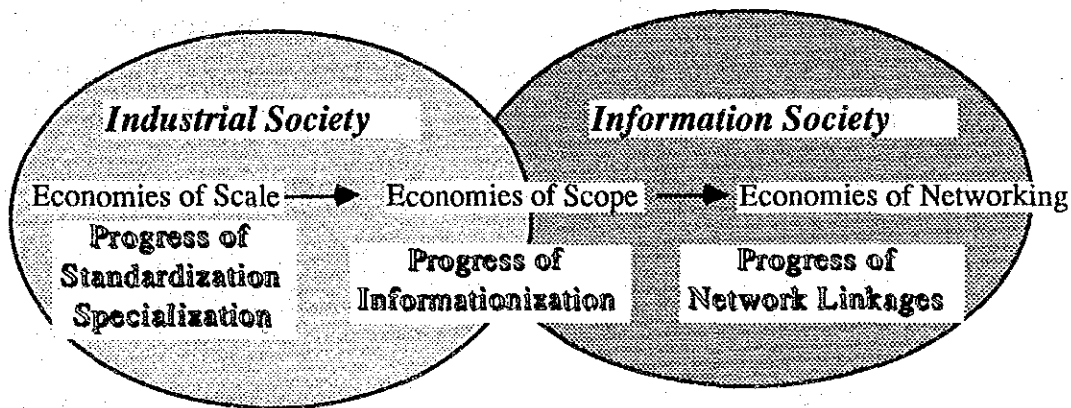


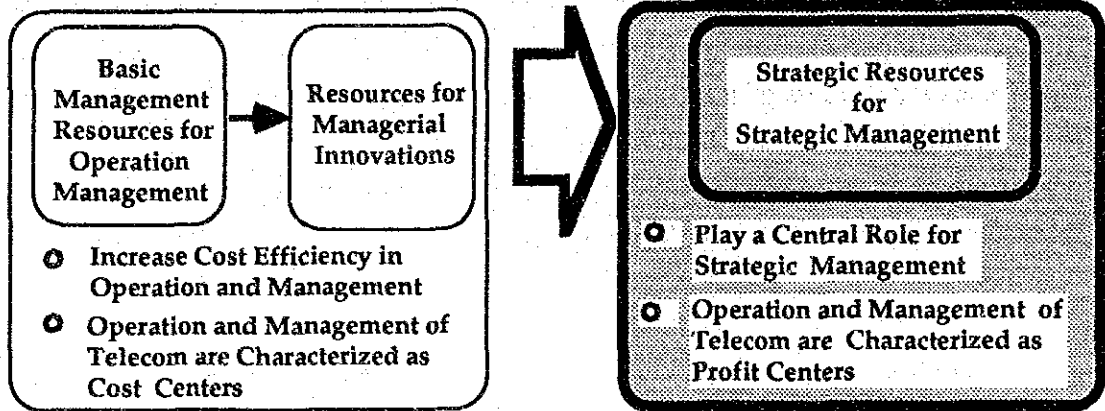
Figure 3.2 Social Development Stages and the Roles of Telecommunications

(1/3)

From the Perspectives of Telecommunications Users

Industrial Society → Information Society

Roles of Telecommunications



Needs for Telecommunications

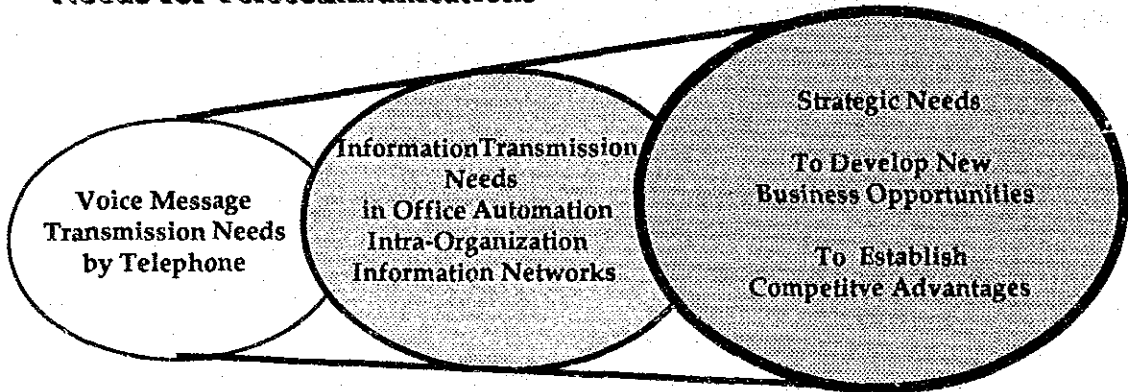
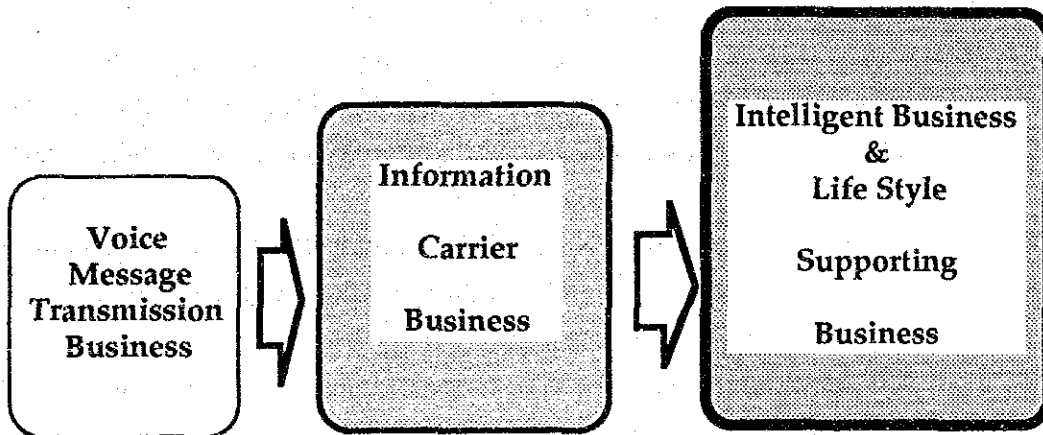


Figure 3.2 Social Development Stages and the Roles of Telecommunications (2/3)

From the Perspectives of a Telecommunications Operating Entity

Industrial Society **→** Information Society

Main Features of Telecommunications Businesses



Management Policies

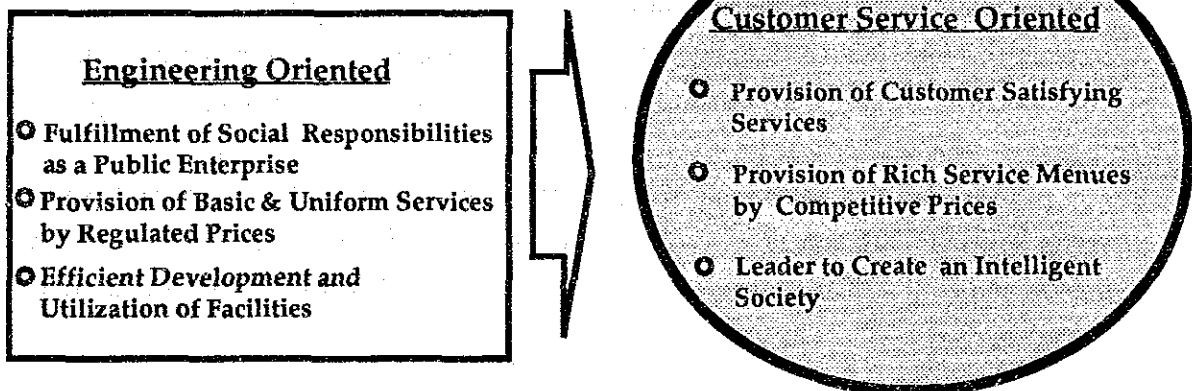


Figure 3.2 Social Development Stages and the Roles of Telecommunications (3/3)

Besides provision of basic telecommunications services and facilities, development of telecommunications can make significant contributions in the following areas:

- To provide essential information / communications resources for development of the financial sector.
- To provide essential information / communications resources for development of nation-wide production-distribution-marketing systems.
- To provide essential integrated international and domestic information / communications resources for export oriented industries by establishing teleports in the BMR, the Eastern Seaboard area, the Southern Seaboard area, and the Northern Region.
- To provide efficient and effective tele-education resources for enrichment of the secondary education system, essential for human resource development.

To estimate how much contribution the past telecommunications investment made for the past socio-economic development, production functions of three sectors, i.e., the agricultural, manufacturing and other remaining sectors, are estimated on the basis of statistical and economic theories.

The average estimated output elasticities during the sample period are 0.29, 0.16, and 0.10 for the agricultural, manufacturing, and other remaining sectors, respectively. This implies that one percent increase of the transportation & communications capital stock contributed to increase three sectoral GDP by 0.29, 0.16, and 0.1 percent.

It has been estimated that the investment in the transportation and communications sector between 1976 and 1986 contributed to increase the output of the agricultural sector by 0.86%, the output of the manufacturing sector by 0.49%, and the output of the remaining sectors by 0.31% on the average.

3.3 Future Trend of Telecommunication Technologies and Services

A contemplation on future trend of telecommunication technologies and services is tried by extrapolating current trends in the supporting technologies and in user requirements.

Telecommunication services in every country have become more and more diversified and sophisticated recently, to cope with the ever-advancing demands from every

governmental and private sector for promoting national prosperity and people's welfare. Naturally, such diversification has been supported by related telecommunication technologies having been evolved remarkably in many countries.

Telecommunication networks have evolved from the simple telephone system into a combination of individual networks for different media such as voice, text and images, and finally into the Integrated Services Digital Network (ISDN).

Advances in telecommunication and information technologies may bring about many forms of intelligent telecommunication services. Full understanding of user desires and requirements is important for making such services available.

The key features of the future services will be multi-media presentation, high-speed, and increased intelligence. As for telecommunication terminals, assuring portability (toward "wrist-phones" as the ultimate goal) and connectability (being able to hook up any terminal at any location) will become more important among the requirements.

CHAPTER 4. DEMAND FORECAST

4.1 Telephone Service

Future demands were forecasted by two methods. One method is based on potential demands, called potential demand approach and the other is based on expressed demand, called expressed demand approach. The results by the two methods are cross-examined.

Potential demand approach is estimated by two models. First model is formulated on the basis of a household monthly income distribution to forecast the number of potential residential subscribers. The second model is formulated on the basis of the number of employees, who have no less than upper secondary school education level, to forecast the number of business subscribers.

Expressed demand approach is also estimated by two models on the basis of the data of existing subscribers and waiting applicants. The first model is a logistic model to forecast the number of subscribers in Bangkok metropolitan telecommunication area. The second is income elasticity model to forecast the number of subscribers in the provincial telecommunication areas.

The results of demand forecast are shown in Figure 4.1-1.

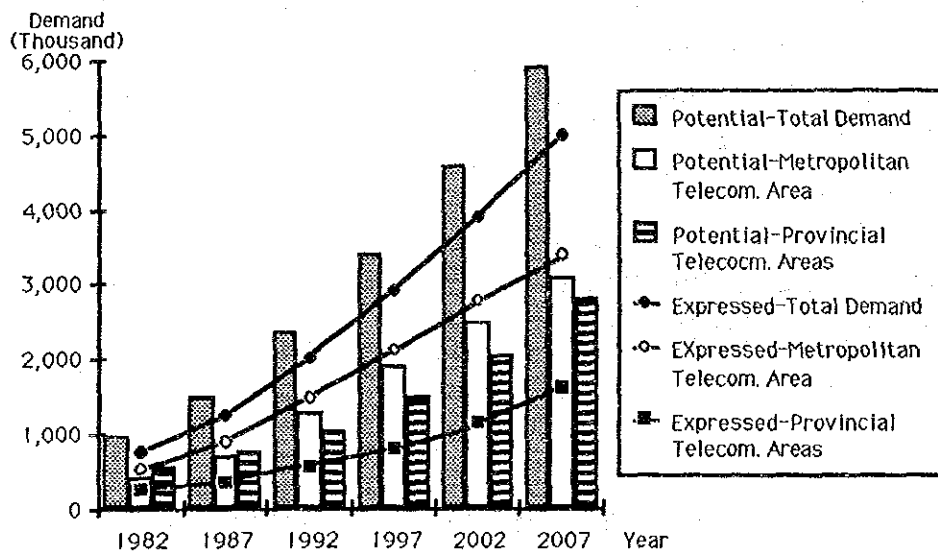


Figure 4.1-1 Result of Forecast

This report employed the forecast results of the potential demand approach for the provincial telecommunication areas, where it may be conjectured that a large part of potential demand has been discouraged to subscribe telephone service. On the other hand, the forecast results of the expressed demand approach for the Bangkok metropolitan telecommunication areas, where potential demand by business subscribers may be higher than the forecasted figure by the model, were employed in this report.

The demand figures for this report are shown in the following.

