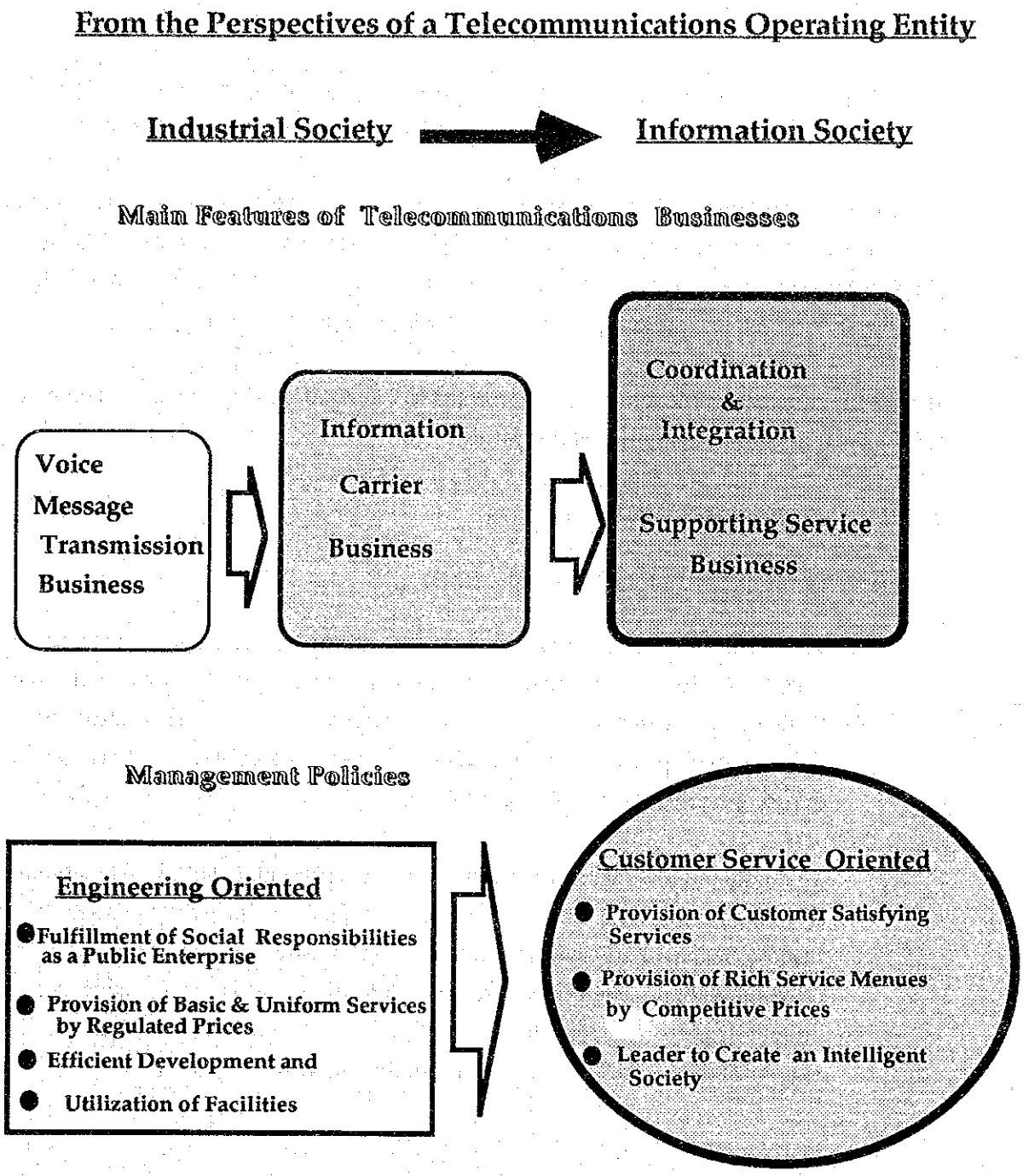

Figure 18.2.2 Social Development Stages and the Roles of Telecommunications (3/3)

3) Effect on Socioeconomic Development

As mentioned in Chapter 2, the most likely scenario in the future development of Thailand can be summarized from the viewpoint of socioeconomic outlook as follows:

Industrial and regional development will progress in a moderate speed. The Thai economy can expect real average annual GDP growth rate of 8% for the next 20 years. The government will increase public sector investment to 7% in 1992 and maintain that level thereafter. The real effective exchange rate will be kept unchanged.

The telecommunications development is expected to support the following socioeconomic development as an info-communications infrastructure.

a) Domestic Economic Viewpoint

i) Development of Industries in the BMR

The BMR will moderately grow over the three directions discussed in Chapter 2. Some of the planned road / highways are not developed yet. The BMR still lacks an effective mass transportation network. Basic infrastructure will be developed along major roads. Some socioeconomic activities will diffuse out towards the outer areas from the central business district (CBD).

Moderate improvement in basic infrastructure arround Bangkok and medium-scale regional development efforts in the first ranked cities will be made. The Eastern Seaboard area will moderately develop heavy chemical industries by utilizing natural gas produced in the Gulf of Siam and labor intensive export oriented industries. Disparities of growth rates and income levels among regions and industrial sectors will be slightly narrowed.

ii) Development of Agro-Industies in the BMR

Agro-industries and labor intensive industries will be moderately developed to exploit the inexpensive but good quality labor workers and richly endowed agro-resources.

In this scenario, the completion of the long-term plan and proposed projects will partially support to realize the above mentioned socioeconomic growth of the country as the information infrastructure of the society.

b) Economic Impact to the Asian Country

Thailand's competitive advantages as an export base for both foreign and domestic export oriented firms over other ASEAN countries will remain unchanged.

Thailand will make moderate efforts in

i) promoting development of manufacturers of parts and components, and intermediate industrial materials for export oriented industries,

ii) promoting development of human resources in the areas of engineers, professionals and middle management personnels.

The political and economic significance of Thailand will slightly increase as the gateway to Laos, Kampuchea, and Viet Nam. Thailand will play a leading role for assisting the economic recoveries of the Indochina countries. Thailand becomes a production base for what they need for their economic recoveries. However, the economic recoveries of these countries will be slow. The Bahts based trading zone will slowly penetrate into the Indochina countries.

18.3 Issues to be Considered for the Implementation of the Long-term Plan

18.3.1 Outlook of Projects Implementation

TOT has already decided to adopt a new project implementation and management scheme, i.e. Build, Transfer and Operation (BTO) during its seventh ESDP period for its local network and facility expansion project in order to fulfill the increasing telephone demand and eliminate waiting applicants for the telephone service. Under this scheme, TOT grants a concession to a private firm by letting them install two million subscriber lines in the BMA during its seventh ESDP period. Further more, it is considered that other projects in the long-term plan may be carried out by private firms in the TOT seventh ESDP period.

However, TOT should perform overall management of domestic telecommunications networks including those operated by the private firms. TOT is expected to carry out network planning, traffic management, numbering plan, signalling systems, etc. as the leading government enterprise in the telecommunications field. Therefore, the Study Team expects that these projects will be entirely coordinated and managed by TOT during the long-term plan period.

Every plan and project need three kinds of resources, i.e. money, materials and man power, to be controlled and managed efficiently. Figure 18.3.1 shows the long-term plan implementation flow. Every effort is required to implement the plan and projects with efficient network

and facility management, proper staff allocation and human resource development, the systematic cost control and financial management.

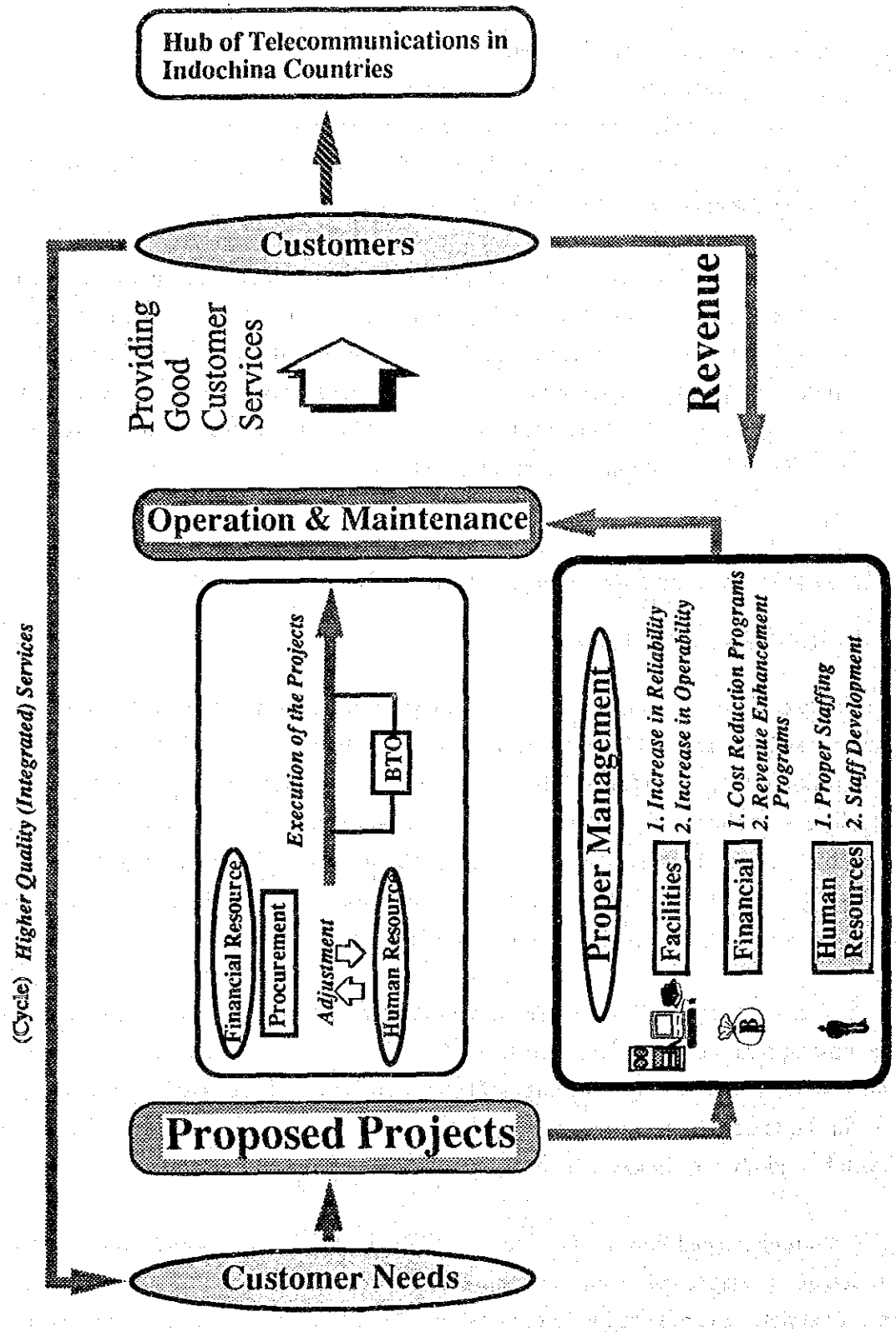

Figure 18.3.1 Flow of the Plan and Projects Implementation

18.3.2 Financial Capability

As mentioned above, TOT adopted a BTO scheme in the seventh TOT ESDP period. It is pointed out that one reason for TOT to adopt this method is the limitation of the foreign loan allocation for governmental enterprises. In order to escape from the tight fund availability which TOT should follow, TOT may consider again to apply BTO schemes in the future projects as long as TOT operates its business as a state-owned enterprise.

There are already many private telecommunications service providers under the concession basis in Thailand, who operate mobile telecommunications services such as paging and cellular mobile services, satellite communications services, data communications services, and various value added services (VAN).

Some developed countries have privatized their monopolized state-owned telecommunications operating entities, and deregulated the market. As the result, the telecommunications market has become liberalized and competitive. Many private operators are competing each other to provide better and less costly services not only in enhanced telecommunications services field but also in long-distance and local telephone services.

There is no guarantee for TOT to be able to maintain its position as a state enterprise monopolizing the domestic telecommunications networks and services in the future. Therefore, it is essential for TOT to improve its financial capability to compete with the private operators and provide better quality and more efficient services for its customers with economical prices.

18.3.3 Construction and Installation Capacity

In the long-term plan period, TOT is required to install the largest number of subscriber telephone lines during the Phase-1. The seventh TOT ESDP expansion projects will be carried out with a BTO scheme to meet the demand for telephone: approximately two (2) million subscriber lines for the BMA and one (1) million for the provincial area. For the efficient and smooth implementation of the long-term plan and its large-scale installation projects, the following construction and installation policies should be considered.

1) Active appliance of new technologies and techniques for construction and installation is necessary to carry out the mass installation work in order to save construction period and investment cost.