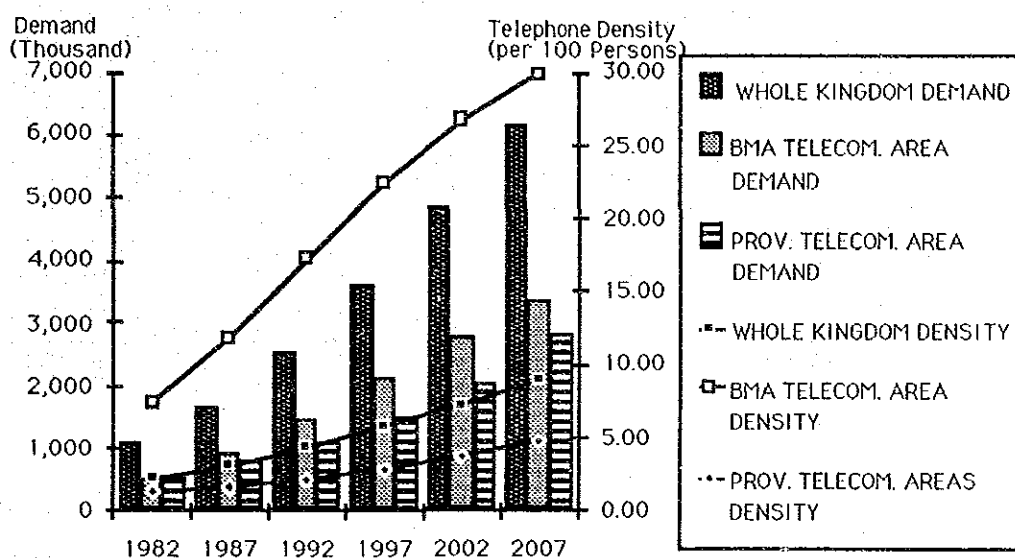


Figure 4.1-2 Telephone Subscription Demand and Density

Table 4.1 Forecasted Telephone Demand and Density (Thousand)

	Telecom. Area	1992	1997	2002	2007
Telephone Demand	Bangkok Metro. Area	1,467	2,120	2,769	3,376
	Provincial Area	1,060	1,494	2,037	2,791
	Whole Kingdom	2,527	3,614	4,806	6,167
Telephone Density	Bangkok Metro. Area	17.27	22.39	26.73	29.92
	Provincial Area	2.14	2.84	3.67	4.82
	Whole Kingdom	4.35	5.82	7.30	8.92

Note: Telephone density is the figure when all the people having intentions to subscribe will be offered telephone service.

4.2 Mobile Communication Service

4.2.1 Cellular Mobile Service

The demands are basically forecasted on the basis of population. The service density forecasted is about one tenth (1/10) of the main telephone density. The results are shown in Table 4.2.1, by classifying into metropolitan & provincial area, and mobile phone & portable phone.

Table 4.2.1 Forecast of Cellular Mobile Service

Year	1992	1997	2002	2007
Population (Thousand)	58,041	62,102	65,865	69,165
Metropolitan	8,496	9,467	10,357	11,284
Provincial	49,545	52,635	55,508	57,881
Mobile Tel./1000 Persons				
Metropolitan	5	10	20	30
Provincial	1	2	4	6
No. of Cellular Service	92,025	199,940	429,172	685,806
Metropolitan	42,480	94,670	207,140	338,520
Provincial	49,545	105,270	222,032	347,286
Share of Portable Phone				
Metropolitan	20%	30%	40%	50%
Provincial	10%	20%	30%	40%
No. of Mobile Tel.				
Metropolitan	33,984	66,269	124,284	169,260
Provincial	44,591	84,216	155,422	208,372
No. of Portable Phones				
Metropolitan	8,496	28,401	82,856	169,260
Provincial	4,955	21,054	66,610	138,914

4.2.2 Paging Service

The paging system is mostly connected to the telephone network as the end station with one way communication. Accordingly, the demands are forecasted on the basis of the main telephone service, namely, by multiplying some ratio to the number of main telephones. The result is shown in Table 4.2.2.

Table 4.2.2 Forecast of Paging Service

Year		Actual	Forecast			
		1987	1992	1997	2002	2007
Number of Telephone Demand (x1000)		902	2,527	3,614	4,806	6,167
Ratio of Paging Station		0.025	0.035	0.044	0.052	0.060
Number of Paging Stations (x1000)		23	88	159	250	370
Area	Metropolitan	20	75	140	220	330
	Provincial	3	13	19	30	40
Terminal Type	Tone & Voice	6	4			
	Digital Display	17	84	159	250	370

4.3 Leased Circuit Service & Data Communication Service

The leased circuits are utilized for data communication, telex access line, hot line, broadcasting etc. As regards data transmission use, the application territory closely relates to the packet data network. Accordingly, data communication service is covered together in this section.

The demands are basically forecasted on the basis of the main telephone service. The results as classified into usage are shown in Table 4.3.

Table 4.3 Forecast of Leased Circuits & Packet Network

Service Menu	1992	1997	2002	2007
Leased Circuit				
Data Transmission up to 48 kb/s	20,216	46,982	72,090	74,004
Data Transmission over 48 kb/s	505	4,337	14,418	37,002
Telex Network Access	10,000	7,200	4,800	0
Packet Data Network Access	1,011	5,060	14,418	37,002
Voice Transmission	13,676	35,923	64,881	88,805
Video Transmission	500	1,000	2,000	3,000
Broadcast Program Transmission	200	500	1,000	1,500
Packet Switched Data Network				
Packet as Direct Accommodation	1,011	5,060	14,418	37,002
Packet via Telephone Network	1,011	7,228	21,627	49,336

4.4 Recorded Communication Service

The recorded communication service is utilized, among others, as telegram service, bureau facsimile service, telex service etc. The demands for telegram & bureau facsimile

service are forecasted in Table 4.4-1 and the demand for telex service is forecasted in Table 4.4-2.

Table 4.4-1 Forecast of Telegram & Bureau Facsimile Service

Year		Actual	Forecast			
		1987	1992	1997	2002	2007
Population (x1,000)		53,873	58,041	62,102	65,865	69,165
Telegram Service	Cases per 100 Persons	14	11	8	5	2
	Total Cases (x1,000)	7,966	6,385	4,968	3,293	1,383
Bureau Facsimile Service	Cases per 100 Persons	0.0	5	10	15	20
	Total Cases (x1,000)	21	2,902	6,210	9,880	13,833

Table 4.4-2 Forecast of Telex Service

Year	Actual	Forecast			
	1987	1992	1997	2002	2007
Telephone Demand (x1,000)	902	2,527	3,614	4,806	6,167
Telexes per 1,000 Telephones	6.8	4	2	1	-
Total Number of Telex Terminals	6,164	10,000	7,200	4,800	-

4.5 Video Communication Service

In the field of Video communication service, Videotex service, Video phone service, Video conference service etc. will be feasible in future. For the time being, the demand is limited to specified subscribers and should be estimated on the basis of the specified market segment.

4.6 ISDN Subscription

ISDN is scheduled to be commenced in the near future. Some of the subscribers will transfer from the existing networks to ISDN network. The volume of transition basically depends on the tariff level of ISDN and the price of digital terminals in comparison to those of existing networks.

CHAPTER 5. OBJECTIVES AND STRATEGIES OF TELECOMMUNICATIONS DEVELOPMENT

5.1 Present and Future Points at Issue in TOT

Today, telecommunications are considered to be important parts of infrastructure to conduct various social and industrial activities in every country. As described in Chapter 2, Thailand has now been achieving remarkable progress in economy. Therefore, it must be a pressing need for Thailand to expand and reinforce the telecommunications more rapidly than ever before in order to support further overall development of the country as well as to promote prosperity of the people.

Meanwhile, as one of the state enterprises for telecommunications in this country, TOT has been making considerable efforts to render the better telecommunication services to the customers since its inauguration in 1954.

However, the present services offered by TOT do not seem sufficiently matured yet, and also some internal management procedures are yet to be improved.

Main points at issue are considered as follows;

- Large amounts of waiting applicants and remaining non-telephone communities,
- Insufficient telecommunication services,
- Less reliable telecommunication network,
- Under-utilization of telephone traffic data,
- Shortage of management resources.

5.1.1 Large Amounts of Waiting Applicants & Remaining Non-Telephone Communities

There were about 451,000 waiting applicants in the whole country in February 1989. Furthermore, this number of total waiting applicants is expected to increase to 705,000 at the end of FY 1992 according to the telephone demand estimation and the present telephone installation program in TOT.

At the end of FY 1992, on the other hand, there will be 4,200 tambons left as non-telephone communities. It is among the most important matters in telecommunications to resolve these problems from the viewpoint of the nation's prosperity.

5.1.2 Insufficient Telecommunication Services

In spite of TOT's considerable efforts in these years, the service qualities are yet to be improved in comparison with the international standards. Taking ordinary telephone service for example, when people want to make a call, they have to make many unsuccessful calls before achieving a successful call at last. When people are talking through telephone, sometimes they perceive unacceptable noise for a comfortable conversation. And also when in urgent need, they often can not find even a working telephone around them.

One reason of the above situation seems to be that the fault ratio caused by outside plant facilities has been as high as about 50 % of the total faults according to TOT data. Therefore, improvement of outside plant facilities is expected to upgrade the service level to a considerable extent. However, the criteria for replacement of timeworn facilities has not been set up yet.

Thus, it is required to provide some appropriate procedures relating to maintenance and operation work of the telecommunication network and facilities for upgrading the service qualities.

Furthermore, recent tendency of diversification in telecommunication services should be taken into consideration. In addition to the Cellular Mobile service, more derivative telephone services and some enhanced non-telephone services will have to be introduced by means of ISDN and CCS to cope with the demands from every sector.

5.1.3 Less Reliable Telecommunication Network

The reliability of the present telecommunication network of this country is not considered sufficiently high. For example, there are many PCs connected to other PCs with single transmission route only. Route duplication of the network and other measures for enhancing network reliability should be promoted.

5.1.4 Under-utilization of Telephone Traffic Data

Traffic management is the key point of telecommunications operation. However, the application system of traffic data is not completed yet. In principle, capacity of the telecommunication facilities should be determined by the traffic data, and traffic promotion activities for successful call ratio improvement and traffic sales promotion should be carried out depending on the actual traffic data.

5.1.5 Shortage of Management Resources

The present and recommended organizations do not seem suitable to TOT. The organization should be changeable according to the scale and condition of the entity in order to achieve the most efficient operation for meeting the needs of the society. In order to keep the present good financial situation in future, it will be indispensable for TOT to reinforce the management executives and overall personnel and also to reserve or raise reasonable funds.

5.2 Long-Range Development Objectives

Taking the above-mentioned situations in the present telecommunications of this country into consideration, the following four long-range objectives are set forth in formulating the Master Plan for domestic telecommunication network development, as the basic principles to assign various projects for improvement of the telecommunication services both in quantity and in quality to the respective areas and periods.

- 1) Fulfillment of national telephone demand
- 2) Upgrade of service qualities
- 3) Diversification of services
- 4) Improvement of management

For the sake of formulation, the period of the Master Plan is divided into three phases as follows;

Phase-1: From FY 1993 to FY 1997,

Phase-2: From FY 1998 to FY 2002,

Phase-3: From FY 2003 to FY 2007.

5.3 Development Strategies and Targets

To achieve the four objectives mentioned in the previous paragraph, some strategies are adopted for each of the objectives as in the following.

5.3.1 Fulfillment of National Telephone Demand

Ordinary telephone service has been the principal service in domestic telecommunication services in Thailand, which is now indispensable to overall development and prosperity of this country. Therefore, this objective is considered to be the most important one to proceed with the implementation of the Master Plan. The following three strategies are set forth in order to achieve this objective.

1) Reduction of Waiting Applicants

To satisfy urgent demands for telephone service from every socio-economic sector, telephone installation for the waiting applicants will be promoted to the extent that most of the applicants in any place of the country except rural areas will be able to receive within a few months after the subscription, by the end of Phase-1 period.

2) Dissolution of Non-Telephone Communities

To keep the security of the nation and also to extend the benefits of telecommunications all over the country, this strategy is also very important. Projects for dissolution of non-telephone "tambons", the same as those being carried out in the current 5th ESDP, will be continued by the end of the Phase-2 period.

In the Phase-3 period, rural telecommunication system introduction will be continued for non-telephone villages (muhbahn) in line with the related items of the ITU Kuala Lumpur Declaration in December 1983, namely, "By the year 2000, national planning bodies should aim at the goal of providing access to national telecommunication services within walking distance of no more than 3 km for people in all countries."

3) Increase of Public Telephones

Installation of public telephones is also important to extend the benefit of telephone service into many and unspecified people in need. In this Master Plan, installation of public telephone will be carried out in such a way that installation numbers of public telephone for each phase are proposed aiming at the target of the average number of public telephones per 1000 population as 2.5 at the end of FY 2007.

5.3.2 Upgrade of Service Qualities

In addition to quantitative improvement, upgrade of service qualities is essential to the administration for meeting requirements from the customers. In telecommunications, many facets of service qualities can be defined. However, in this Master Plan, fault ratio and successful call ratio are employed as the principal criteria of the service qualities.