2) Normalization and levelling of construction and installation work volume are important to keep the work force in a constant level and improve their capability. Normalization and levelling are also necessary to improve productivity of telecommunications equipment manufacturers and shorten a procurement period. Local production is one of the effective measures to procure necessary materials economically with a stable level of quality and quantity.

3) Total project management is necessary for TOT in order to assure smooth and efficient construction work for switching systems, transmission systems, outside plant, and civil engineering. The key function of the total project management is to find out any difficulty on construction, to recover any delay and bottleneck of construction, and to complete construction and installation as soon as possible and as economically as possible.

4) An appropriate contract price is indispensable for contractors to constantly maintain technicians and workers who have efficient abilities and to improve their technical level. Supervisory work, instruction manual, acceptance test and procedure, and reporting should be more simple and accurate. It is necessary to check contractors' technical level, construction capacity, and management capability. It is also important to lead them to the proper level of these capacity and capability with continuous orders.

5) Various permission and approval procedures should be simplified so that the required period should become shorter. Not only the approval procedures but also the approval organization structure should become simple.

18.3.4 Follow-up of the Project Implementation (Operation & Maintenance)

1) Operation & Maintenance Systems and Structure

In this study, the Study Team proposed the establishment of an integrated network management system in the switching and transmission section and a reinforcement of the outside plant maintenance center (OPMC). The both are planned to be established in the Phase-1. If they start working, the maintenance and operation of telecommunications networks and facilities is expected to improve their performance and increase their efficiency.

2) Human Resources Management and Development

The human resources need to play more important roles as the telecommunications networks and facilities expand, telecommunications services grow, and the telecommunications technology changes. The advanced telecommunications networks and systems can not function well without adequate human resources and its management system.

The human resources development is required not only for implementing the long-term plan and projects but also for following up the plan. Both human resources management and human resources development are key factors for the successful implementation of the long-term plan. The former includes skill management and manpower management and the later includes technical and management training and education. TOT should promote the human resources management and education during the long-term plan period.

18.3.5 Consideration on Project Implementation

The proposed projects can be classified into a few technical and administrative fields. For implementation of these projects, the following policies should be taken into consideration.

1) Effective Implementation

Telecommunications services and networks should be expanded efficiently from the viewpoints of rendering better services and also effective investment.

For this reason, projects aiming at the same purpose in the same area should be coordinated to be carried out in the same period. For example, implementation period of a switching facility expansion project and an outside plant facility expansion project should be adjusted to the same time as much as possible.

Both expansion projects and rehabilitation projects should be well coordinated to avoid duplicated construction works and save construction period and investment costs.

As described in Chapter 9 and Chapter 17, the Study Team put the priority on the proposed projects; and put a ranking on the Study Area for implementing the projects efficiently.

2) Coordination with National Development Policies

Reinforcement of telecommunications services in appropriate time will bring a great impact for sound development of each socioeconomic sectors. Therefore, implementation of the projects should be carried out not only in the developed areas but also the developing areas in accordance with the National Economic and Social Development Plan.

APPENDIX

CHAPTER 1 INTRODUCTION

APPENDIX

MINUTES OF THE MEETINGS
ON
INCEPTION REPORT
FOR
A STUDY
ON
REGIONAL DEVELOPMENT PLAN
FOR
TELECOMMUNICATIONS NETWORK
IN
THE BANGKOK METROPOLITAN AREA
IN
THE KINGDOM OF THAILAND

The meetings were held on 19th and 22nd of July 1991 between Telephone Organization of Thailand (hereinafter referred to as "TOT") and the JICA Study Team (hereinafter referred to as "the Team") on the Inception Report (hereinafter referred to as "the Report") for a Study on Regional Development Plan for Telecommunications Network in the Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study"). The attendants of the meetings are shown in Annex-1.

1. The Team explained the Report and TOT accepted the Report.

2. Through the meetings, the following items have been agreed on between the both sides.

(1) TOT proposed to provide the Team with counterpart groups for each section and the Team accepted it.

(2) TOT explained that counterparts would be selected from Corporate Planning Office, Operation Department, Engineering Department, Human Resources Department, and Financial Department.

(3) For the purpose of mutual cooperation between TOT and the Team, and smooth execution of the Study, TOT counterpart groups and the Team members will have group meetings regularly once a week. All the counterpart members will have progress meetings regularly once a month.

(4) In the process of the Study, the Team will work in close cooperation with TOT counterparts and will make efforts to transfer technology through the meetings and discussions of the Study and the counterpart on-the-job-training in Japan.

(5) TOT requested the Team to consider new technologies such as Subscriber Optical Fiber Network, Asynchronous Transfer Mode (ATM), Synchronous Digital Hierarchy (SDH), to make the long-term plan and the Team accepted it.

(6) The Team requested TOT to provide necessary data and information in particular regarding the 7th EDP project. TOT tries to collect necessary data and information concerned the Study for the Team from the other organizations concerned.

(7) It was confirmed that JICA would accept one (1) counterpart for on-the-job-training in Japan in the Japanese fiscal year 1991 and that TOT would make necessary procedure. TOT wished to send more counterparts for on-the-job-training to Japan in the next Japanese fiscal year 1992. The Team promised to convey the wish to the Japanese organizations concerned.

Bangkok, July 22nd, 1991

Mr. Sanan PHIROMSWAD
Director of
Corporate Planning Office,
Telephone Organization of Thailand

Mr. Satoshi AKAIKE
Leader of the JICA Study Team

Mr. Osamu KOYAMA
Chairman of
Japanese Advisory Committee

ANNEX-1

ATTENDANTS LIST

July 19th, 1991

TOT

1.	Mr. Sanan PHIROMSWAD	Director of Corporate Planning Office
2.	Mr. Deacha MONGKOLRAT	Head of Corporate Planning Process Sector, Corporate Planning Office
3.	Mr. Chakree SUBPRAWONG	Counterpart Team leader, Corporate Planning Office
4.	Mr. Sawat CHAIYEN	Development Planning and Economy, Corporate Planning Office
5.	Mr. Amnuay THONGDEETARE	ditto
6.	Ms. Vilaiporn BOONYASURAKUL	ditto
7.	Miss Yupa LEEWONGCHAROEN	ditto
8.	Mr. Seree CHINTARATANA	Switching System, Corporate Planning Office
9.	Mr. Suwat NAKAPUNCHAI	ditto
10.	Ms. Jintana PRASERTSOM	Transmission System, Corporate Planning Office
11.	Capt. Akom KRACHANGMOL	ditto
12.	Mr. Kamron TEINTHONGDEE	Outside Plant and O&M, Corporate Planning Office
13.	Mr. Pichet LEEPITAKWATANA	ditto
14	Miss Atchada RUAMMAHASAP	Demand Forecast, Corporate Planning office

15.	Mr. Suwit TREJAREONWIWAT	New Services, Corporate Planning office
16.	Miss Chothip SUTHONTHUNYAKORN	ditto
17.	Miss Somsri NGOWROONGRUENG	Marketing Research, Corporate Planning office
18.	Miss Chanida SUKHAVIRAJ	Financial and Economic Analyses, Corporate Planning office
19.	Miss. Chadaporn KUNUDOM	ditto
20.	Ms. Valaikul SATTHARPHORN	Human Resources, Corporate Planning office
21.	Miss Ratree MALAISIRIRAT	ditto
22.	Ms. Kanungnid RATTANASEREEWONG	ditto

JICA Experts

23.	Mr. Toshihiro HIGUCHI	Engineering Department
24.	Mr. Masaaki KOTA	Telecommunication Network Department
25.	Mr. Sunao NANGU	Subscriber Services Department

Study Team

26.	Mr. Satoshi AKAIKE	Leader of JICA Study Team (NTTI)
27.	Mr. Katsumi MURAKAMI	Member (NTTI)
28.	Mr. Hiroshi NAKAI	ditto
29.	Mr. Hiroyuki KANO	ditto

Japanese Advisory Committee

30.	Mr. Osamu KOYAMA	Chairman (MPT)

31.	Mr. Kiyoshi KONO	Member (MPT)

JICA

32.	Mr. Noriki ASAHI	JICA Head Office

ATTENDANTS LIST

July 22nd, 1991

TOT

1.	Mr. Sanan PHIROMSWAD	Director of Corporate Planning Office
2.	Mr. Deacha MONGKOLRAT	Head of Coporate Planning Process Sector, Corporate Planning Office
3.	Mr. Chakree SUBPRAWONG	Counterpart Team leader, Corporate Planning Office
4.	Mr. Sawat CHAIYEN	Development Planning and Economy, Corporate Planning Office
5.	Mr. Seree CHINTARATANA	Switching System, Corporate Planning Office
6.	Ms. Jintana PRASERTSOM	Transmission System, Corporate Planning Office
7.	Mr. Kamron TEINTHONGDEE	Outside Plant and O&M, Corporate Planning Office
8.	Miss Atchada RUAMMAHASAP	Demand Forecast, Corporate Planning office
9.	Mr. Suwit TREJAREONWIWAT	New Services, Corporate Planning office
10.	Miss Somsri NGOWROONGRUENG	Marketing Research, Corporate Planning office

11. Miss Chanida SUKHAVIRAJ	Financial and Economic Analyses, Corporate Planning office
12. Ms. Valaikul SATTHARPHORN	Human Resources, Corporate Planning office

JICA Experts

13. Mr. Toshihiro HIGUCHI	Engineering Department

Study Team

14. Mr. Satoshi AKAIKE	Leader of JICA Study Team (NTTI)
15. Mr. Katsumi MURAKAMI	Member (NTTI)
16. Mr. Hiroshi NAKAI	ditto
17. Mr. Hiroyuki KANO	ditto

Japanese Advisory Committee

18. Mr. Osamu KOYAMA	Chairman (MPT)
19. Mr. Kiyoshi KONO	Member (MPT)

JICA

20. Mr. Noriki ASAHI	JICA Head Office

MINUTES OF THE MEETINGS
ON
INTERIM REPORT
FOR
A STUDY ON REGIONAL DEVELOPMENT PLAN
FOR
TELECOMMUNICATIONS NETWORK
IN
THE BANGKOK METROPOLITAN AREA
IN
THE KINGDOM OF THAILAND

The meetings were held on 20th and 21st of January 1992 between Telephone Organization of Thailand, (hereinafter referred to as "TOT") and the JICA Study Team (hereinafter referred to as "the Team") on the Interim Report (hereinafter referred to as "the Report") for a Study on Regional Development Plan for Telecommunications Network in the Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study")

The attendants of the meetings are shown in Annex.

1 Mr Sanan PHIROMSWAD, Director of Corporate Planing Office of TOT, expressed his gratitude to the Team members for their study, and Mr. Osamu Koyama, Chairman of Japanese Advisory Committee and Mr. Satoshi AKAIKE, Leader of the Team, appreciated the close cooperation of TOT counterparts.

2. The Team made a presentation of the Report and TOT accepted the Report.

3. Through the meetings, the followings have been agreed on between the both side.

3.1 Regarding the Report:

1) TOT pointed out that the demand forecasts for paging services and mobile telephone services should be reviewed again and the Team accepted to review the forecasts.

2) TOT and the Team confirmed that TOT will send comments and questions if any regarding the Report by the middle of February 1992 and the Team will clarify and take them into consideration in the Draft Final Report.

3) TOT pointed out that the concept of the operation right to the private firm should be changed to collaborating of work and investment with the private firm.

3.2 Regarding the Feasibility Study:

1) TOT and the Team confirmed that the title of the Feasibility Study to be conducted in the next phase of the Study is changed from "Replacement of Deteriorated Facilities" to "Implementation Plan to Upgrade the Telecommunications Services Quality".

2) TOT and the Team confirmed that the feasibility study will focus on the following objectives:
   a) Improvement of Fault Ratio,
   b) Improvement of Call Completion Ratio.

3) The Team will study the following measures which are related directly to the above mentioned objectives:
   a) Replacement of deteriorated facilities,
   b) Maintenance management standards,
   c) Installation and construction methods.

Bangkok, January 21st, 1992

Mr. Sanan Phiromswad
Director of Corporate Planning
Office,
Telephone Organization of Thailand

Mr. Satoshi Akaike
Leader of the JICA Study Team

Mr. Osamu Koyama
Chairman of
Japanese Advisory Committee

ANNEX

ATTENDANTS LIST OF THE MEETING on January 20, 1992

TOT

Name	Duty in Charge	Department
Mr Sanan Phiromswad	Director of Office of Corporate Planning TOT	Corporate Planning Office
Mr. Deacha Mongkolrat	Head of Process Sector of CPO	ditto
Mr. Apichat Indralagshana	Acting Head of Corporate Planning Policy	ditto
Mr. Chakree Subprawong	Leader of the Counterpart Team of TOT	ditto
Mr Sawat Chaiyen	Development Planning, Economy	ditto
Mr. Amnuay Thongdeetare	ditto	ditto
Ms. Vilaiporn Boonyasurakul	ditto	ditto
Ms. Issra Fongsrun	ditto	ditto
Mr Suwat Nacapunchai	Switching System	ditto
Ms. Jintana Prasertsom	Transmission System	ditto
Maj. Akom Krachangmol	ditto	ditto
Mr Kamron Teinthongdee	Outside Plant and O&M	ditto
Mr. Pichet Leepitakwatana	ditto	ditto
Mr. Tinnakorn Iterangkul Na Ayuthaya	Telecommunications Network, Traffic Forecast	ditto
Mr Somchai Vicmuktanont	ditto	ditto
Ms Atchada Ruammahasap	Demand Forecast	ditto
Mr. Taksin Hengtrakul	ditto	ditto
Mr. Suwit Trecharoenviwat	New Services	ditto

Name	Duty in Charge	Department
Ms. Chothip Suthonthunyakorn	ditto	Corporate Planning Office
Mr. Prateep Thirati	Marketing Research	ditto
Ms. Somsri Ngowroongrueng	ditto	ditto
Mr. Chanatip Vijakkhana	ditto	ditto
Ms. Apinya Klinfung	Marketing Research	ditto
Ms. Chanida Sukhaviraj	Financial and Economic Analysis	ditto
Ms Chadaporn Kunudom	ditto	ditto
Ms. Yupa Leewongcharoen	ditto	ditto
Ms. Valaikul Sattharphorn	Human Resources	ditto
Ms. Ratree Malasirirat	ditto	ditto
Ms. Kanungnid Rattanasereewong	ditto	ditto
Mr. Nimit Wattanutchariya	Switching System	Bureau of Engineering & Project
Mr. Prasert Manpiboon	ditto	Bureau of Operation
Mr. Charoen Wilaihong	Transmission System	Bureau of Operation
Mr. Sorrasak Sookthai	Traffic Forecast	Bureau of Engineering & Project
Ms. Wannaporn Lilahajiva	Financial	Bureau of General Affairs
Ms. Sanipong Hongspanij	Human Resources	ditto

JICA Expert

Mr. Toshihiko Higuchi	Engineering Department, TOT

Japanese Advisory Committee

Mr. Osamu Koyama	Chairman (New Service)	Senior Advisor for International Cooperation, Communications Policy Bureau, Ministry of Posts and Telecommunications (MPT)
Mr. Kiyoshi Kono	Member (Network Planning)	Assistant Director, Teleccomunications Systems Division, Telecommunications Bureau, MPT
Mr. Nozomu Goda	Member (Switching System Planning)	Info-communications Development Specialist, Institute for International Cooperation, Japan International Cooperation Agency (JICA)

The JICA Study Team

Mr. Satoshi Akaike	Leader of JICA Study Team, NTT International Corporation (NTTI)
Mr. Katumi Murakami	Assistant Team Leader / Transmission System Planning (NTTI)
Mr. Kiyoshi Mushu	Network Planning (NTTI)
Mr. Hiroyuki Kano	Financial and Economic Analysis (NTTI)

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Mr. Haruhiko Yoshida	JICA Head Office

ATTENDANTS LIST OF THE MEETING on January 21, 1992

TOT

Name	Duty in Charge	Department
Mr. Sanan Phiromswad	Director of Office of Corporate Planning TOT	Corporate Planning Office
Mr. Deacha Mongkolrat	Head of Process Sector of CPO	ditto
Mr. Chakree Subprawong	Leader of the Counterpart Team of TOT	ditto
Mr. Sawat Chaiyen	Development Planning, Economy	ditto
Mr. Ammuay Thongdeetare	ditto	ditto
Ms. Vilaiporn Boonyasurakul	ditto	ditto
Mr. Suwat Nacapunchai	Switching System	ditto
Ms. Jintana Prasertsom	Transmission System	ditto
Mr. Kamron Teinthongdee	Outside Plant and O&M	ditto
Mr. Pichet Leepitakwatana	ditto	ditto
Mr. Tinnakorn Itsrangkul Na Ayuthaya	Telecommunications Network, Traffic Forecast	ditto
Mr. Somuchai Vicmuktanont	ditto	ditto
Mr. Suwit Trecharoenviwat	New Services	ditto
Ms. Chothip Suthonthunyakorn	ditto	ditto
Mr. Prateep Thirati	Marketing Research	ditto
Ms. Somsri Ngowroongrueng	ditto	ditto
Mr. Chanatip Vijakkhana	ditto	ditto
Ms. Chanida Sukhaviraj	Financial and Economic Analysis	ditto
Ms. Chadaporn Kunudom	ditto	ditto
Ms. Yupa Leewongcharoen	ditto	ditto
Ms. Valaikul Sattharphorn	Human Resources	ditto

Sanan SA

Name	Duty in Charge	Department
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Ms. Kanungnid Rattanasereewong	ditto	ditto
Mr. Nimit Wattanutchariya	Switching System	Bureau of Engineering & Project
Mr. Prasert Manpiboon	ditto	Bureau of Operation
Mr. Thawisak Kittijarurak	Transmission System	Bureau of Engineering & Project
Mr. Sorrasak Sookthai	Traffic Forecast	ditto

JICA Expert

Mr. Toshihiko Higuchi — Engineering Department, TOT

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Mr. Osamu Koyama	Chairman (New Service)	Senior Advisor for International Cooperation, Communications Policy Bureau, Ministry of Posts and Telecommunications (MPT)
Mr. Kiyoshi Kono	Member (Network Planning)	Assistant Director, Teleccomunications Systems Division, Telecommunications Bureau, MPT
Mr. Nozomu Goda	Member (Switching System Planning)	Info-communications Development Specialist, Institute for International Cooperation, Japan International Cooperation Agency (JICA)

The JICA Study Team

Mr. Satoshi Akaike — Leader of JICA Study Team, NTT International Corporation (NTTI)

Mr Katumi Murakami	Assistant Team Leader / Transmission System Planning (NTTI)
Mr. Kiyoshi Mushu	Network Planning (NTTI)
Mr Hiroyuki Kano	Financial and Economic Analysis (NTTI)

JICA

Mr. Haruhiko Yoshida	JICA Head Office

MINUTES OF THE MEETINGS
ON
DRAFT FINAL REPORT
FOR
A STUDY ON REGIONAL DEVELOPMENT PLAN
FOR
TELECOMMUNICATIONS NETWORK
IN
THE BANGKOK METROPOLITAN AREA
IN
THE KINGDOM OF THAILAND

The meetings were held on 11th, 13th and 14th of August, 1992 between Telephone Organization of Thailand (hereinafter referred to as "TOT") and the JICA Study Team (hereinafter referred to as "the Team") on the Draft Final Report (hereinafter referred to as "the Report") for a Study on Regional Development Plan for Telecommunications Network in the Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study").

The attendants of the meetings are shown in Annex.

K.S.

1. Mr. Sanan PHIROMSWAD, Director of Corporate Planning Office of TOT, expressed his gratitude to the Team members for their study, and Mr. Kaoru SUZUKI, Chairman of Japanese Advisory Committee and Mr. Satoshi AKAIKE, Leader of the Team, appreciated the close cooperation of TOT counterparts.

2. The Team made a presentation of the Report and TOT accepted the Report.

3. Through the meetings, the followings have been agreed between the both sides.

1) TOT pointed out that in the measures for the faulty public telephones, it should be considered not only by way of the replacement but also by way from the viewpoint of the effective usage of the existing facility.

The Team accepted to add necessary measures for it in the Final Report.

2) TOT pointed out that the replacement of XB switches with SPC switches should be considered further from the availability of maintenance parts of XB switches in the future.

The Team replied to add necessary comments on this matter in the Final Report.

SA

K.S.

3) TOT pointed out the cost for the replacement of XB switches with SPC switches seemed to be underestimated. The Team replied to reestimate it again for the Final Report.

TOT and the Team confirmed that TOT will send comments and questions, if any, regarding the Report by 15th of September, 1992. The Team will clarify comments and questions and, if necessary, take them into consideration in the Final Report.

Bangkok 17th August, 1992

Sanan Phiromswad

Mr.Sanan PHIROMSWAD
Director of Corporate Planning Office,
Telephone Organization of Thailand.

S. Akaike

Mr.Satoshi AKAIKE
Leader of the JICA
Study Team

鈴木薫

Mr.Kaoru SUZUKI
Chairman of
Japanese Advisory Committee

K.S.

Sanan

Annex

ATTENDANTS LIST OF THE MEETINGS

on August 11, 1992

Name	Duty in Charge	Department
TOT		
Mr.Deacha MONGKOLRAT	Head of Process Sector of Corporate Planning Office	(CPO)
Mr.Chakree SUBPRAWONG	Leader of the Counterpart Team of TOT	CPO
Mr.Seree CHINTARATANA	Switching System	CPO
Mr.Suwat NAKHAPHANCHAI	ditto	CPO
Ms.Jintana PRASERTSOM	Transmission System	CPO
Maj.Arkom KRACHANGMOL	ditto	CPO
Mr.Kamron TEINTHONGDEE	Outside Plant and O&M	CPO
Ms.Chothip SUTHONTHUNYAKORN	ditto	CPO
Mr.Pichet LEEPITAKWATANA	ditto	CPO
Mr.Somchai VICMUKTANON	Telecommunications Network and Traffic	CPO
Ms.Chanida SUKHAVIRAJ	Financial and Economic Analyses	CPO
Ms.Yupa LEEWONGCHAROEN	ditto	CPO
Ms.Chadaporn KUNUDOM	ditto	CPO
Ms.Atchada RUAMMAHASAP	Demand Forecast	CPO
Mr.Amnuay THONGDEETARE	Development Planning, Economy	CPO

Mr.Nimit WATTANUTCHARIYA	Switching System	Bureau of Engineering and Project
Mr.Chavalit JIARANUCHART	ditto	ditto
Mr.Charoen WILAIHONG	Transmission System	Bureau of Operation
Mr.Thawisak KITTIJARURAK	ditto	Bureau Engineering and Project
Mr.Somchai NAKPLUANG	Telecom Network and Traffic	ditto
Mr.Pattharin PATTHARASIKARIN	ditto	ditto
Mr.Sorrasak SOOKTHAI	Traffic Forecast	ditto
Mr.Amroong HEEBTAMAI	Outside Plant and O&M	Bureau of Operation
Mr.Sopchoke SOMCHAIWONG	ditto	ditto
Mr.Surasak PUTNONVIT	ditto	ditto
Mr.Subphong THANTARAWON	O&M	ditto
Mr.Sinchai KAMOLRUNGSRIPORN	Network & Traffic	ditto
Ms.Sanipong HONGSPANIJ	O&M	Bureau of General affairs
Ms.Wannaporn LILAHAJIVA	Financial and Economic Analyses	ditto

The JICA Study Team

Mr.Satoshi AKAIKE	Leader of JICA Study Team, NTT International Corporation (NTTI)
Mr.Kiyoshi MUSHU	Network Planning (NTTI)
Mr.Tomoyoshi ASO	Outside Plant Systems Planning (NTTI)
Mr.Hiroyuki KANO	Financial and Economic Analysis (NTTI)

ATTENDANTS LIST OF THE MEETINGS

on August 13, 1992

Name	Duty in Charge	Department
TOT		
Mr.Chakree SUBPRAWONG	Counterpart Team Leader	CPO
Mr.Arkom KRACHANGMOL	Transmission System	CPO
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Ms.Yupa LEEWONGCHAROEN	Financial and Economic	CPO
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on August 14, 1992

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CHAPTER 6 PRESENT STATE OF TELECOMMUNICATIONS FACILITY

APPENDIX

APPENDIX

6.3 Present State of Outside Plant Facilities

6.3.6 Characteristics of the Local Cables

Figure 6.3.6-1 to 6.3.6-14 show the characteristics of the existing local cables of TOT. These figures are made according to the Progress Report of Investigation on Local Cable Network for ISDN.