The following strategies are selected for upgrade of service qualities in regard to the above criteria with respective targets. In applying these strategies, comprehensive and continuous efforts in close cooperation among the departments concerned in the administration will be required to achieve the targets.

1) Improvement of Telecommunication Facilities

a) Rehabilitation of Subscriber Cables and Wires

In the installation process of outside plant facilities, replacement of timeworn subscriber cables and wires will be carried out with the installation work from the beginning of Phase-1, aiming at improving fault ratio into less than 1.3 per 100 subscribers per month by the end of FY 2007.

b) Replacement of Analog Facilities

Digitization of the domestic telecommunication network will be completed including all TC, SC and PC level by the end of the Phase-1 period. Besides, all the new LS facilities will be digital system through the whole period.

In the meantime, remove and reuse plan for XB system with replacement of analog transmission system will be carried out from Phase-1 taking service life, new service demand, economical viewpoint etc. into consideration.

2) Enhancement of Network Reliability

As a measure of network reliability enhancement, transmission route duplication will be completed among all of the TCs and the SCs by the end of Phase-2. For connection to the PCs, duplication will be realized among all the PCs in principle by the end of Phase-3. In addition, introduction of digital transmission switching system will be planned during and after Phase-2.

3) Improvement of Operation and Maintenance

a) Review of Outside Plant Maintenance Center

Vehicles and installation machinery will be rearranged at the existing outside plant maintenance centers, in order to carry out larger quantities of the installation work more smoothly and also to conduct the maintenance work more efficiently.

b) Introduction of Network Management System

The matters relevant to introduction of network management system for switching and transmission facilities will be studied.

5.3.3 Diversification of Services

In studying introduction of various services, the following priorities should be considered;

- To meet the customers' demand,
- To promote the customers' benefit effectively,
- To contribute revenue increase of the enterprise,
- To use network facilities efficiently.

1) Reinforcement of Telecommunication Network

a) Introduction of ISDN

As an essential means toward information oriented society, development plan of Integrated Services Digital Network (ISDN) will be carried out for rendering diversified services in order to cope with the request from the society. As a proposed schedule, ISDN introduction will be continued in Phase-1, and the extension will be promoted by the end of Phase-3.

b) Application of CCS

Application plan of common channel signalling system (CCS) will be adopted for Cellular Mobile network and ISDN trial service by 1992. Then from Phase-1, CCS will be introduced with ISDN commercial service or other new diversified services into the areas concerned.

c) Development of Satellite Communication System

Development plan of satellite communication system will be carried out from Phase-1 for the purpose of reinforcement of the domestic telecommunication network, measures against natural disasters and provision of transmission means for various new services.

2) Introduction and Extension of Various Services

According to the ISDN introduction, the services to be available will become more diversified. Taking account of the recent telecommunication services trend in the other countries and also the customers' demand in this country, introduction and extension plan of some feasible services should be studied for each phase in the Master Plan period.

3) Extension of Cellular Mobile Service

Extension plan of the existing cellular mobile service, which is superior in terms of instantaneity and mobility to the ordinary telephone service, will be completed to cover all over the country by the end of the Phase-1 period.

The second cellular mobile system for TOT using 900 MHz frequency band will be introduced in Phase-1 period in order to cope with the increasing demand.

5.3.4 Improvement of Management

1) Human Resource Issues

a) Manpower Management

When facilities are expanded, the manpower must also be expanded at the same time. Massive facilities will be just wasted without proper expansion and allocation of human resources. Expenses on human resources are the major expense items in business operations; therefore, they must be efficiently and carefully managed.

Each department of TOT has its own staff requirement standard. However, in order to control the total number of the staff properly, the human resource department should have a total manpower plan and staff allocation policies.

b) Reorganization

As the number of subscribers increases, it will become more difficult for the TOT Headquarters to centrally manage the whole organization. Some management functions

should be decentralized to the regional offices. An adaptation of a profit and cost center system should be considered sometime in the later part of the Master Plan.

c) Human Development

Organizations flourish through the efforts of individuals, because people are the most important resource a manager has. It is expected that the operation and management of TOT will become larger and more complicated in the future; therefore, it must develop skills and abilities of its people up to the sufficient level to be able to operate its own complex, massive, and sophisticated facilities. It is quite indispensable for TOT to provide large-scale training programs at the earliest possible time because many new technologies will be introduced in the Master Plan

d) Promotion and Compensation System

Promotion and compensation systems affect employee motivations and incentives. Hence, they must be formulated and practiced to take out the fullest extent of employees contributions to organizations.

2) Financial Issues

In order to raise enough internal and external capital to carry out the Master Plan, TOT should examine the following issues to improve its financial position.

a) Fund Management

TOT must manage not only large amount but also many kinds of financial funds for many years, once the Master Plan starts. Financial mismanagement will jeopardize implementation of the projects and cause a tremendous loss to TOT and the society. Hence, it is recommended to obtain a help of a professional fund manager who is knowledgeable on both domestic and international money markets.

b) Remittance to the Treasury

In order to increase its internal reserve so that TOT can generate larger amount of own fund for implementing projects, the remittance to the Treasury is a heavy burden. TOT should work more aggressively on being totally or partially excused from paying remittance to the Treasury until at least TOT eliminates the existence of waiting applicants.

c) Depreciation

One good and widely practiced method to increase the available amount of internal reserve is to take the maximum advantage of depreciation, although net income on book decreases. There are three issues to be examined on depreciation. The first is on accounting method of calculating depreciation. The second is on service lives of equipment and facilities. The third is on work in progress and plant under construction.

d) Tariff

Tariff is one of major revenue management tools. Tariff structures of TOT have never been closely examined from either economic theoretic viewpoints or management viewpoints. To establish a sound and effective financial management system, it is recommended for TOT to conduct a tariff review project at the earliest possible time.

e) Marketing and Customer Relations

Marketing and customer relations are one of the least developed management areas in TOT. To improve the marketing and customer relations, the immediate efforts should be primarily concentrated on improvement of the following:

- i) Development of the data base on the customers and traffic,
- ii) Clear and easy documentation of jobs, tasks, duties, objectives, procedures, rules, and system flowcharts.

After TOT eliminates the existence of waiting applicants and achieves demand-supply balance for the telephone services, marketing efforts must be greatly enhanced in order to create more demands for the telecommunication services and offer customer friendly services. Marketing becomes very important in opening up people's minds to make them being fully aware that modern and sophisticated telecommunication services are not just to transmit voice messages, but to transmit, store, and process all kinds of information and to support people in making intelligent decisions. TOT should lead the industry to promote "Informationization" of the society and become the primary promoter of the telecommunication services.

f) Increase General Work Efficiency

TOT should consider the following measures to increase general work efficiency:

- i) Promotion of office automation,

- ii) Clarifications, documentation, and manualization of job definition, purposes, objectives, duties, rules, procedures, standards, and organization-wide education of middle and lower management people,
- iii) Promotion of QC circles,
- iv) Effective utilization of management information system.

5.4 Strategy Formation and Execution

Figure 5.4 presents a system flow chart which illustrates how the present issues will be incorporated into the objectives and strategies, and how they will be executed in each of three phases.

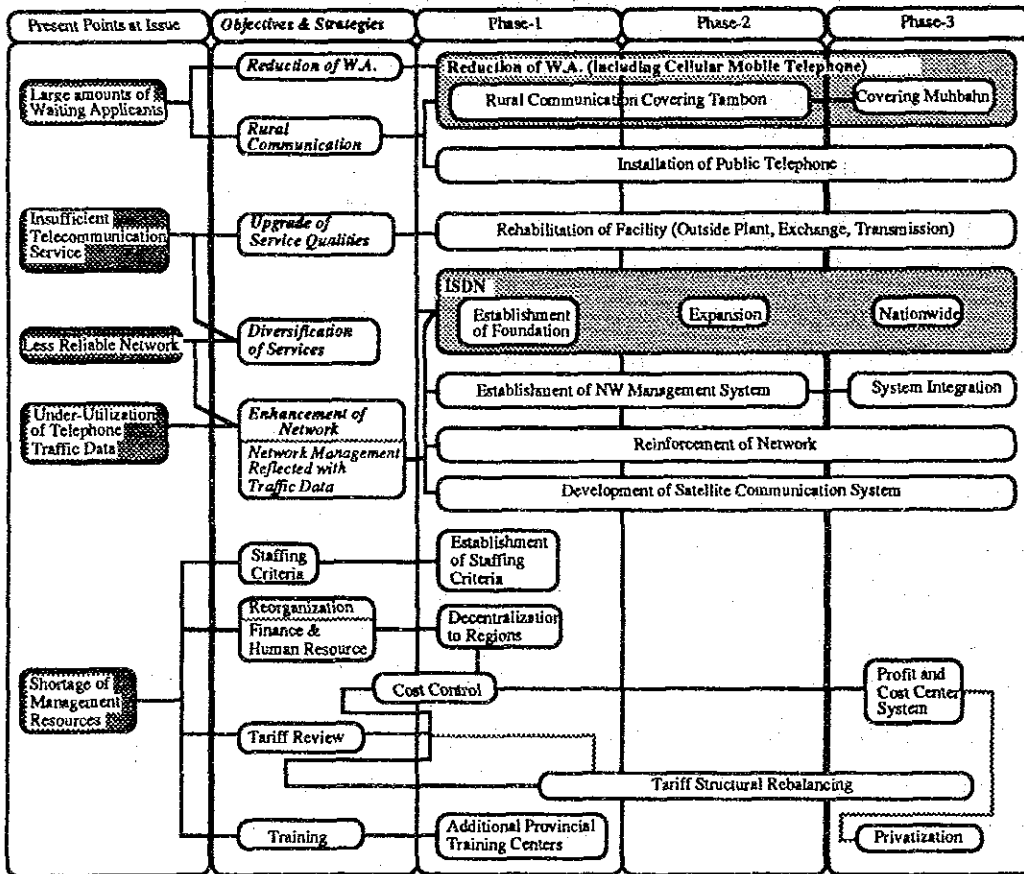


Figure 5.4 Strategy Formation and Execution

5.5 Effects Produced through Implementation of the Master Plan

As the results of implementation of the Master Plan, the following effects will be exerted on the users, the society and the telecommunication sector.

1) On the Users

The users will be offered with faster, cheaper and more versatile services as well as more friendly services.

2) On the Society

The industrial structure will be upgraded, the financial sector will be reformed. Thus, the society will gradually be evolved into an informationized society according as the development of the infrastructure will progress.

3) On the Telecommunication Sector

In the telecommunication sector, it will become possible to perform more dynamic and innovative business operation toward the customer oriented one with enforcement of fair and efficient regulation. At the same time, telecommunication entities will be providing more and fair career development opportunities to the employees.

In the future, the common carriers of telecommunication sector will provide not only voice transmitting service but also various intelligent services supporting new life styles of the people.