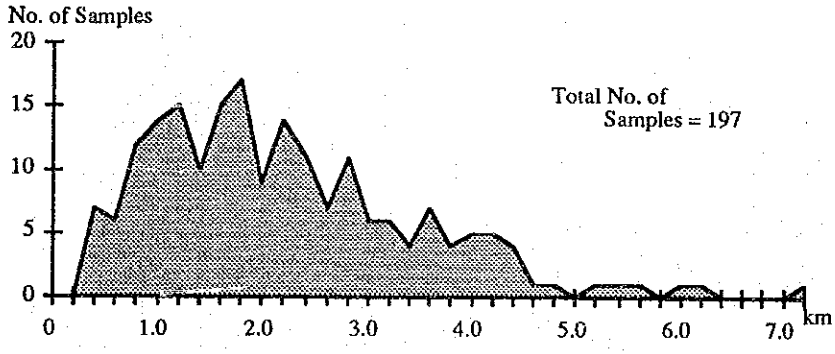

Figure 6.3.6-1 Distribution of the Subscriber Loop Length in BMA

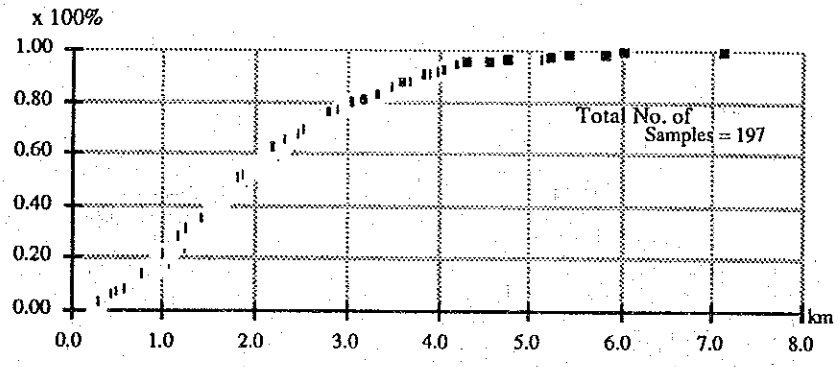

Figure 6.3.6-2 Cumulative percentage of the Subscriber Loop Length in BMA

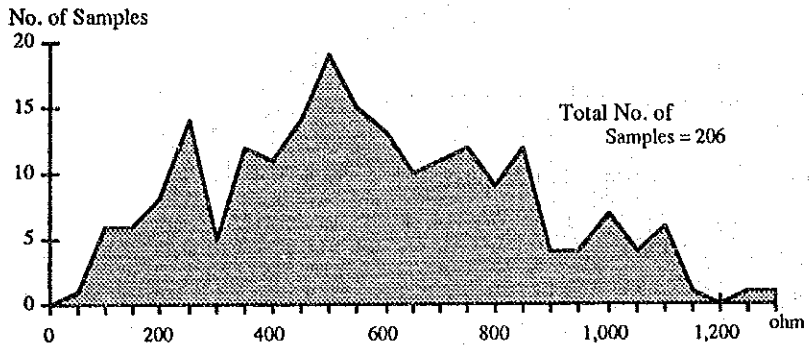

Figure 6.3.6-3 Distribution of the Subscriber Loop Resistance in BMA

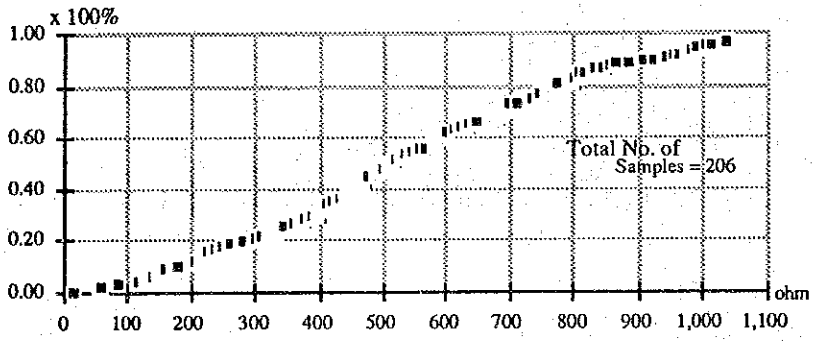

Figure 6.3.6-4 Cumulative percentage of the Subscriber Loop Resistance in BMA

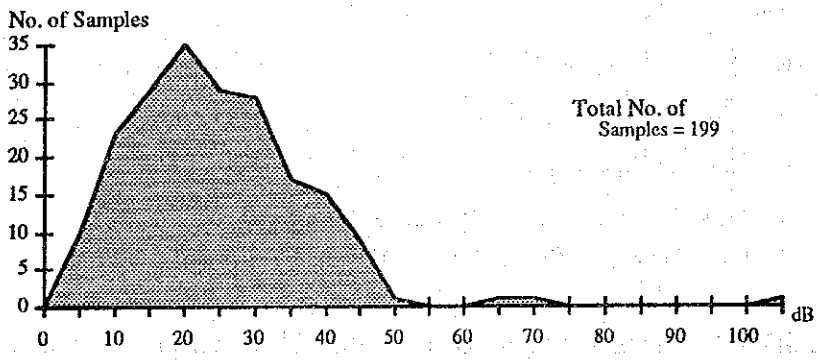

Figure 6.3.6-5 Distribution of the Subscriber Line Loss at 80kHz in BMA

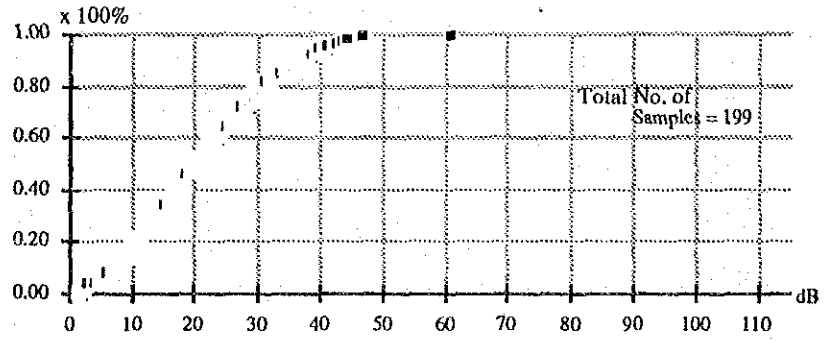

Figure 6.3.6-6 Cumulative percentage of the Subscriber Line Loss at 80kHz in BMA

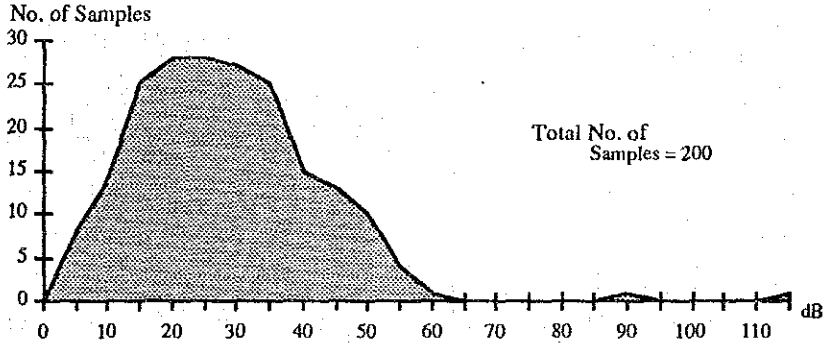

Figure 6.3.6-7 Distribution of the Subscriber Line Loss at 160kHz in BMA

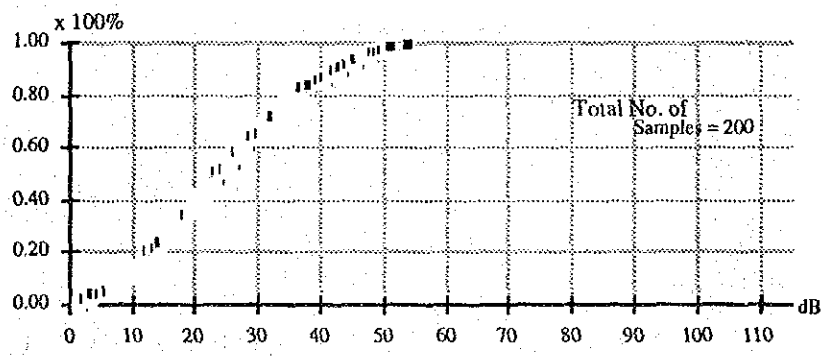

Figure 6.3.6-8 Cumulative percentage of the Subscriber Line Loss at 160kHz in BMA

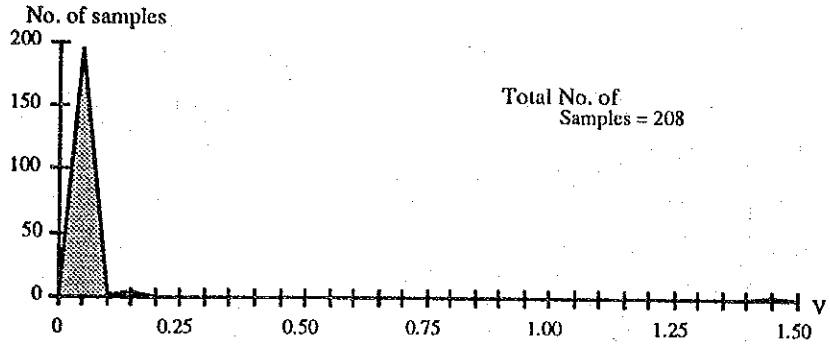

Figure 6.3.6-9 Distribution of the Induced AC Voltage on the Local Cables in BMA

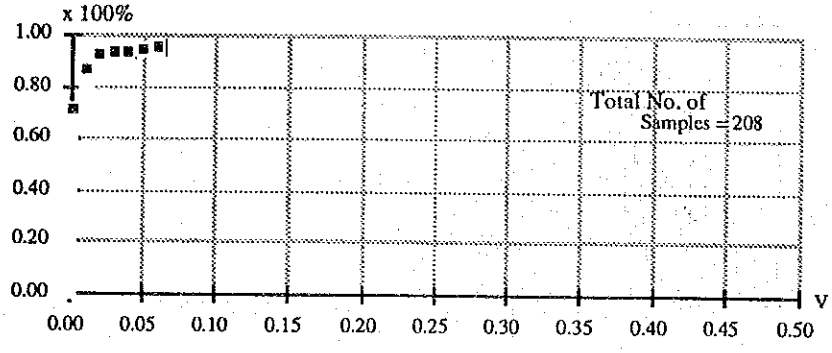

Figure 6.3.6-10 Cumulative percentage of the Induced AC Voltage on the Local Cables in BMA

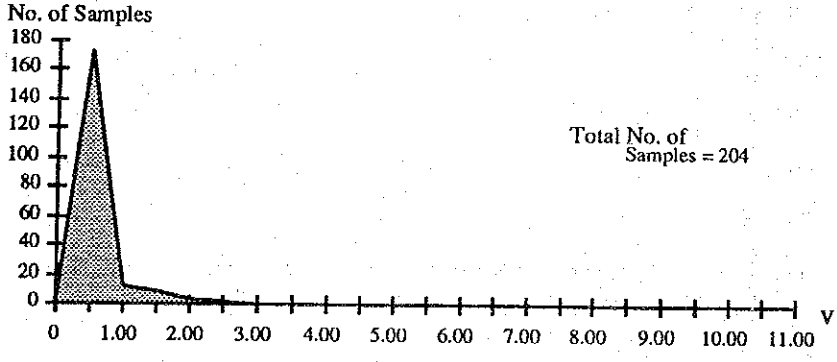

Figure 6.3.6-11 Distribution of the Induced DC Voltage on the Local Cables in BMA

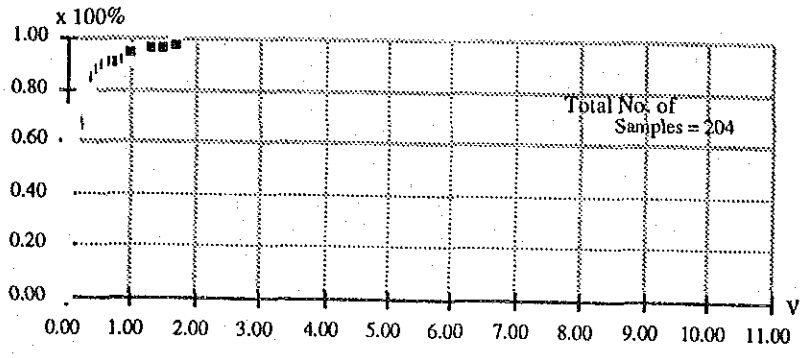

Figure 6.3.6-12 Cumulative percentage of the Induced DC Voltage on the Local Cables in BMA

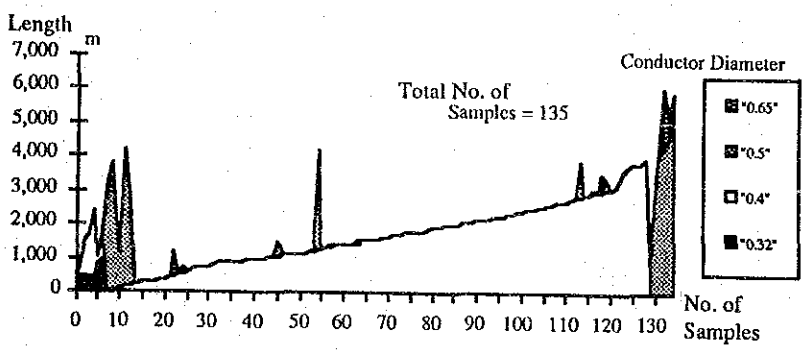

Figure 6.3.6-13 Conductor Combination of the Local Cables in BMA

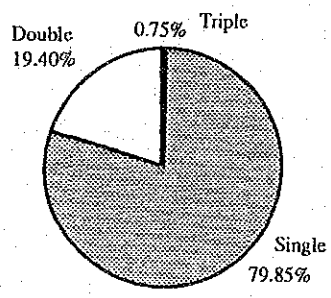

Figure 6.3.6-14 Percentage of Conductor Combination of the Local Cables in BMA

CHAPTER 7 PRESENT ORGANIZATION AND MANAGEMENT

APPENDIX

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7.4 TOT TELEPHONE SERVICE RATES as of FY 1991

7.4.1 Subscriber and Public Telephone Service

1) Installation Charges

	Type of Installation	Charge
(1)	In case TOT shall provide the installation with station protector and station wiring	3,700 Baht
(2)	In case subscriber shall provide and install the station protector and handle the station wiring	3,350 Baht

Note: The cable length should not be more than 300 meters. 350 Baht is charged per 50 meters of additional cable length used. There is no charge if the additional cable is length less than 25 meters.