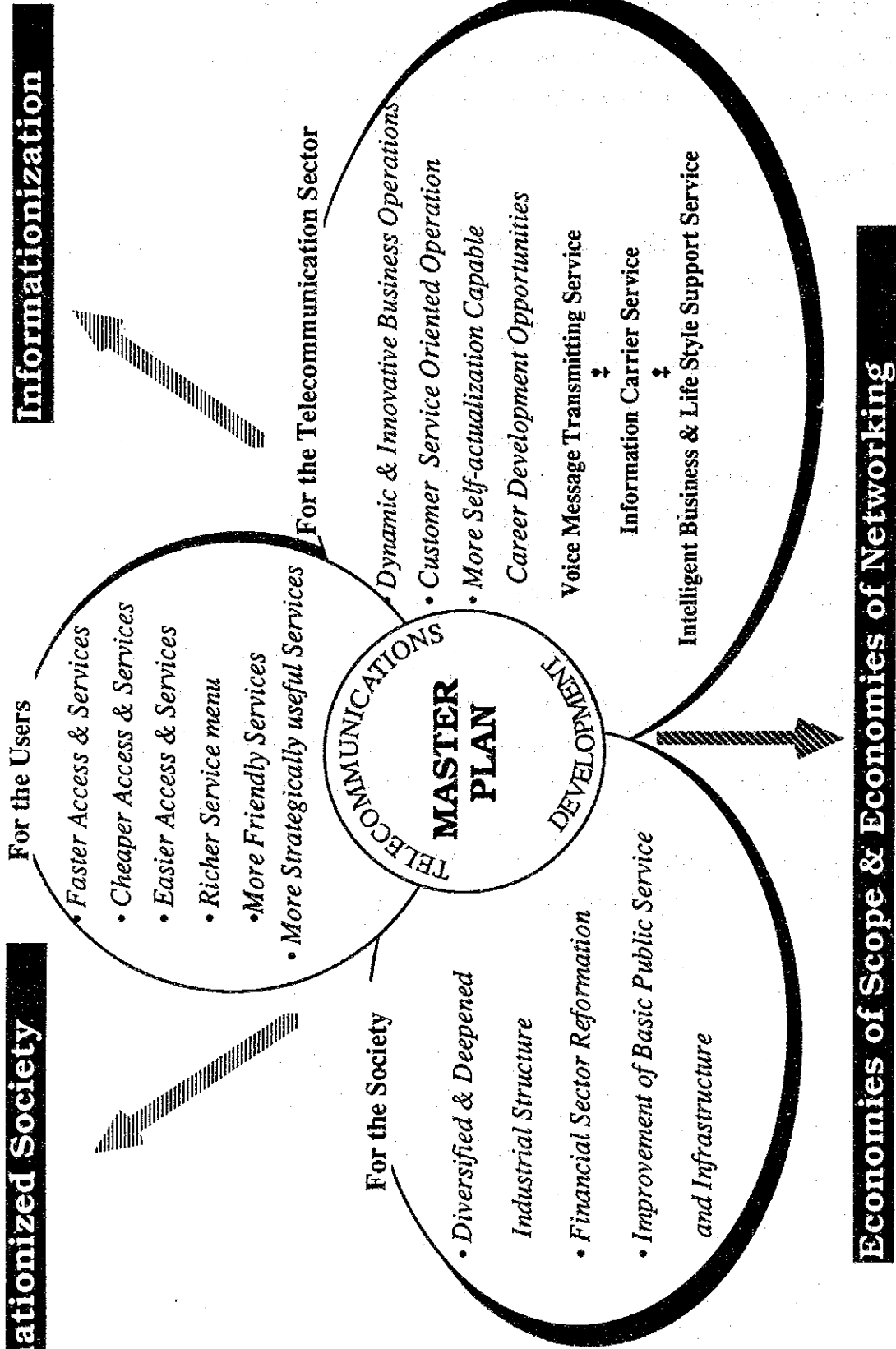


Figure 5.5 Effects Produced through Implementation of Master Plan

CHAPTER 6. TRAFFIC FORECAST

6.1 Telephone Service

In this study, traffic volume among primary centers (PC) in the whole country, and traffic volume among local exchanges in Bangkok multi-exchange area (LE) is forecasted.

The forecast procedure of the above traffic volumes consists of the following four steps:

- a) Creation of the future traffic matrix,
- b) Forecast of outgoing or originating traffic from PCs or LEs,
- c) Calculation of incoming or terminating traffic for PCs or LEs,
- d) Forecast of traffic matrixes for the planning years.

The growth rate of outgoing traffic for PC was estimated by a multiple regression model to analyze on the basis of outgoing traffic data for 17 XB exchanges in the past five years. From 2002, the results of estimated traffic for PCs were revised through substituting by the values of 1997's calling rate. Further traffic of network service is estimated on the basis of the 1 to 4 % of network services for basic telephone service.

The volume of originating traffic for LE in the future was predicted by a multiple regression model to analyze on the basis of the data of originating traffic in 1987. Further traffic of network service is estimated on the basis of the 1 to 4 % of network services for basic telephone service.

The results of traffic forecast are shown in the following.

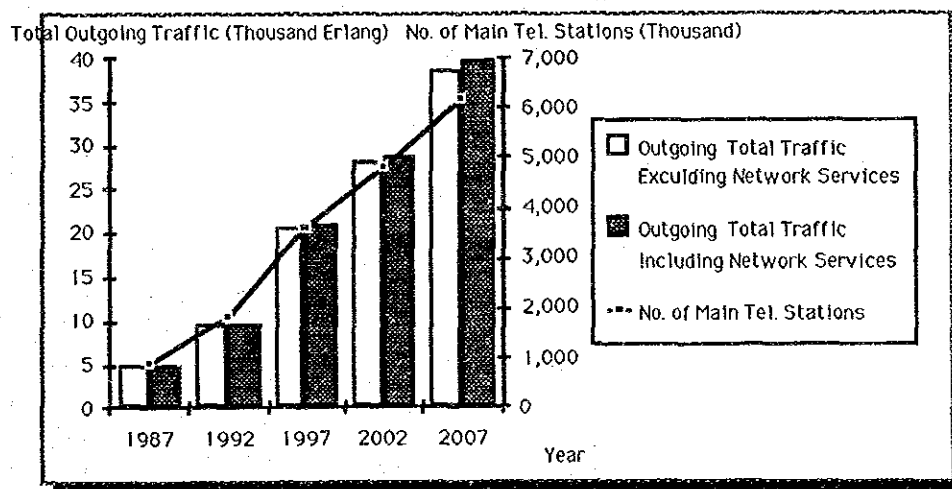


Figure 6.1-1 Results of Forecast of Total Outgoing Traffic for PCs

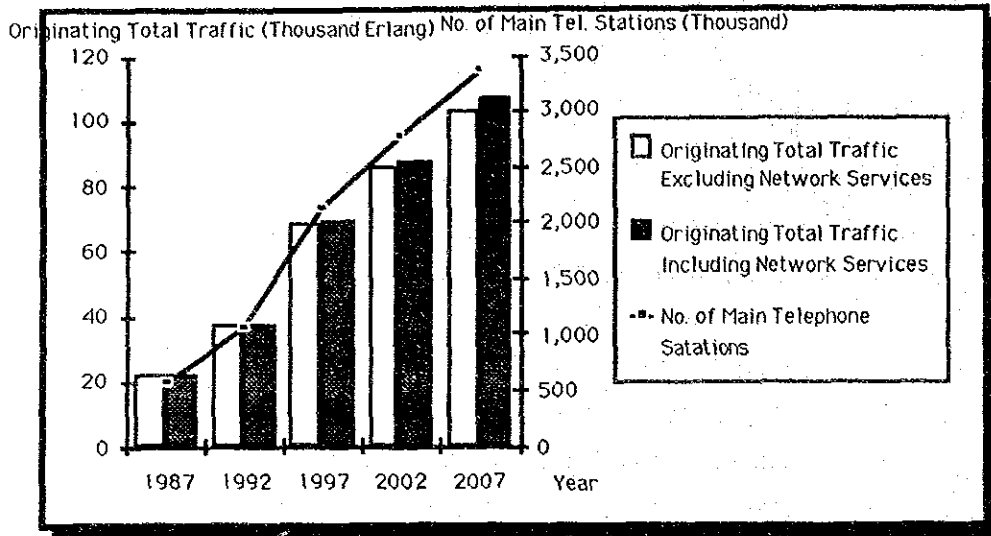


Figure 6.1-2 Results of Forecast Total Originating Traffic LEs

6.2 Cellular Mobile Service

According to the actual traffic data, the traffic per subscriber is estimated at about 0.03 erlang for Bangkok metropolitan area and 0.05 erlang for provincial areas. This calling rate in cellular mobile service closely relates to the expansion of ordinary telephone service, and will become lower in future in proportion to the expansion of ordinary telephone service.

6.3 Other Services

The traffic forecast of other services is studied from the general point of view as shown in Figure 6.3. It is considered to practical to reflect the traffic to the networks by estimating at within 5 % of the telephone traffic.

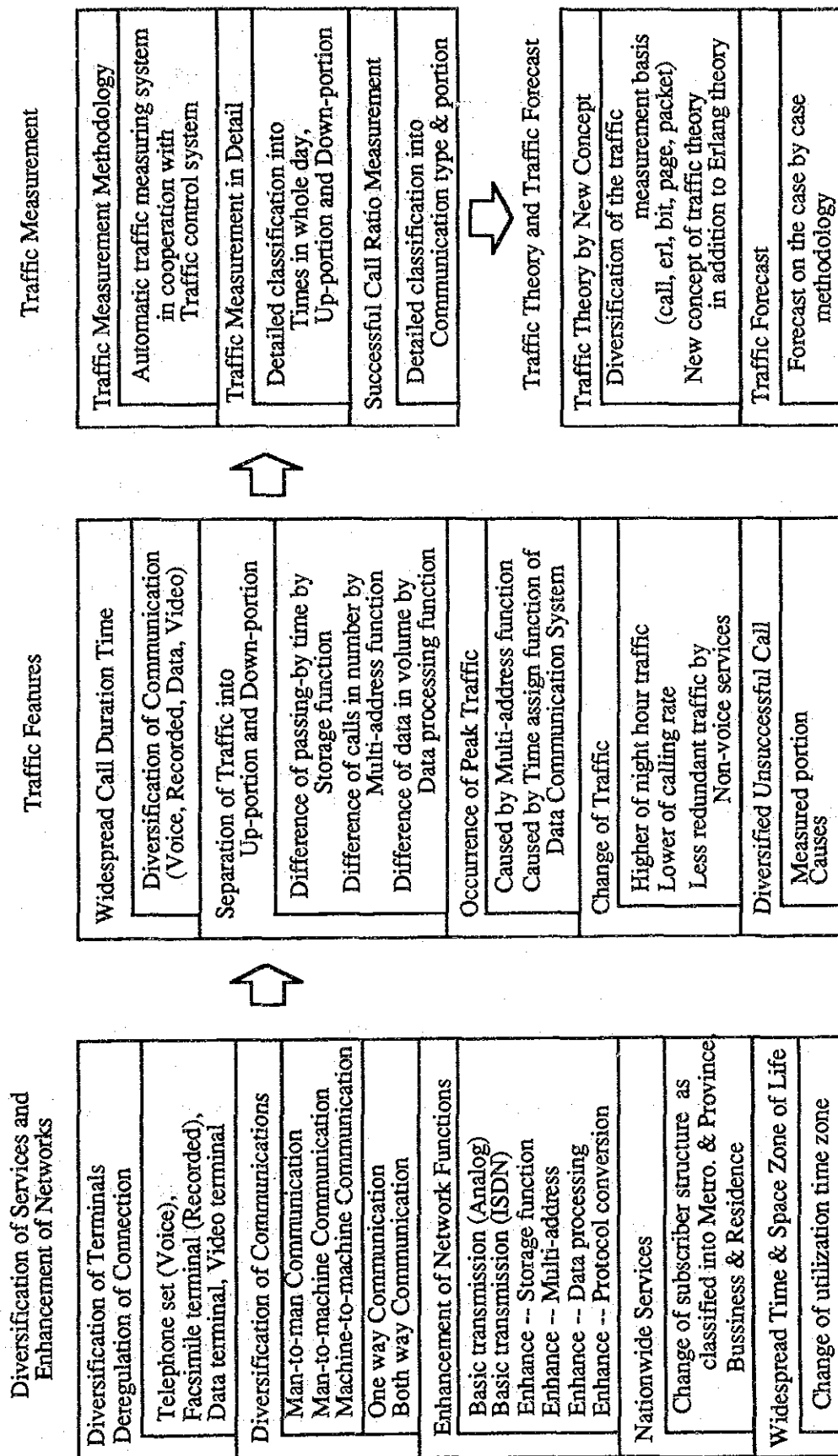


Figure 6.3 Relations among Traffic Factors

CHAPTER 7. TELECOMMUNICATION NETWORK PLAN

7.1 Telecommunication Engineering Standards

In this section, the present state of Engineering Standard is reviewed, and some engineering standards in the digital telecommunication network are proposed, because digitization of the network has already progressed up to about 75 percent by the end of FY 1988.

Generally, there are three fundamental engineering standards for telephone service as follows:

- a) Traffic Engineering Standard,
- b) Transmission Engineering Standard,
- c) Reliability Engineering Standard.

In this section, some concepts of new traffic engineering and transmission engineering standards are proposed.

1) Traffic Engineering Standard

Loss probability of each connection of digital transit switching is proposed to be allocated as shown in Table 7.1.

Table 7.1 Digital Switching Loss Probability

Connection Stage	Loss Probability
Transit Connection	0.001

In the table, the transit connection loss probability is based on CCITT Recommendation Q.504.

CCITT recommends the loss probability 0.05 (one side) for domestic data switching network (Rec. X.131). Therefore, end-to-end loss probability of digital switching (including connection loss) should not exceed 0.1.

Figure 7.1 shows an example of loss probability, allocation mentioned above. In the figure, the loss value between end-to-end is 0.078, so it has value 0.022 as the margin which can be distributed for the mixed network with analog and digital switching.

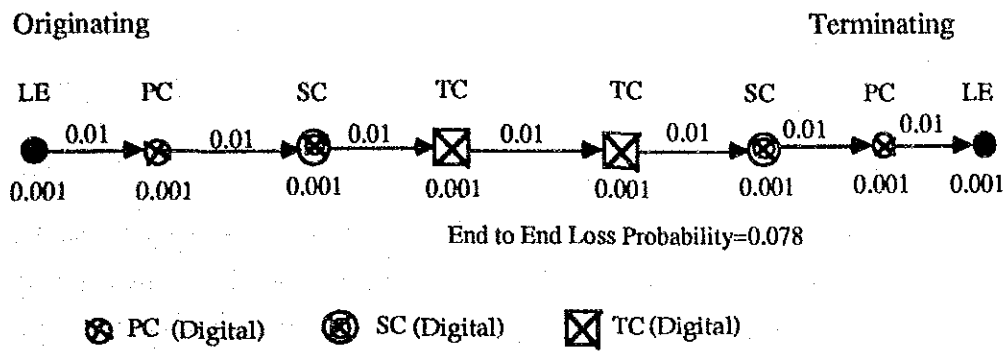


Figure 7.1 Proposed Loss Probability Allocation

2) Transmission Engineering Standard

As the transmission engineering standard, the consideration on establishing the standard is described.