2) Customer Deposit

A security deposit of 3,000 Baht for a general telephone line will be refunded to the user upon his termination of the service, if no telephone bill is left unpaid.

3) Subscription Charge (Monthly Charge)

A general telephone of automatic type	50 Baht
A push button telephone of automatic type	100 Baht

4) Local Call Charge 3.00 Baht per each call

5) Long Distance Call Charge (Trunk Call Charge)

Baht / minute

Between Provinces within the Same Area Code	Day Time 7:00 ~ 18:00	Late Evening 18:00 ~ 22:00	Night Time 22:00 ~ 07:00
0 - 50 Km	3.0	1.5	1.0
51 - 100	6.0	3.0	2.0
101- Over	9.0	4.5	3.0

5) Long Distance Call Charge (Trunk Call Charge) (Continued)

Baht / minute

Between Provinces with Different Area Code	Day Time 7:00~18:00	Late Evening 18:00~22:00	Night Time 22:00~07:00
0 - 50 Km	3.0	1.5	1.0
51 - 100	6.0	3.0	2.0
101 - 200	9.0	4.5	3.0
201 - 350	12.0	6.0	4.0
351 - 500	15.0	7.5	5.0
501 - Over	18.0	9.0	6.0

6) Public Telephone

a) Local Call 1 Baht / 3 minutes

b) Trunk Call

Baht / minute

Distance (km)	Day Time 7:00~18:00	Late Evening 18:00~22:00	Night Time 22:00~07:00
0 - 50	3.0	1.5	1.00
51 - 100	6.0	3.0	2.00
101 - 200	8.0	4.0	2.67
201 - 350	12.0	6.0	4.00
351 - 500	15.0	7.5	5.00
501 -	20.0	10.0	6.67

7.4.2 Leased Circuit Service

1) Local Leased Circuit

(1)	The originating and terminating points belong to the same telephone exchange area (per pair)	1,000 Baht per month
(2)	The originating and terminating points belong to different but adjacent telephone exchange areas (per pair)	2,000 Baht per month
(3)	The originating and terminating points belong to different and non-adjacent telephone exchange areas (per pair)	3,000 Baht per month

2) Long Distance Leased Circuit

Distance (km)	Baht per Day	Baht per Month
0 - 125	960	24,000
126 - 200	1,200	30,000
201 - 350	1,440	36,000
351 - 600	1,920	48,000
601 - 900	2,400	60,000
901 - Over	2,880	72,000

3) Telegraph Circuit

Distance (km)	Single Customer		Group Customer	
	Per Day	Per Month	Per Day	Per Month
0 - 125	320	8,000	480	12,000
126 - 200	400	10,000	600	15,000
201 - 350	480	12,000	720	18,000
351 - 600	640	16,000	960	24,000
601 - 900	800	20,000	1,200	30,000
901 - Over	960	24,000	1,440	36,000

4) Broadcasting Circuit (Voice)

a) In case that the period of the contract is less than one (1) year:

Distance (km)	One-Way		Two-Way	
	Per Day	Per Month	Per Day	Per Month
0 - 125	1,920	48,000	2,880	72,000
126 - 200	2,400	60,000	3,600	90,000
201 - 350	2,880	72,000	4,320	108,000
351 - 600	3,840	96,000	5,760	144,000
601 - 900	4,800	120,000	7,200	180,000
901 - Over	5,760	144,000	8,640	216,000

b) In case that the period of the contract is more than one (1) year but less than five (5) years, the rental charge will be as follows:

	Baht per Year
1. Long Distance Circuit/km	340
2. Telegraph Circuit/km	36
3. Broadcasting Circuit (Voice)/km	
3.1 Two-Way	1,100
3.2 One-Way	610

c) In case that the period of the contract is more than five (5) years, the rental charge will be as follows:

	Baht per Year
Long Distance Circuit/km	170
Telegraph Circuit/km	18
Broadcasting Circuit (Voice)/km	
Two-Way	550
One-Way	305

5) Broadcasting (Television)

a) TOT's Own Investment (1 year ≤ Leasing Period)

	Baht/year
Two-Way / km	23,000
One-Way / km	14,000

b) Customer's Own Investment (1 year ≤ Leasing Period < 5 years)

	Baht/year
Two-Way / km	16,000
One-Way / km	10,000

c) Customer's Own Investment (5 years ≤ Leasing Period

	Baht/year
Two-Way / km	11,500
One-Way / km	7,000

7.4.3 Facsimile Service

Sending Charge	Baht/page
A4 size	20
Larger than A4 size	30

Receiving Charge	Baht/page
A4 size	20
Larger than A4 size	30

7.4.4 Digital High Speed Circuit

1) Access Charge

Data Transmission Speed	Baht/circuit/side
64 kb/sec	4,000
2Mb/sec	22,500

2) Rental Charge

a) Sender and Receiver are in the same province:

(Unit: Baht/month/circuit)

	64 Kb/sec	2 Mb/sec
The originating and terminating points of which are in the same exchange	3,000	25,000
The originating and terminating points of which are in different exchanges with distance not exceeding 2 exchanges	6,000	50,000
The originating and terminating points of which are in different exchanges with distance exceeding 2 exchanges	9,000	75,000

b) The sender and the receiver are in the adjacent provinces:

Data Transmission Speed	Baht/month/circuit
64 kb/sec	18,000
2 Mb/km	150,000

c) The sender and the receiver are not in the same or the adjacent provinces:

(Monthly Rate: Baht)

Distance (km)	64 kb/sec	2 Mb/km
0 - 125	28,800	240,000
126 - 200	36,000	300,000
201 - 350	43,200	360,000
351 - 600	57,600	480,000
601 - 900	72,000	600,000
901 - Over	86,400	720,000

7.4.5 Multi Access Radio

Rental Charge

One (1) month	1,000 Baht
One (1) day	1,000 / 30 Baht

7.4.6 Mobile Telephone

1) Installation Charge (License Charge) 1,000 Baht
2) Customer Deposit 3,000 Baht
3) Rental Fee 500 Baht
4) Call Charge

	Baht / Minute
Within the same mobile telephone zone (M.T.Z.)	3
Between the adjacent M.T.Z.	8
Between M.T.Z. (not adjacent)	12

7.4.7 Phone Point

A portable cordless public telephone from which an outgoing call can be initiated within 100 meter radius of the base station.

Access Charge	700 Baht/ unit
Subscription Charge	350 Baht/ unit/ month
Domestic Call	Additional. 2 Baht
International Call	Additional. 4 Baht

7.4.8 Paging Service

1) Phonelink

(Unit: Baht)

1. Service Charge		
1.1 Tone Only	Local Regional Nationwide	200 Baht/month 250 Baht/month 300 Baht/month
1.2 Numeric	Local Regional Nationwide	400 Baht/month 425 Baht/month 450 Baht/month
1.3 Alphanumeric (numeric+letters)	Local Regional Nationwide	500 Baht/month 525 Baht/month 550 Baht/month
2. Access Charge		500 Baht/unit
3. License Fee		180 Baht/unit/year
4. Customer Deposit	Tone Only Numeric Alphanumeric	500 Baht/unit 1,000 Baht/unit 1,000 Baht/unit
5. Voice Mailbox Service		200 Baht/month

2) Pagephone

(Unit: Baht)

1. Service Charge		
1.1 Tone Only	Local Regional Nationwide	225 Baht/month 250 Baht/month 300 Baht/month
1.2 Numeric	Local Regional Nationwide	400 Baht/month 425 Baht/month 450 Baht/month
1.3 Alpha Numeric (Numeric & English letters)	Local Regional Nationwide	500 Baht/month 525 Baht/month 550 Baht/month
1.4 Alpha Numeric (Numeric & English, Thai letters)	Local Regional Nationwide	625 Baht/month 625 Baht/month 650 Baht/month
1.5 Voice Mail Box	Local Regional Nationwide	200 Baht/month 225 Baht/month 250 Baht/month
2. Access Charge		500 Baht/unit
3. Customer Deposit		1,000 Baht/unit

7.4.9 Data Communication

1) DataNet: A value added service that provides data communication facilities.

		Port Charge without VDM	Port Charge with VDM
1. Installation	Dial Up Other	500 Baht 2,500 Baht	 5,000 Baht
2. Security Deposit	Dial Up Other	2,500 Baht 5,000 Baht	 5,000 Baht
3. Monthly Service Charge			
3.1 Asynchronous	Low speed 2,400 High speed 2,400 dial up	1,500 Baht/month 2,000 Baht/month 300 Baht/month	2,000 Baht/month 2,500 Baht/month
3.2 Synchronous		2,500 Baht/month	3,000 Baht/month
3.3 X.25		15,000 Baht/month	15,500 Baht/month

CHAPTER 8 DEMAND FORECAST

APPENDIX

APPENDIX

8.2 Demand Forecast for Other Telecommunications Services

8.2.3 Mobile Telephone

1) Demand Forecast Model (short-term)

To estimate the demand in short-term such as year 1992, an exponential curve model is more suitable than a logistic curve. Because the slope of the demand growth of it does not change immediately. Table 8.2.3-1 shows the mobile telephone development in Thailand from 1986 to 1991.

Table 8.2.3-1 Mobile Telephone Service Development (whole kingdom)

Year	TOT		CAT	Total	No. of Mobile /
	470 MHz	900 MHz	800 MHz		100 person
1986	8,200			820	0.002
1987	4,410		1,170	5,580	0.01
1988	10,610		6,970	17,580	0.03
1989	20,940		14,170	35,110	0.06
1990	31,980		31,240	63,220	0.11
1991	42,710	36,490	44,340	123,540	0.22

(Source TOT August 1992)

In the table, the number of mobile telephone subscribers is expected to be developed with a exponential curve from 1988 to 1991. The Study Team, therefore, considers that the demand for mobile telephone will develop in accordance with this curve until around 1993. The exponential curve model is given as follows:

$$y = a \times b^t$$

The common logarithms of the above formula are as follows:

$$\log y = \log a + t \times \log b$$

where

y : the number of mobile telephone subscribers,

a, b : constants,

t : year.

Values of a and b are calculated by using the data in Table 8.2.3-1 as shown in Table 8.2.3-2. The data from 1988 to 1991 is employed in an exponential formula to keep the estimated data in a high accuracy.

Table 8.2.3-2 Calculation of Demand Forecast of Mobile Telephone Service (short -term)

Model : $y = a \times b^t$, (t = 0 in 1990, n = 4)

Year	y	log y	t	t x log y	t^2
1988	17.580	1.245	-1.5	-1.868	2.25
1989	35.110	1.545	-0.5	-0.773	0.25
1990	63.220	1.801	0.5	0.900	0.25
1991	123.540	2.092	1.5	3.138	2.25
Sum		6.683	0	1.398	5

The normal equations, as Σt is equal to zero, are as follows:

$$\Sigma \log y = n \times \log a$$
$$\Sigma (t \times \log y) = \log b \times \Sigma t^2$$

Substituting values in the table and 4 into the normal equations, the results of calculation are as follows:

$\log a = 1.671$ $\quad a = 46.857$

$\log b = 0.280$ $\quad b = 1.904$

Therefore, the formula to calculate the demand for the mobile telephone service in the short-term is expressed as follows:

$$y = 46.857 \times 1.904^t$$

The number of subscribers of mobile telephone service is calculated by using above formula as shown in Table 8.2.3-3. The estimated data are in beautiful agreement with the observed data.

Table 8.2.3-3 Demand for Mobile Telephone Service (short-term, whole kingdom)

(unit : thousand)

Year	1988	1989	1990	1991	1992	1993
y	17.58	35.11	63.22	123.54	(234.28)	(445.97)
y'	(17.84)	(33.96)	(64.66)	(123.10)		
t	-1.5	-0.5	0.5	1.5	2.5	3.5

Note : The figures in the parentheses are the estimated ones.