7.2 Introduction of ISDN

1) General

ISDN has the basic rate access interface provided through the existing telephone line and the primary rate access interface provided through the subscriber optical transmission system or the subscriber radio system. ISDN services are classified into bearer services and teleservices. And by combining additional functions with these services, supplementary services are provided some supporting convenient services.

2) Introduction Policy

The center of the social and economic activities in Thailand is Bangkok. In this connection, the disparity between Bangkok and other areas is conspicuous. However, it is expected to develop not only Bangkok Metropolitan Region but also Northeastern Region, Southern Region and Northern Region.

Figure 7.2-1 shows the circumstances relating to ISDN introduction. As for the present state of telecommunication, provincial areas seem to be still behind. However, the ISDN services should be introduced in some provincial areas where higher demand is expected in the earlier stage such as the main developing areas, etc. as well as Bangkok Metropolitan Telecommunication Areas. The introduction policy is as follows:

- a) ISDN introduction areas are provided with 2B+D, 30B+D services.
- b) ISDN services are extended through the whole country in Thailand at Phase-3.
- c) H₀ (384 kb/s) and H₁₂ (1920 kb/s) in the primary rate access interface have to be considered separately taking the trend of demand into consideration.
- d) B-ISDN commercial service will be commenced at Phase-3.

3) Introduction Target

ISDN services will be introduced from large cities at Phase-1 and then middle cities at Phase-2, and the remaining areas in the country will follow one after another at Phase-3. B-ISDN service will be commenced in large cities at Phase-3. The each phase target for the service introduction is set taking account of the sixth national economic and development plan and the number of subscribers in each area. The evolution of ISDN services is shown in Figure 7.2-2. The introduction areas based on the target are shown in Figure 7.2-3, Figure 7.2-4 and Figure 7.2-5.

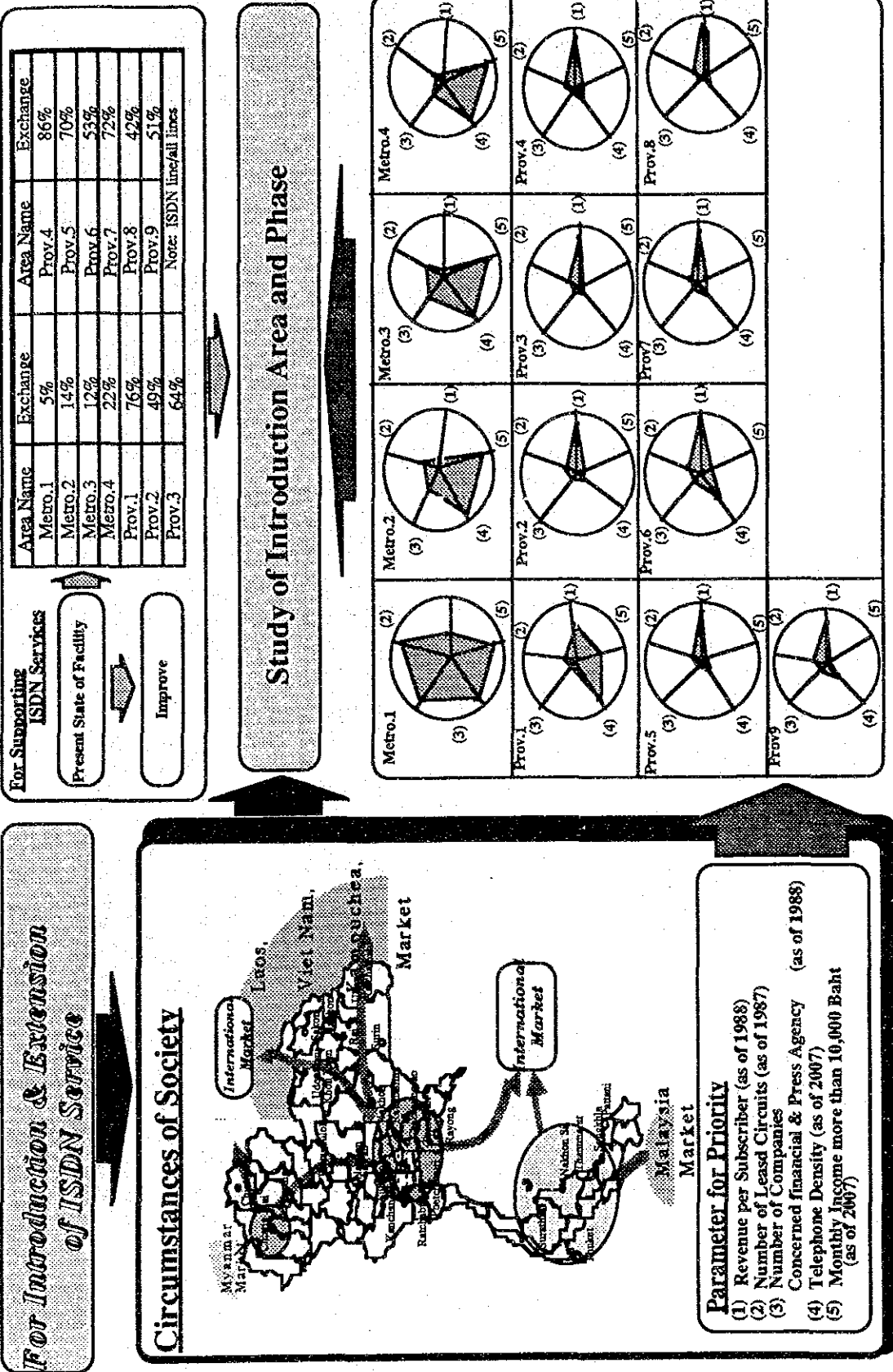


Figure 7.2-1 Circumstances Relating to ISDN Introduction

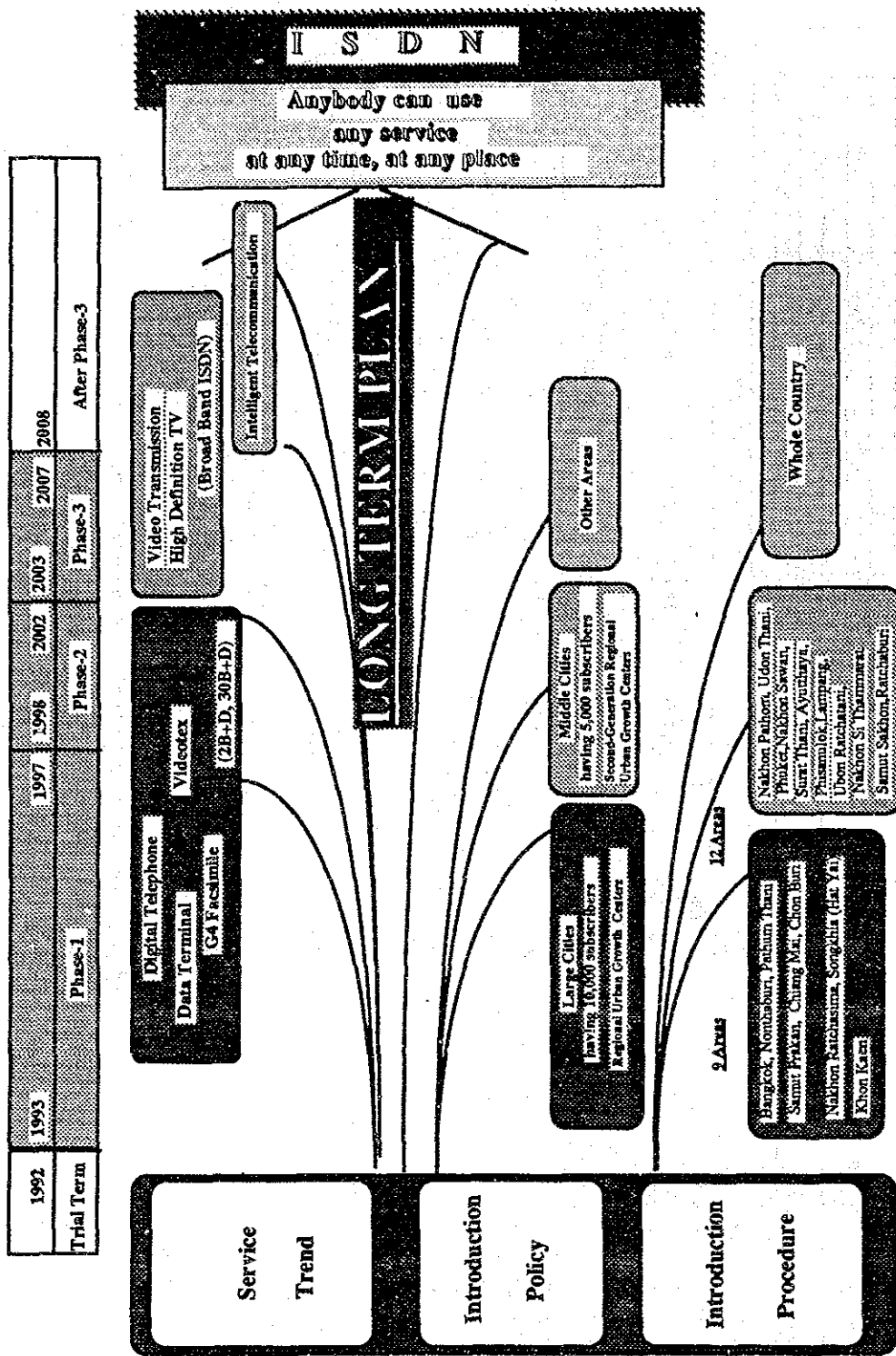


Figure 7.2-2 Evolution of ISDN Services

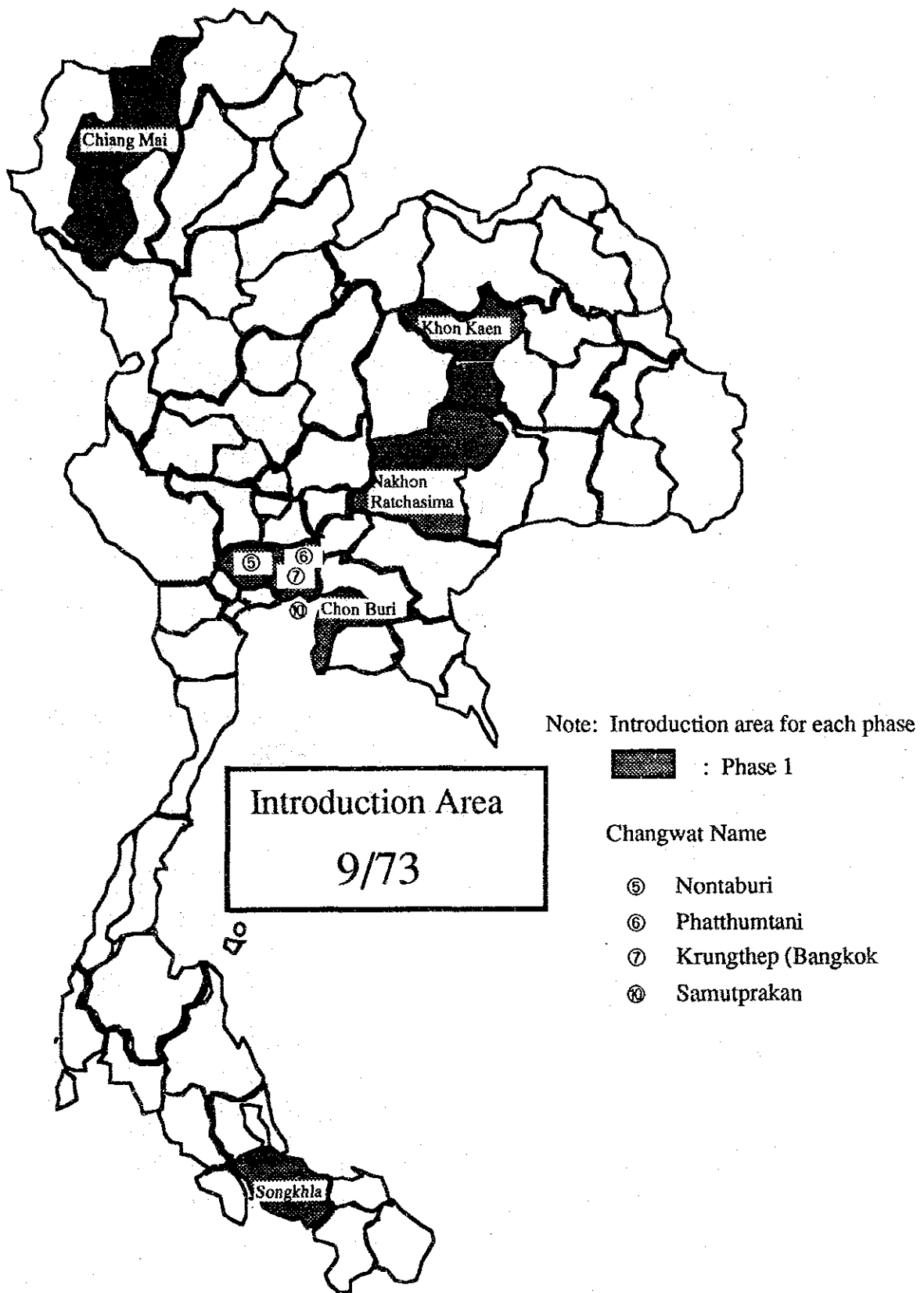


Figure 7.2-3 ISDN Introduction Area (End of Phase-1)

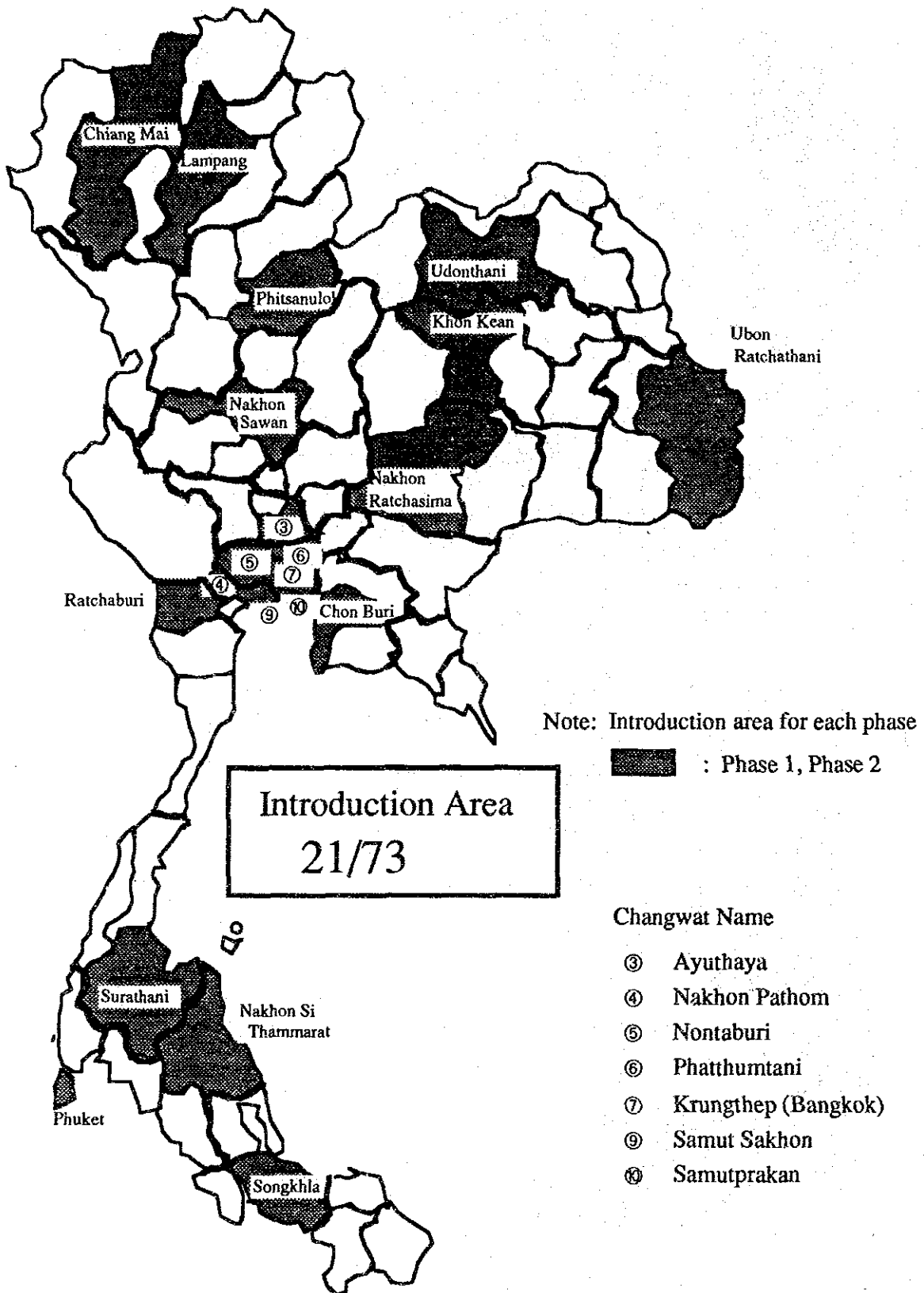


Figure 7.2-4 ISDN Introduction Area (End of Phase-2)

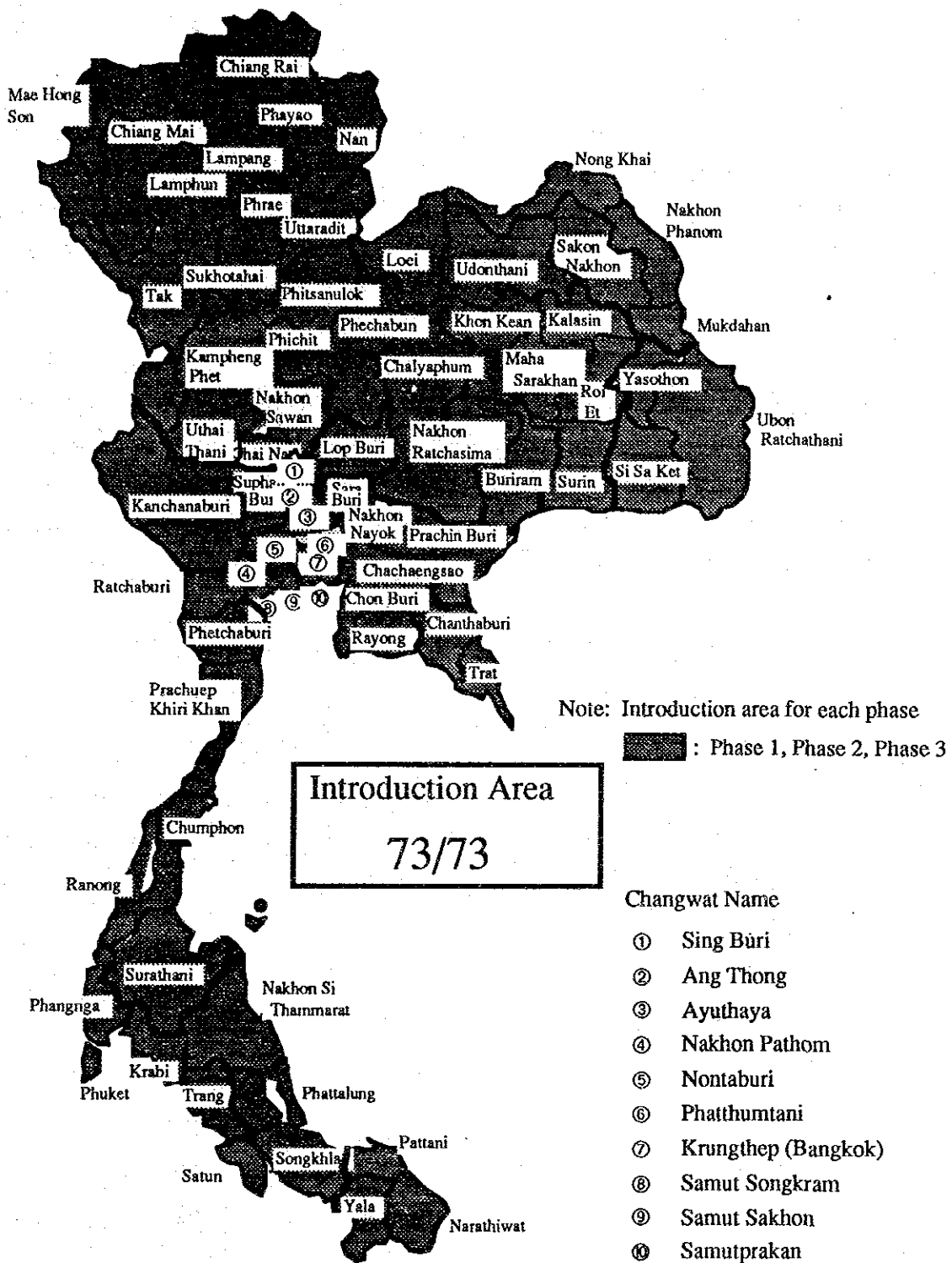


Figure 7.2-5 ISDN Introduction Area (End of Phase-3)

7.3 Network Management

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 mean time, 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 what has been available up to now, in order to manage the telecommunication systems in both quantity and quality.

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, an integrated network management system is proposed as shown in Figure 7.3.

To improve the present situations and to utilize the existing facilities in more efficient manner, Outside Plant Maintenance Center (OPMC) should be installed at all telecommunication areas. The expansion of OPMCs should be carried out taking the on-going expansion project, long-term plan, and present situation of maintenance activity into considerations.

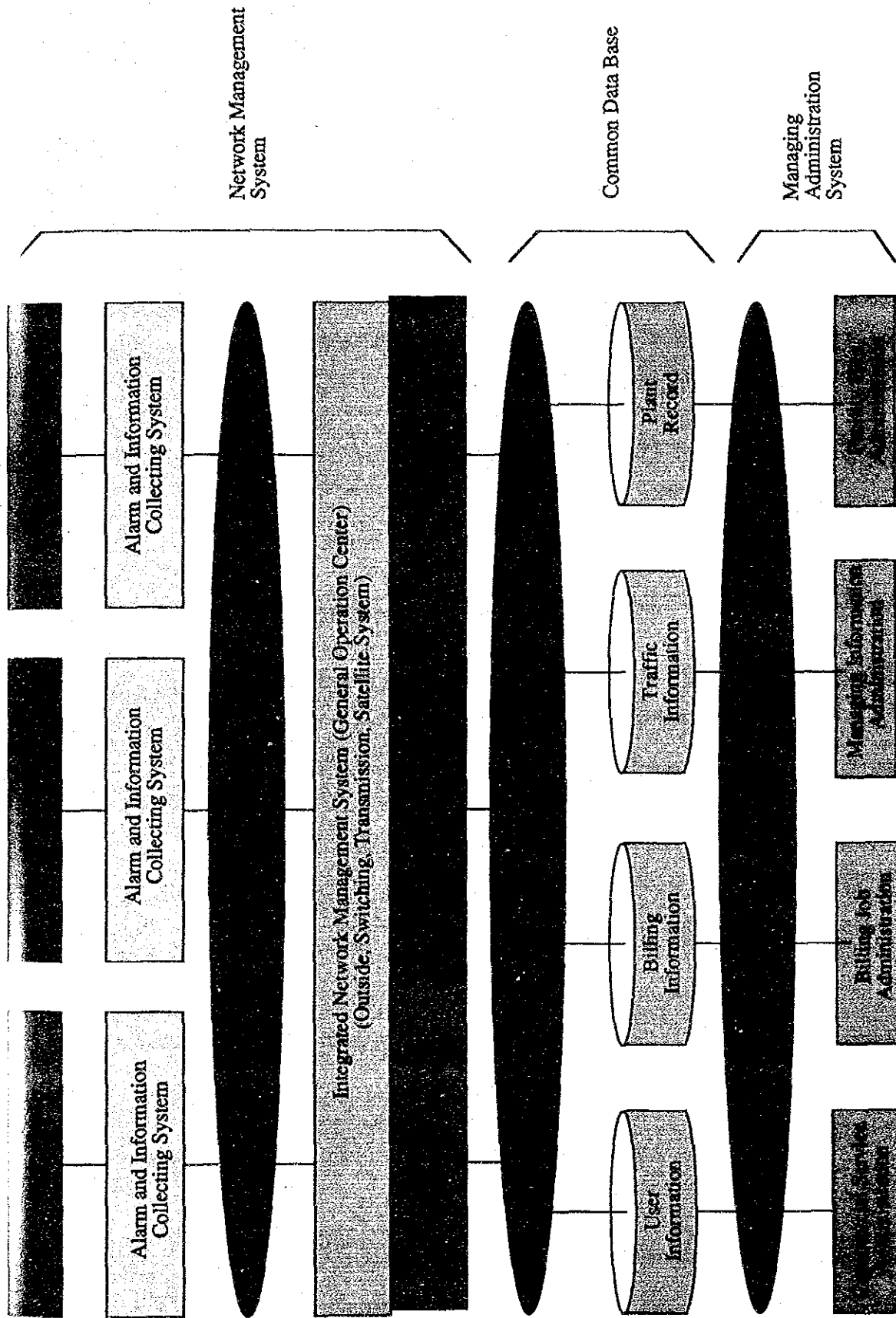


Figure 7.3 Integrated Network Operation System (Phase-3)

CHAPTER 8. TELECOMMUNICATION FACILITY EXPANSION PLAN

This chapter presents a future installation and expansion plan of telecommunication network in Thailand covering the period from 1993 until 2007 on the basis of telephone service demand and traffic forecast. Table 8 shows the summary of facility plan in this study.