2) Demand Forecast Model (long-term)

A logistic curve demand model for long-term forecast is expressed as follows:

$$Dt = \frac{K}{1 + m \times EXP(-at)},$$

where

Dt : the number of mobile telephones in year t,

K: : saturation level (number of mobile telephones per 100 persons),

m, a : constants,

t : year.

a) Calculation Process of K level

To decide the saturation level K, the Study Team firstly examined to get the value K directly from the data in Table 8.2.3-3 by using the method discussed in Section 8.3.2 of present APPENDIX.

By using the data from 1988 to 1993, K (number of mobile telephones) is calculated as follows:

$$K = 6,415,000$$

This K is too big for using as the saturation level in the whole kingdom. As the next step, the Study Team intended to calculate K by using the data from 1988 to 1992, K (number of mobile telephones) is calculated as follows:

$$K = 2,472,000$$

This K also seems too big figure than that the Study Team expected. The data from 1988 to 1991 is not applicable for the logistic curve model.

The number of mobile telephone subscriber in Thailand has been increasing abruptly in the past several years. The Study Team analyzed that the customers has been subscribing mobile telephone instead of ordinary telephone during past several years . Because they cannot get a ordinary telephone service easily by being a lot of waiting applicants.

Therefore, the Study Team decide to employ the K value 2 in taking the trend of the development of mobile telephone service in Japan and in the world.

b) Calculation Process of m and a

To calculate m and a, K value 2 is employed by the above reason. By using the data from 1988 to 1992 and applying the least square method, m and a are calculated from Table 8.2.3-4.

Table 8.2.3-4 Nomogram for Calculation of m and a

Model : Y = K / (1 + m x EXP(-at)) , (t= 0 in 1990, K = 2.0, n=5)

Year	y	Population	Y	K/Y - 1	log(K/Y-1)	t	t^2	t x log(K/Y-1)
1988	17.58	54,535	0.032	61.042	1.786	-2	4	-3.571
1989	35.11	55,448	0.063	30.585	1.486	-1	1	-1.486
1990	63.22	56,341	0.112	16.824	1.226	0	0	0.000
1991	123.54	57,196	0.216	8.260	0.917	1	1	0.917
1992	234.27	58,041	0.404	3.955	0.597	2	4	1.194
Sum					6.011	0	10	-2.946

The normal equations, as Σt is equal to zero, are as follows:

$$\Sigma \log \left(\frac{K}{Y} - 1\right) = n \times \log m$$

$$\Sigma \left(t \times \log \left(\frac{K}{Y} - 1\right)\right) = - a \times (\log e) \times \Sigma t^2$$

Substituting the values in the table into the normal equations, the results of calculations are:

m = 15.931
a = 0.678
(K = 2.0)

By substituting above figures into the formula, the final formula is given as follows:

$$Dt = \frac{2.0}{1 + 15.931 \times EXP(-0.678 \times t)}$$

c) Estimation Result

The result of the estimation is shown in Table 8.2.3-5. The estimated value in 1992 is adopted the value obtained from the exponential curve.

Table 8.2.3-5 Estimation Result of Mobile Telephone Service

(whole kingdom)

Year	Demand (x 1,000)	Population (x 1,000)	Destiny per 100 persons
1992	234.27	58,041	0.40
1997	1,091.28	62,102	1.76
2002	1,311.20	65,865	1.99
2007	1,383.08	69,165	2.00

8.2.4 Paging Phone

1) Calculation of K value from the time series data

A logistic curve is expressed by the following expression:

$$Y = \frac{K}{1 + m \times EXP(-at)} \quad \text{---------} \quad (1)$$

where

Y : the number of paging phone subscribers
K : saturation level
a,m : coefficients
t : year

Then the relative increase ratio at an arbitrary year in the logistic curve is given by the following expression:

$$\frac{1}{Y} \times \frac{dY}{dt} = a - \frac{a}{K} \times Y \quad \text{----------} \quad (2)$$

Replacing dY and dt with ΔY and Δt respectively, then, if $\Delta t = 1$,

$$\frac{\Delta Y}{Y} = a - \frac{a}{K} \times Y \qquad \text{---------- (3)}$$

Suppose the relative increase ratio $\frac{\Delta Y}{Y} = R$, then

$$R = P + q \times Y \qquad \text{---------- (4)}$$

$$P = a, \quad q = -\frac{a}{K} \qquad \text{---------- (5)}$$

Applying the number of subscribers in each year for Y in each year, then, using the least square method, the values of P and q are calculated. Herewith the normal equations,

$$\Sigma R = n \times P + q \times \Sigma Y \qquad \text{--- (6)}$$

$$\Sigma dY = \Sigma(Y \times R) = P \times \Sigma Y + q \times \Sigma Y^2 \qquad \text{---------- (7)}$$

Actual calculation process is as follows (see Table 8.2.4-1);

a) Fill in the number of subscribers in the past years in Y column and calculate the sum but Y in the latest year is excluded from the sum.

b) Calculate each year's dY, R and Y^2.

c) Calculate P and q by next expressions;

$$P = \frac{\Sigma R \times \Sigma Y^2 - \Sigma Y \times \Sigma \Delta Y}{n \times \Sigma Y^2 - (\Sigma Y)^2} = \frac{5.2902 \times 20465083777 - 249155 \times 181478}{7 \times 20465083777 - 249155^2}$$

$$= 0.7767$$

$$q = \frac{n \times \Sigma \Delta Y - \Sigma R \times \Sigma Y}{n \times \Sigma Y^2 - (\Sigma Y)^2} = \frac{7 \times 181478 - 5.2902 \times 249155}{7 \times 20465083777 - 249155^2} = -0.0000005880$$

d) Calculate K

$$K = -\frac{P}{q} = -\frac{0.7767}{-0.0000005880} = 1{,}321{,}000$$

Table 8.2.4-1 The Table for Calculation of K Value

Year	t	Y	DY	R=DY/Y	Y^2
'84	1	6,233	1,759	0.2822	38,850,289
'85	2	7,992	-39	-0.0049	63,872,064
'86	3	7,953	15,138	1.9034	63,250,209
'87	4	23,091	3,700	0.1602	533,194,281
'88	5	26,791	20,727	0.7737	717,757,681
'89	6	47,518	82,059	1.7269	2,257,960,324
'90	7	129,577	58,134	0.4486	16,790,198,929
'91		(187,711)			
Sum		249,155	181,478	5.2902	20,465,083,777

2) Calculation of a and m

Although, the values of a and m can be gained directly from the expression (5) and (1), the Study Team applies the following method which uses the least square method in the calculation of m and a, which might reflect the past year's trend more precisely.

From (1), m is expressed as follows;

$$\frac{K}{Y} - 1 = m \times EXP(-at)$$

then,

$$\log\left(\frac{K}{Y} - 1\right) = -at \times \log(e) + \log(m)$$

The values of a and m are gained using the least square method.

The normal equations are

$$\Sigma\log\left(\frac{K}{Y} - 1\right) = -a \times \log(e) \times \Sigma t + n \times \log(m) \quad \text{- - - -} \quad (8)$$

$$\Sigma t \times \log\left(\frac{K}{Y} - 1\right) = -a \times \log(e) \times \Sigma t^2 + \log(m) \times \Sigma t \quad \text{- - - - - -} \quad (9)$$

if $\Sigma t = 0$, then

$$S\log\left(\frac{K}{Y} - 1\right) = n \times \log(m) \quad \text{- - - - -} \quad (10)$$

$$St \times \log\left(\frac{K}{Y} - 1\right) = -a \times \log(e) \times St^2 \qquad \cdots\cdots \quad (11)$$

Actual calculation process is as follows (see Table 8.2.4-2);

a) Fill in the data in Y column

b) Calculate each year's $\left(\frac{K}{Y} - 1\right)$ and $\log\left(\frac{K}{Y} - 1\right)$

c) Fill in t column so as to the total of t becomes 0.

d) Calculate each year's t^2 and total of t^2

e) Calculate each year's $\left(t \times \log\left(\frac{K}{Y}\right) - 1\right)$ and total of $\left(t \times \log\left(\frac{K}{Y} - 1\right)\right)$

f) Calculate log(m), m and a by the following expressions;

$$\log(m) = \frac{\Sigma \log\left(\frac{K}{Y} - 1\right)}{n} = \frac{11.0393}{7} = 1.57704$$

$$m = 10^{1.57704} = 37.6910$$

$$a = -\frac{\Sigma t \times \log\left(\frac{K}{Y} - 1\right)}{\log(e) \times \Sigma t^2} = \frac{7.1344}{0.4343 \times 28} = 0.5867$$

g) Estimated Y in year t

$$Y = \frac{K}{1 + m \times EXP(-at)} = \frac{1321000}{1 + 37.6910 \times EXP(-0.5867 \times t)}$$

For example, in the case of 1992, t = 4

$$Y = \frac{1321000}{1 + 37.6910 \times EXP(-0.5867 \times 4)} = 286{,}336$$

Table 8.2.4-2 The Table for the Calculation of m and a

Year	Y	K/Y-1	log(K/Y-1)	t	t^2	t x log(K/Y-1)	k/(1+m x EXP(-at))
'85	7,992	164.27	2.2156	-3	9	-6.6467	5,990
'86	7,953	165.08	2.2177	-2	4	-4.4354	10,732
'87	23,091	56.20	1.7497	-1	1	-1.7497	19,172
'88	26,791	48.30	1.6840	0	0	0.0000	34,076
'89	47,518	26.80	1.4281	1	1	1.4281	60,034
'90	129,577	9.19	0.9635	2	4	1.9270	104,165
'91	187,711	6.04	0.7808	3	9	2.3424	176,203
'92	-	-	-	-	-	-	286,336
Sum	-	-	11.0393	0	28	-7.1344	-

Table 8.2.4-3 shows calculated Y in the future years.

Table 8.2.4-3 Calculated Y in the Future Years in the Whole Kingdom

Year	Y	Year	Y
1992	286,336	2000	1,278,549
'93	438,909	'01	1,296,978
'94	623,761	'02	1,307,459
'95	814,560	'03	1,313,362
'96	981,542	'04	1,316,669
'97	1,107,850	'05	1,318,515
'98	1,193,249	'06	1,319,543
'99	1,246,698	'07	1,320,116

8.2.5 Leased Circuit Service

1) Leased Circuit

a) Analysis of Leased Circuit Development in Thailand

Table 8.2.5-1 shows the development of the leased circuit service in Thailand. The table indicates that the trend of the leased circuit service get already saturated. However the use of leased circuit service will be supposed to evolve from now on especially after eliminating the accumulated waiting applicants for telephone service. Because, more and more business enterprises, in particular, large-scale enterprises will establish their corporate communications network employing a leased circuit service including a high speed digital leased circuit service.

To estimate the demand for leased circuit in Thailand, some examination were achieved such as development of leased circuit in the world, the ratio between the development of leased circuit and the number of ordinary telephone lines, and the

relationship between development of leased circuit and GDP per capita. The trend of the relationship between business telephone and leased circuit was selected to estimate the demand for leased circuit. Because both business telephone and leased circuit are usually used for company activity.

Table 8.2.5-1 Development of Leased Circuit Service in Thailand

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

Source: TOT , July 1991

Table 8.2.5-2 shows the relationship between the business telephone and the leased circuit in Thailand from 1988 to 1991. In the table, the percentage of the leased circuit to the business telephone is 4.6 % in 1988 and it has slowly grown to 4.9 % in 1990, however, the growth ratio decreases to 3.9 % in 1991.

Table 8.2.5-2 Relationship Between Business Telephone and Leased Circuit (whole kingdom)

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

b) Development of Leased Circuit in Japan

Table 8.2.5-3 shows the development of business telephone and leased circuit in Japan from 1981 to 1990. In the table, the ratio between business telephone and leased circuit development is 3.24 % in 1981 and it slowly grows to 5.15 % in 1990.

Table 8.2.5-3 Development of Business Telephone and Leased Circuit Service in Japan

(unit : thousand)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Business Telephone. (A)	12,500	12,824	13,161	13,470	13,709	14,250	14,837	15,542	16,355	17,475
Leased Circuit (B)	424	449	473	499	534	574	644	747	825	901
Ratio (%) (B/A)	3.39	3.50	3.59	3.70	3.40	4.03	4.34	4.81	4.50	5.15

The development process between business telephone and leased circuits in Japan in Table 8.2.5-3 have a strong relationship as shown in Figure 8.2.5-1.
A regression line is given, employing the least square method, as follows:

Ln = - 863.9 + 0.1021 x Bn,

Ln : number of leased circuits (thousand),

Bn : number of business telephone subscribers (thousand),

Coefficient of correlation (R)=0.995.