8.1 Installation Schedule

1) Main Telephone

The main telephone 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 these 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 21,600 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.

8.2 Switching Facilities

The expansion 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.

8.3 Transmission Facilities

1) Long Distance Transmission System

Proposed plans 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, 87 systems during Phase-3 and total 205 systems.

2) Metropolitan Junction Transmission System

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

3) Spur Route Transmission Systems

The numbers 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.

4) Satellite Communication System

For satellite communication system, 17 earth stations will be installed during Phase-1, 5 earth stations during Phase-2, 4 earth stations during Phase-3 and total 26 earth stations.

8.4 Outside Plant Facilities

1) 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.

2) Rehabilitation Plan

About 4.1 billion bahts are proposed for the rehabilitation of outside plants during the period of 1993 to 2007. As the results of this rehabilitation plan, the fault ratio can be expected 1.3 per 100 subscribers per month at the end of Phase-3.

8.5 Mobile Communication Facilities

1) Cellular Mobile Facilities

The 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.

2) 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 and total 140,000 line units.

8.6 Leased Circuit and Data Communication Facilities

1) Leased Circuit

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

2) Data Communication Facilities

Packet switching facilities are planned 10,000 lines during Phase-1, 23,000 lines during Phase-3 and total 83,000 lines.

8.7 Investment Cost

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.

The summary of these expansion plan are shown in Figure 8.2, Figure 8.3 and Figure 8.4.

Table 8 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)
Switching Facility	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)
Building	(Provincial) (pair)	(1,862,000)	(1,109,000)	(1,332,000)	(4,303,000)
		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

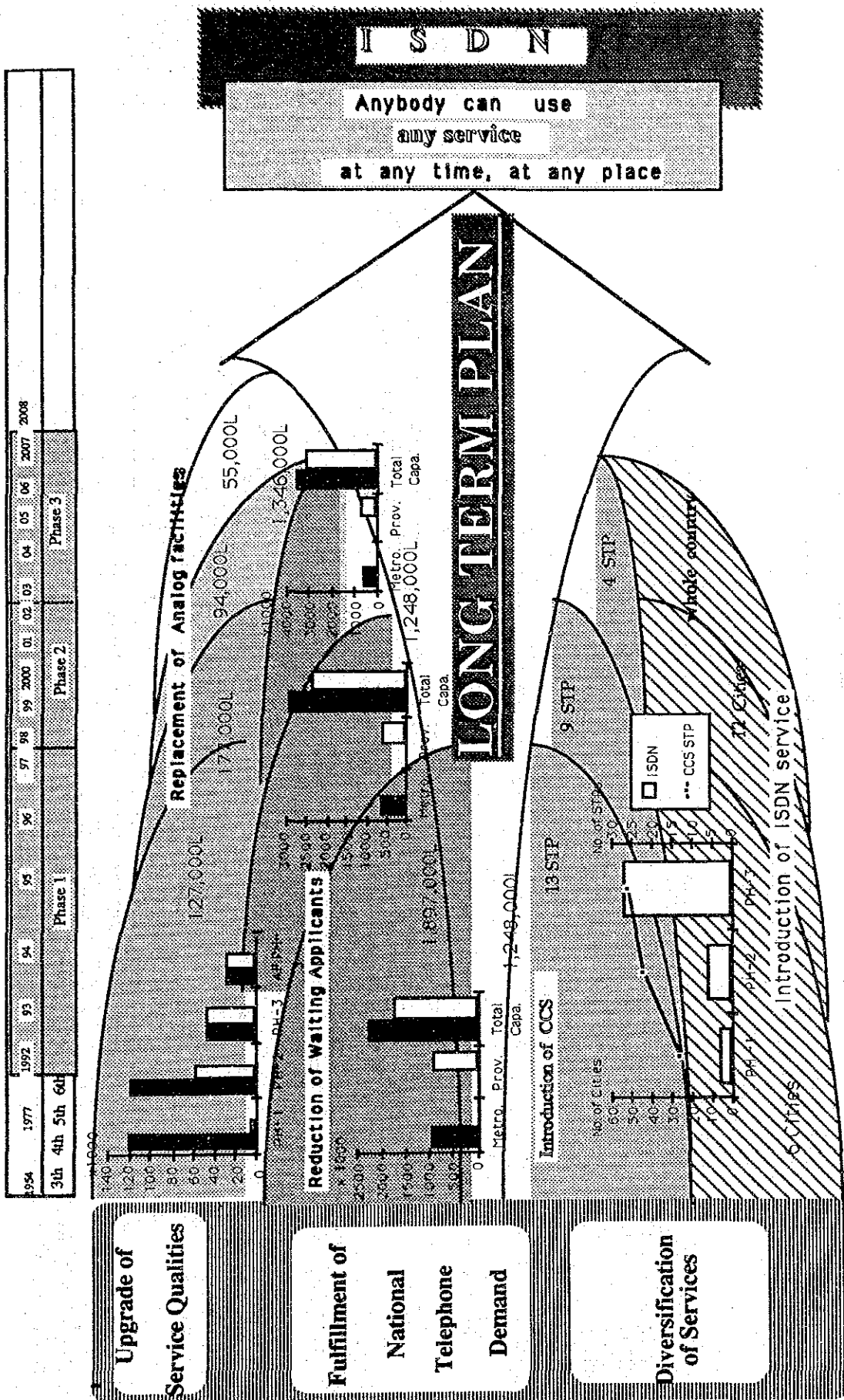


Figure 8.2 Summary of Switching Expansion Plan

1954	1977	1992	93	94	95	96	97	98	99	2000	01	02	03	04	05	06	2007	2008					
3rd			4th		5th		6th		Phase 1										Phase 2			Phase 3	

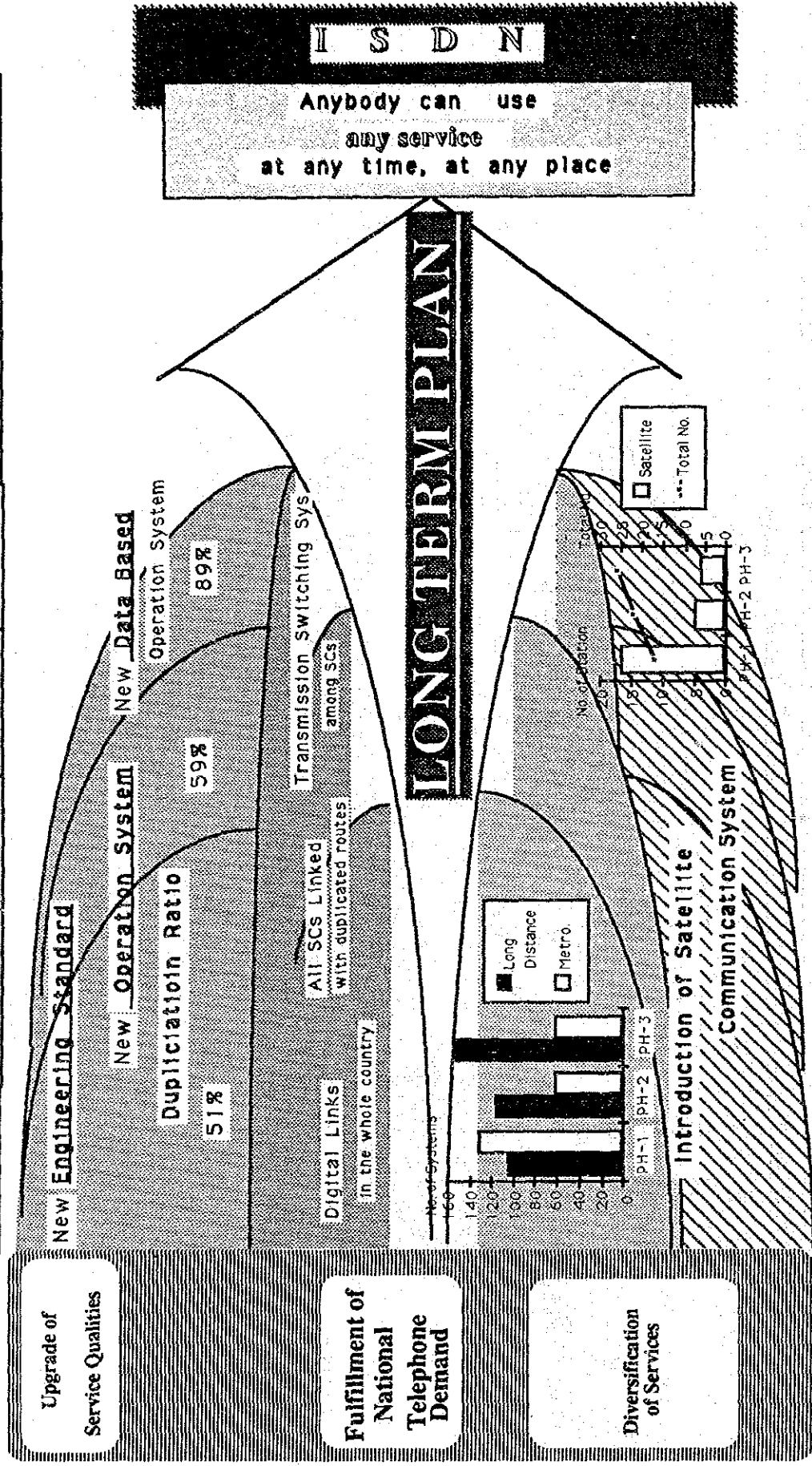


Figure 8.3 Summary of Transmission Long Term Plan

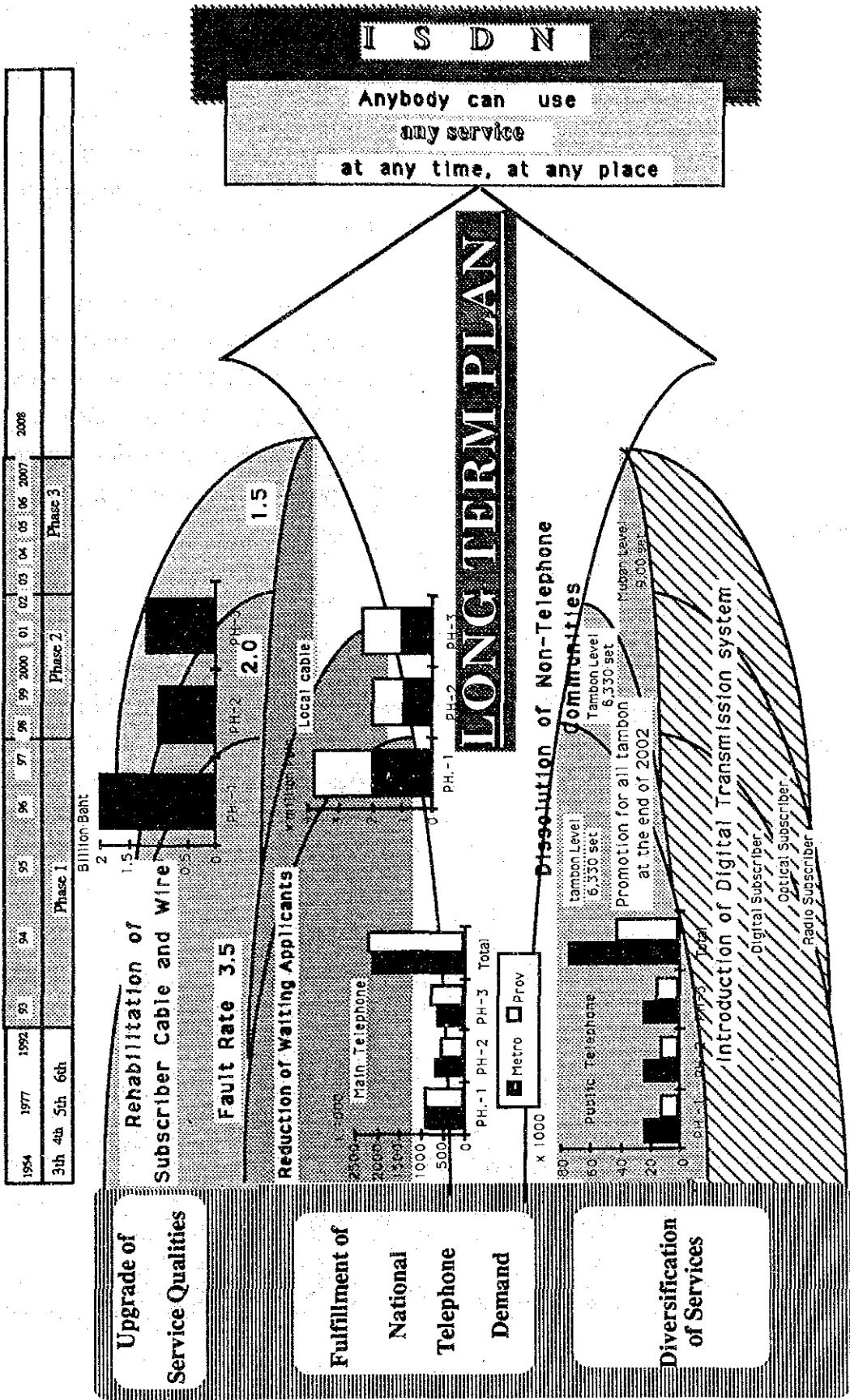


Figure 8.4 Summary of Outside Plant Expansion Plan

CHAPTER 9. FINANCIAL ANALYSIS

9.1 Objective and Methodology of Financial Analysis

The objective of this chapter is to analyze and examine profitability of the project from a financial point of view. The outputs of this chapter are estimates of future revenues (Financial In-Flow), costs (Financial Out-Flow), cash flow, and FIRR of the Project.