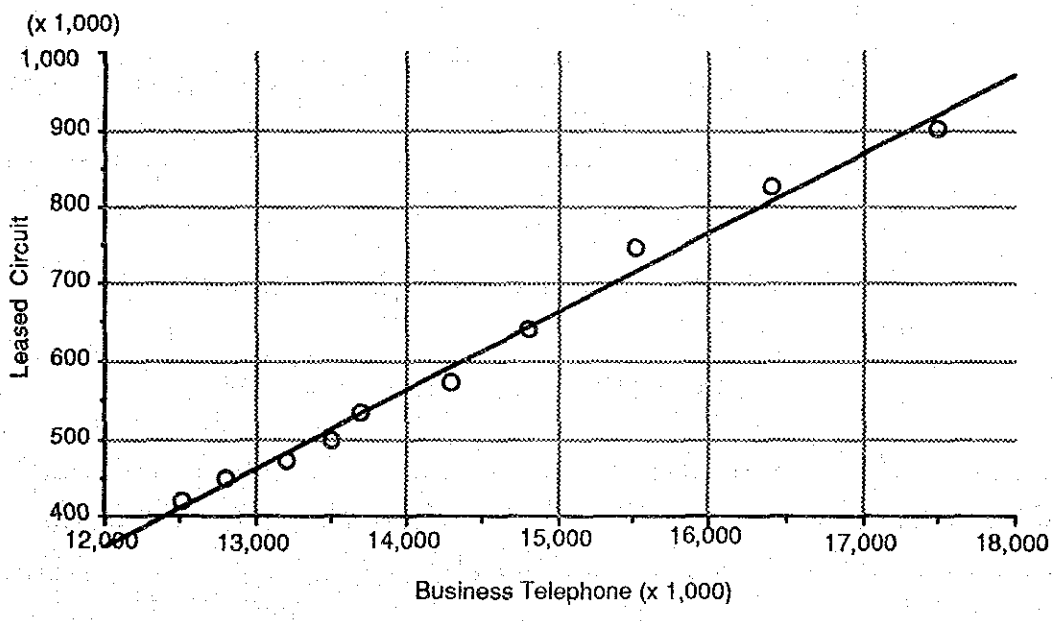


Figure 8.2.5-1 Relationship Between Business Telephone and Leased Circuit in Japan

c) Method of Demand Forecast

The data in Table 8.2.5-2 is not employed for the demand forecast by the reason previously mentioned. The percentage of the leased circuit to the business telephone in Japan is expressed with a regression line as shown in Figure 8.2.5-2. The regression line is as follows:

$y = a + bt$

where y : percentage of the leased circuit to the business telephone in Japan

a, b : coefficients

t : year.

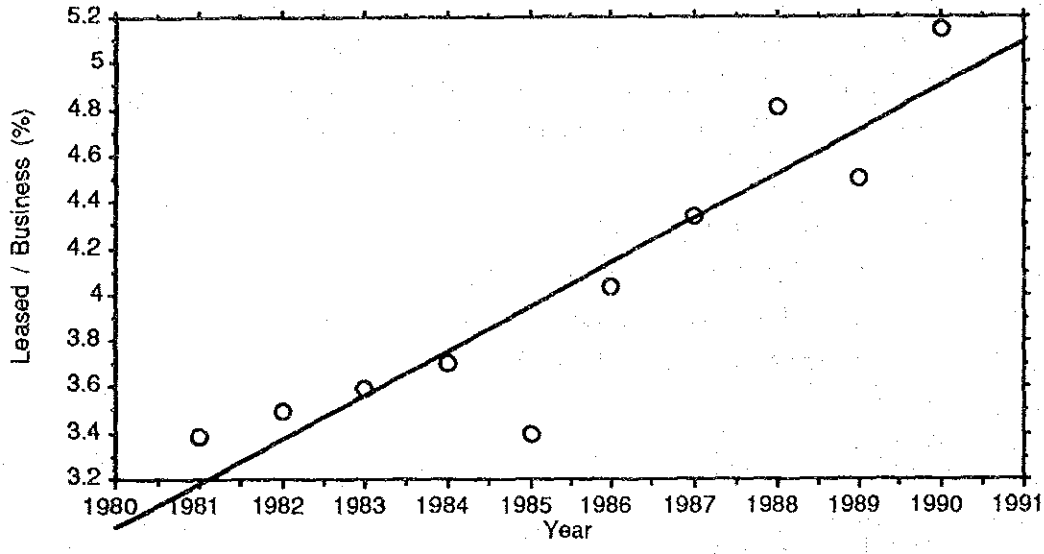


Figure 8.2.5-2 Trend of Percentage of Leased Circuit to Business Telephone in Japan

Table 8.2.5-4 shows the nomograph for values of a and b, employing the least square method.

Table 8.2.5-4 Nomograph for Values of a and b

$y = a + bt$ (t = 1.5 in 1986 n = 10)

Year	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	Sum
t	-5.5	-4.5	-3.5	-2.5	-1.5	1.5	2.5	3.5	4.5	5.5	0
y	3.39	3.50	3.59	3.70	3.40	4.03	4.34	4.81	4.50	5.15	40.41
txy	-18.65	-15.75	-12.57	-9.25	-5.10	6.05	10.85	16.84	20.25	28.33	21.00
t^2	30.25	20.25	12.25	6.25	2.25	2.25	6.25	12.25	20.25	30.25	142.50

The normal equations, as $\Sigma t = 0$, are as follows:

$\Sigma y = a \times n$

$\Sigma (t \times y) = b \times \Sigma t^2$

Substituting the data in Table 8.2.5-4 into the normal equations, the values of a and b are given as follows:

$$a = 4.041$$
$$b = 0.147$$

accordingly y is

$$y = 4.041 + 0.147 \times t.$$

Table 8.2.5-5 shows the estimated percentage of the leased circuit to the business telephone.

Table 8.2.5-5 Forecasted Percentage of Leased Circuit to Business Telephone

Year	'84	'85	'86	'87	'88	'89	'90	'91	'96	01
t	-2.5	-1.5	-1.5	2.5	3.5	4.5	5.5	6.5	11.5	16.5
y		3.40	4.03	4.34	4.81	4.50	5.15			
y'		3.82	4.23	4.41	4.56	4.70	4.85	5.00	5.73	6.47
t'(Thailand)	'90	'91	'92	'93	'94	'95	'96	'97	'02	'07

Note: y: observed data (percentage) y': estimated data (percentage)

As the actual percentage of the leased circuit to the business telephone in Thailand in 1992 (t = -1.5) is 3.9%, the estimated percentage, 3.83% corresponds with the year 1992, t = 6.5 with 1997, t = 11.5 with 2002, t = 16.5 with 2007.

d) Forecasted Result of Demand

Table 8.2.5-6 shows the forecasted result of demand for the leased circuit service in Thailand.

Table 8.2.5-6 Forecasted Demand for Leased Circuit Demand

	1992	1997	2002	2007
Leased Circuit (A)	21,431	74,021	132,009	193,177
Business Telephone. (B)	506,649	1,480,413	2,303,814	2,985,728
Percentage (%) (C)	4.23	5.00	5.73	6.47

Note: A = B x C / 100

2) High Speed Digital Leased Circuit (HSLC)

Table 8.2.5-7 shows the growth of high speed digital leased circuit service in Japan.

Table 8.2.5-7 Development of LC and HSLC in Japan

Year	LC (x 1,000)	HSLC (x 1,000)	Percentage (HSLC/LC)	Growth Rate of HSLC
1983	473	0		
1984	499	0.03	0.0060	
1985	535	0.64	0.1196	21.33
1966	575	2.23	0.3878	3.48
1987	646	4.41	0.6827	1.98
1988	747	6.46	0.8648	1.46
1989	829	8.56	1.0326	1.33
Sep. 1990	868	9.75	1.1233	1.14

Source : 'White paper on Communications 1991' Ministry of Posts and Telecommunications in Japan

Note; LC : Leased Circuit.
HSLC : High Speed Digital Leased Circuit.

The percentage of high speed digital leased circuit to leased circuit against year is expressed in form of a corrected exponential curve in Figure 8.2.5-3.

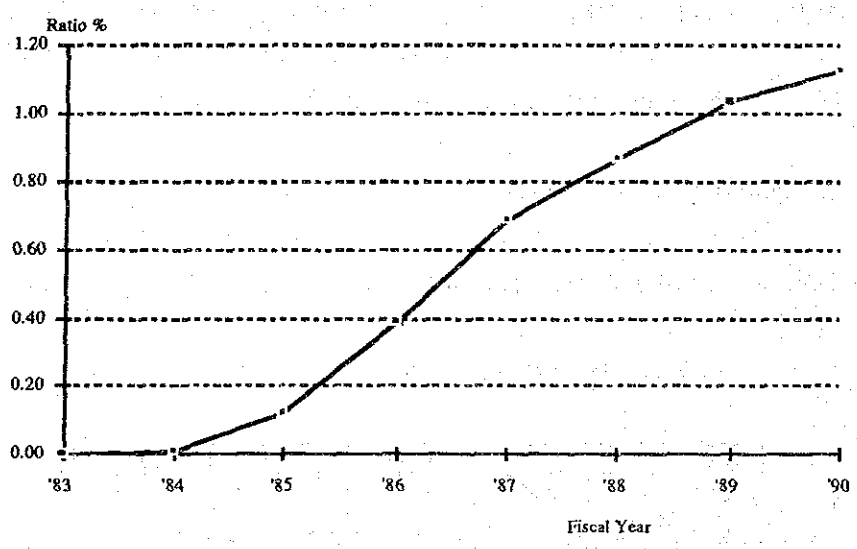


Figure 8.2.5-3 Relationship of the Percentage of HSLC to LC Against Year

The formula of the modified exponential curve is expressed as follows:

$$Y = K - a \times b^t \qquad (1)$$

where

K: saturation level

t: year

a, b: constants

The nomogram to calculate the values of K, a, and b by the three-point estimation method is as follows:

Year	t	Y(1/100)	D Y
'84	0	1	11
'85	1	12	27
S 1	–	13	–
'86	2	39	31
'87	3	68	16
S 2	–	107	–
'88	4	86	17
'89	5	103	–
S 3	--	189	--

The formula for calculating the value of b is as follows:

$$b^n = \frac{\Sigma_3 Y - \Sigma_2 Y}{\Sigma_2 Y - \Sigma_1 Y}$$

From the nomogram

$$b^n = \frac{189 - 107}{107-13} = \frac{82}{94} = 0.8723$$

$$\log b = \frac{1}{n} \times \log 0.8723 = \frac{1}{2} \times 0.(-0.0593) = -0.0297$$

The value of b is given as follows:

$$b = 0.9340$$

The formula for calculating the value of a is as follows:

$$a = (\Sigma_1 Y - \Sigma_2 Y) \times \frac{b-1}{(b^n - 1)^2}$$

From nomogram

$$a = (13-107) \times \frac{0.9340 - 1}{(0.8723-1)^2}$$

$$= -94 \times \frac{- 0.0660 - 1}{0.0163} = 380.61$$

The formula for calculating the value of K is as follows:

$$K = \frac{1}{n} \times (\Sigma_1 Y + \frac{b^n - 1}{b-1} \times a)$$
$$= \frac{1}{2} \times (13 + \frac{0.872 - 1}{0.9340-1} \times 380.61)$$
$$= 374.71$$

Accordingly the following formula is taken:

$$Y = 374.71 - 380.61 \times 0.9340^{t} \qquad (2)$$

The estimated data obtained by the formula (2) give good agreement with the observed data with a value of t ranging from 3 to 5 as shown in the table bellow.

	1984	1985	1986	1987	1988	1989
t	0	1	2	3	4	5
Y (%) Observed data	0.005	0.12	0.39	0.68	0.86	1.03
Y' (%) Estimated data	-0.059	0.19	0.43	0.65	0.85	1.04

Supposes that HSLC service are provided in 1992, the values of t is as follows:

t = 0	in 1992
t = 5	in 1997
t = 10	in 2002
t = 15	in 2007

The percentage of HSLC subscriber to LC subscriber in each year is estimated by the formula (2), and the number of HSLC in the whole kingdom is calculated as shown in Table 8.2.5-8.

Table 8.2.5-8 Forcasted Demand for HSLC

(whole kingdom)

Year	No. of HSLC (A)	No. of LC (B)	Percentage of HSLC (C)
1997	770	74,021	1.0402
2002	2,403	132,009	1.8203
2007	4,598	193,177	2.3802

Note: A = B x C / 100

8.2.6 Facsimile Communications

1) Demand Forecast Process of Facsimile Service Subscriber

The revised number of facsimile subscribers is shown in Table 8.2.6-1. The constants of formulas concerned are calculated by using the data in the table.

Table 8.2.6-1 Revised Number of Facsimile Subscriber Terminal

(whole kingdom)

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

a) Demand Forecast (Model-1)

The number of facsimile subscriber terminals are estimated by using a linear formula of the growth curve is calculated as follows:

The growth curve is shown in Figure 8.2.6-1 by using the data in Table 8.2.6-1.