The long term development plan, which consists of three five-year intervals between the fiscal years of 1993 and 2007, is considered as one project in this study. The project life is set to be 35 years from FY 1993. Fifteen years from FY 1993 to FY 2007 are regarded as the construction period of the project (Phase-1, Phase-2, and Phase-3). After completion of all the construction, additional 20 years will be assumed as a remaining operation period considering service lives of telecommunication facilities. The operation will start from the beginning of the project life, i.e., FY 1993.

9.2 Revenue Estimation

This section presents estimated revenues of installation charge, monthly charge, local call charge, and trunk call charge from business, residence, and government subscribers, and the revenue from public telephones. For the revenue estimation from the project, the total revenue from the network is calculated at first by regression analyses. After that, the revenue from the project is divided according to the telephone line shares of the existing facilities and the future expanded facilities as shown in Figure 9.2.

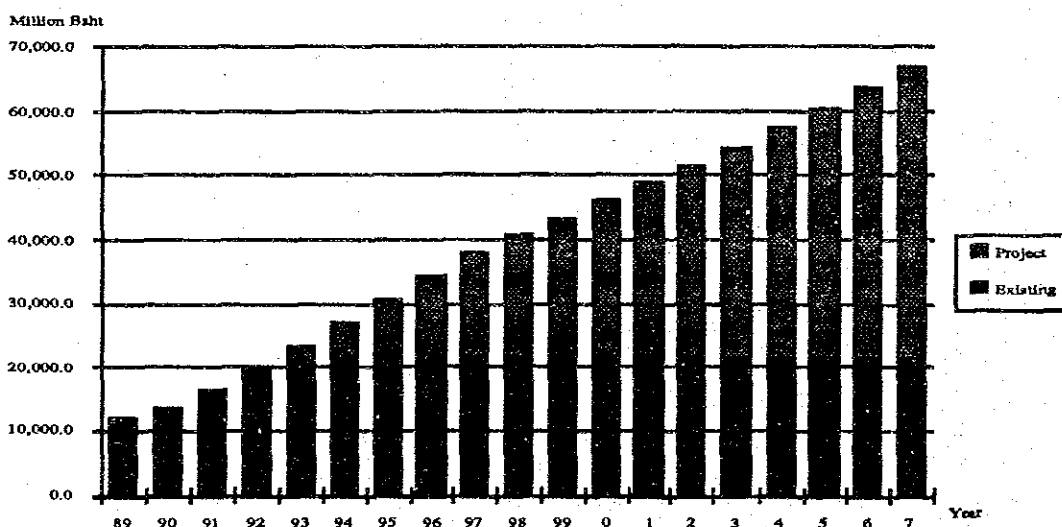


Figure 9.2 Operating Revenue Estimation of the Project

9.3 Cost Estimation

This section estimates the Project costs which are composed of the following items: installation cost (initial investment cost and replacement and rehabilitation cost), working capital, working cost, tax (remittance to the Treasury), and financial cost. Figure 9.3 shows the installation costs of three phases.

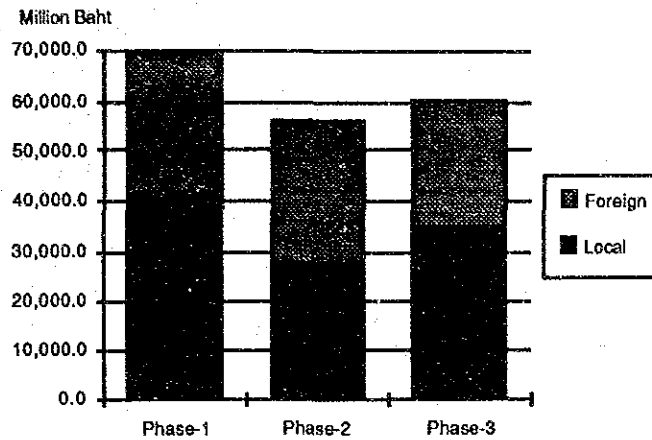


Figure 9.3 Foreign and Local Portion of the Total Installation Cost

9.4 Financial Cash Flow

This section shows the cash flows of the Project. The FIRR of the Project without long-term debt is calculated as 13.87%, which indicates that the Project is profitable by itself on the basis with those assumptions described in the previous sections.

From the viewpoint of financing, the amount of the required fund is approximately 14 billion Baht at FY 1992, which will be almost 71% of the total operating revenue estimate of the same year. Figure 9.4 shows net cash flow trend from FY 1992 until 2007.

Negative accumulated net cash flow will keep increasing until 1996 and reaches approximately 51 billion Baht. This amount will be almost 148% of the total operating revenue estimate of the same year. From FY 1997, total cash in-flow will start exceeding total cash out-flow and negative accumulated net cash flow will begin to decrease.

In order to provide for the Project's initial investment cost, it is assumed that 75% of the initial investment cost is provided by a long term loan from outside sources.

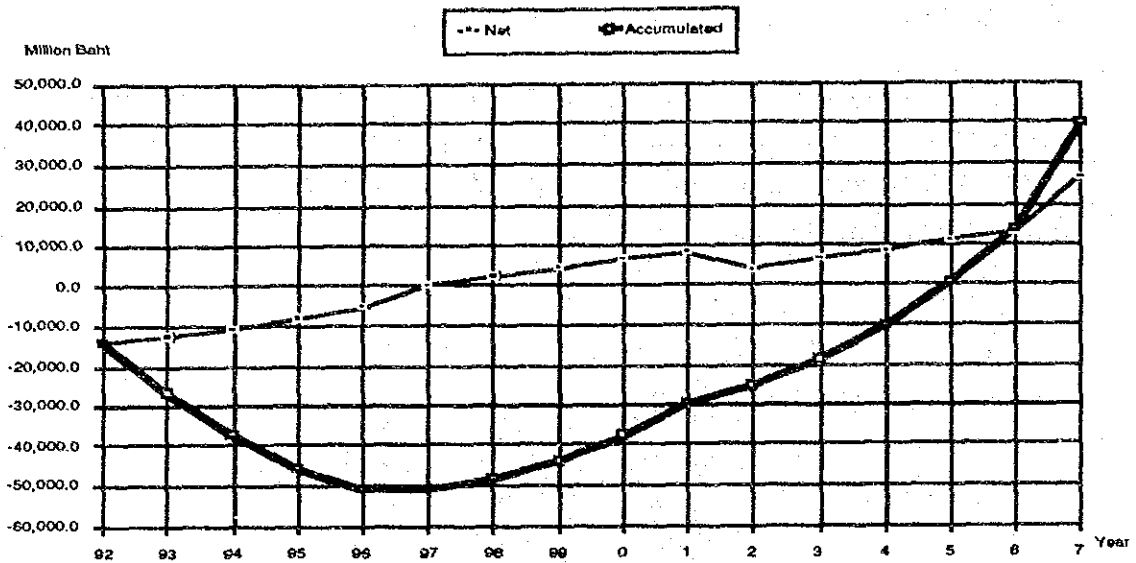


Figure 9.4 Net Cash Flow and Accumulated Net Cash Flow without Borrowings

9.5 Sensitivity Analyses

The financial internal rate of return of the Project is 13.87% without borrowings and 14.89% with 75% borrowings when the Project is implemented on the conditions set in the previous sections of this chapter. In general, these conditions and assumptions could be changed in the long term plan. Therefore, we set assumptions of fluctuation ranges of the operating revenue, installation cost, and the working cost, which are main constituent parts of calculating FIRR, and examine sensitivities how these items' fluctuations affect on the financial internal rate of return. We analyze FIRR without borrowings here.

We consider following cases:

- 1) The operating revenue (the local and trunk revenues of ordinary subscribers):
 - a) 10% increase,
 - b) 10% decrease.

- 2) The installation cost due to the outside plant cost fluctuations:
 - a) 30% increase,
 - b) 50% increase.

- 3) Operating cost increases because the number of employees increase by more than 2% per year and becomes 32,000 at the end of FY 2007.

Figure 9.5 shows net present value curves of the operating revenue fluctuations cases

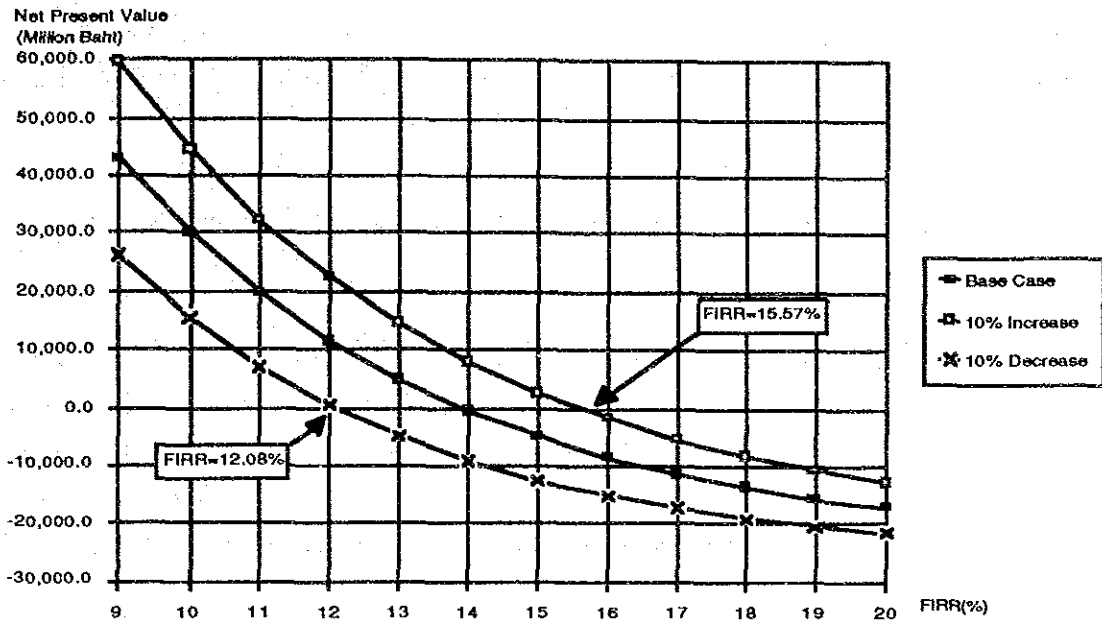


Figure 9.5 Net Present Values of Revenue Fluctuation Cases

Table 9.5 shows the result of the sensitivity analyses of the Project. The sensitivity analyses indicate that this Project is feasible enough from a financial point of view.

Table 9.5 Summary of Financial Analysis of the Project

(Unit: percent)

Case	Financial Internal Rate of Return (FIRR)
Base Case	13.87
Base Case with Borrowings	14.89
Sensitivity Analyses	
10% Revenue Increase	15.57
10% Revenue Decrease	12.08
30% Outside Plant Cost Increase	11.68
50% Outside Plant Cost Increase	10.46
Employee Increase Case	13.33

CHAPTER 10. ECONOMIC ANALYSIS

- 1) Chapter 9 examined the financial profitability and fund management plans of the Master Plan. Chapter 10 examines how much nation-wide economic benefits of the the Master Plan can generate. To do so, the sectoral production functions are used as basic analytical tools.
- 2) The premises of the analysis are the same as those made in the financial analysis in Chapter 9.
- 3) The sectoral outputs of the agricultural, manufacturing, and other remaining sectors will be estimated for the years between 1987 and 2027 by the sectoral production functions for the with and without the Master Plan cases.
- 4) The difference between the estimated outputs with and without the Master Plan was obtained as the economic benefit of the Master Plan.
- 5) The telecommunications investment by the Master Plan was estimated to contribute to increase the sectoral outputs by the minimum 0.34% and the maximum 4.77% in the agricultural sector, the minimum 0.24% and the maximum 3.72% in the manufacturing sector, the minimum 0.12% and the maximum 1.67% in the other remaining sectors between 1994 and 2027.
- 6) With the estimated economic benefit expressed as the sum of the increment of the three sectoral outputs produced by the Master Plan and the construction and operational costs obtained in Chapter 9 for the years between 1992 and 2027, the Economic Internal Rate of Return (EIRR) was calculated for the Master Plan.

The EIRR of the Master Plan was calculated as 24.17%. This is higher than the FIRR, 13.87%; therefore, the Master Plan is proved to be not only profitable and feasible from the operating entity's point of view but also quite beneficial to the society.