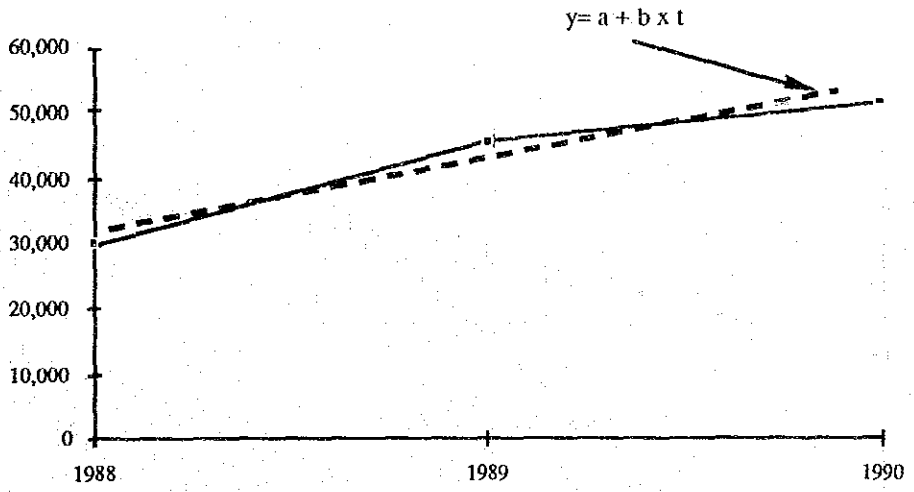


Figure 8.2.6-1 Development of Facsimile Terminal

From the figure, a linear line model is given as follows:

$$y = a + b \times t$$

where
y : the number of facsimile terminals,
a, b : constants,
t : year (1989 = 0).

By using the data in Table 8.2.6-1 and applying the least square method, a and b are given as follows:

a = 42,4735
b = 10,670

By substituting above figures to the formula, final formula is shown as follows:

$$y = 42,475 + 10,670\ t$$

The forecasted demand is shown into Table 8.2.6-2 and Figure 8.2.6-3.

b) Demand Forecast (Model-2)

The number of facsimile terminal is estimated by using the simple linear regression between business telephone and facsimile terminal. By using the figures in Table 8.2.6-1, the relationship curve between business telephone and facsimile terminal are shown in Figure 8.2.6-2.

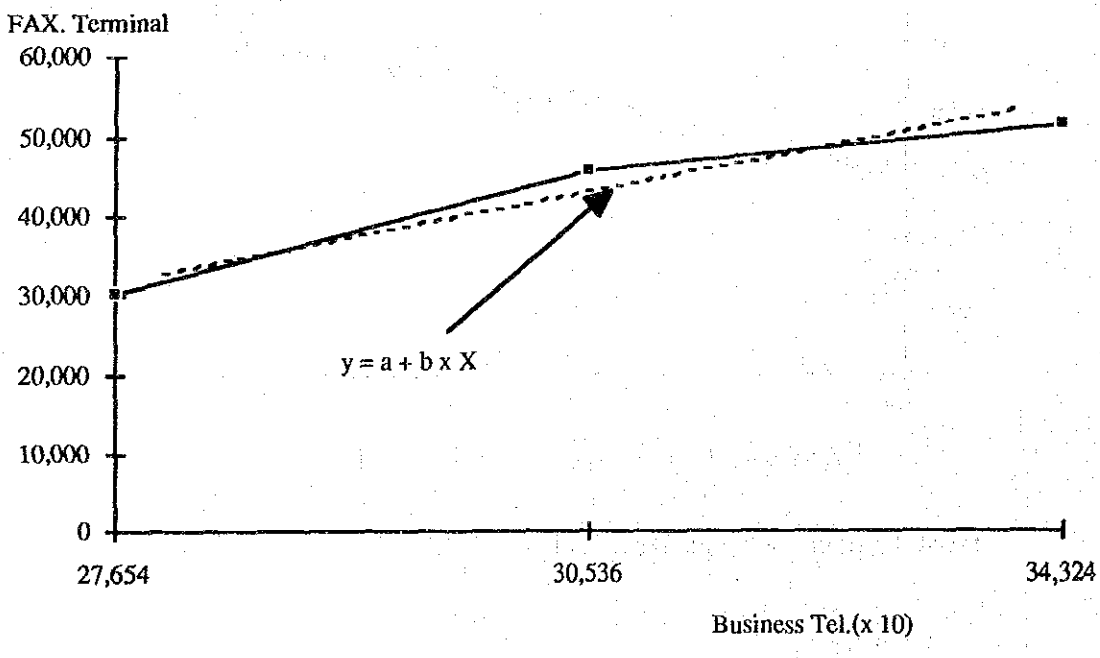


Figure 8.2.6-2 Relationship Between Business Telephone and Facsimile Terminal

From the figure, a linear line model is given as follows:

$y = a + b \times Bn$

where

y : the number of facsimile terminals,

a, b : constants,

Bn : the number of business telephone subscribers.

By using the data in Table 8.2.6-1 and applying the least square method, a and b are given as follows:

$a = -53{,}561$

$b = 0.31$

By substituting above figures to the formula, final formula is shown as follows:

$y = -53{,}561 + 0.31\ Bn$

The forecasted demand is shown in Table 8.2.6-2 and Figure 8.2.6-4.

c) Demand Forecast (Model-3)

Number of facsimile subscriber terminals are estimated by using a linear curve of the ratio of facsimile terminal to business telephone and the number of business telephone. The ratio curve is shown in Figure 8.2.6-3 by using the data in Table 8.2.6-1.

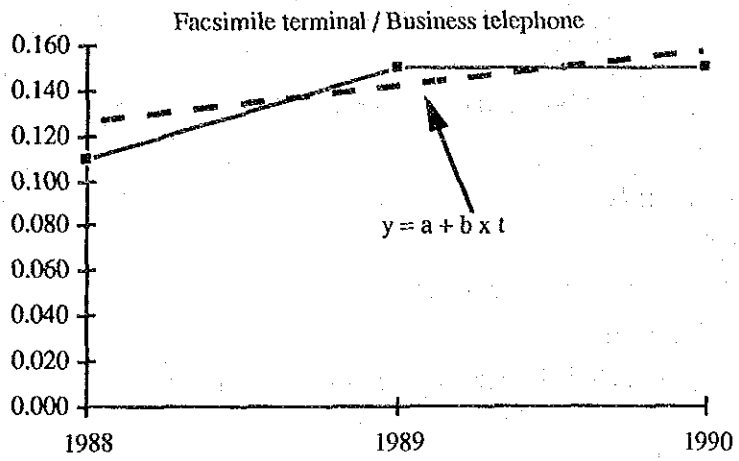


Figure 8.2.6-3 Relationship Between Business Telephone and Facsimile Terminal

From the figure, a linear line model is given as follows:

$y = a + b \times t$

where

y : the number of facsimile terminals,

a, b : constants,

t : year (1989 = 0).

Values a and b are given by using the figures in Table 8.2.6-1 and applying the least square method as follows:

$a = 0.027$

$b = 0.004$

Final formula is shown as follows:

$y = 0.027 + 0.004 \times t$

The demand is given as follows:

$Y = y \times B$

where

Y : the number of facsimile terminals,

B : the number of business telephones.

The forecasted demand is shown in Table 8.2.6-2 and Figure 8.2.6-2.

Table 8.2.6-2 Forecasted Demand in Each Model

Year	Forecasted Facsimile Terminal			Ratio (Fax T. / Business Sub.)		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
1992	74,484	103,501	98,797	0.15	0.20	0.20
1997	127,834	405,367	436,722	0.09	0.27	0.30
2002	181,184	660,622	910,007	0.08	0.29	0.40
2007	234,534	872,015	1,477,935	0.08	0.29	0.50

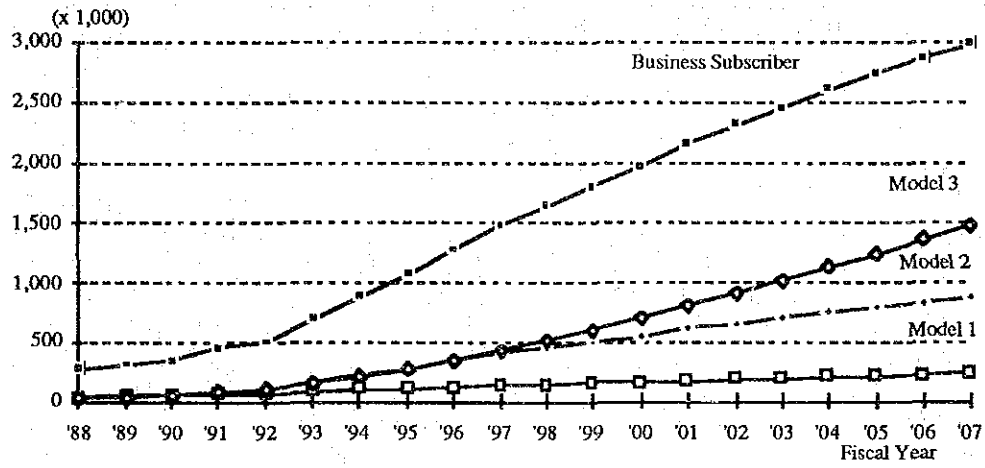


Figure 8.2.6-3 Forecasted Demand in Each Model

The Study Team examined the forecasted demand for facsimile terminal with the three models in comparison with the ratio of facsimile terminal to business telephone in Japan. Model 2 was selected as the formula to estimate the demand forecast for facsimile terminal in the country.

2) Demand Forecast for Facsimile Network

a) Development of Facsimile Network Service in Japan

The development of facsimile network service in Japan is shown in Table 8.2.6-4 and Figure 8.2.6-4. As shown in the figure, the ratio of facsimile network service to business telephone in Japan has increased rather radically from 1984 to 1991. The ratio reached to around 2.7 % in 1991. The development of facsimile network service in Japan is estimated to saturate in around 2000. The saturation level K for the facsimile network service is estimated to be a 3 % of facsimile network to the

business telephone. Because the growth ratio has been already saturated from 1988 to 1991.

Table 8.2.6-4 Development of Facsimile Network Service in Japan

Year	Business .Sub. (A) (x 1,000)	F.Net Sub (B)	Ratio (B/A) %	Year	Business .Sub. (A) (x 1,000)	F.Net Sub (B)	Ratio (B/A) %
1981	12,507	1,000	0.0079	1987	14,825	201,058	1.3562
1982	12,824	2,603	0.0203	1988	15,520	297,852	1.9191
1983	13,161	9,551	0.0726	1989	16,170	369,261	2.2836
1984	13,470	18,214	0.1352	1990	17,091	435,000	2.5452
1985	13,727	46,271	0.3371	1991	17,644	482,000	2.7318
1986	14,268	85,234	0.5974				

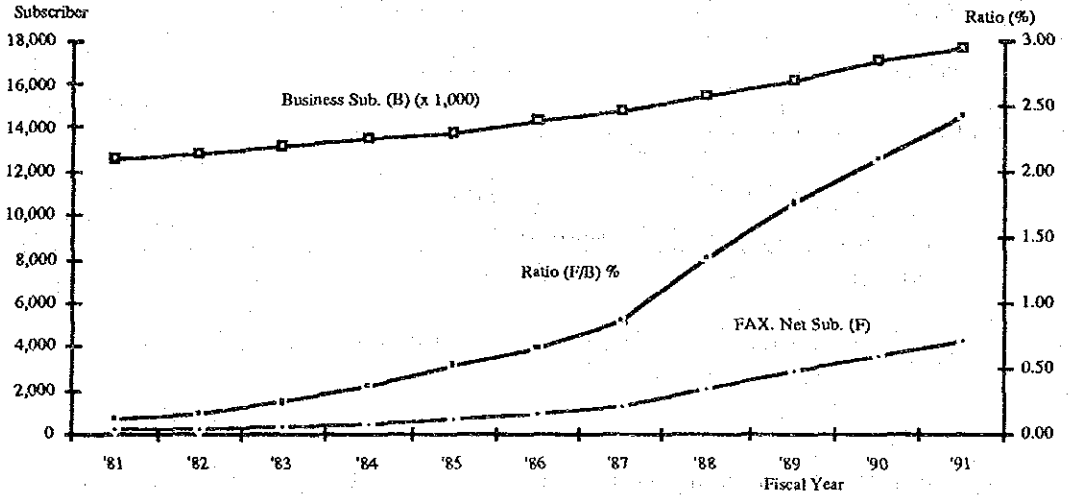


Figure 8.2.6-4 Facsimile Service Development in Japan

The Study Team estimates that the growth of facsimile network service in Thailand will progress in the same way to Japan. The logistic curve model is, therefore, employed to estimate the demand of facsimile network service as follows:

$$DN = \frac{K}{1 + m \times EXP(-at)}$$

where

DN : the percentage of facsimile network subscriber to business telephone in year t,

K : saturation level,

m, a : constants,

t: year

i) Estimation of Saturation Level K

The Study Team decided to employ K value 3 in taking the trend of the development of the facsimile network service in Japan. K is the ratio (percentage) of facsimile network service subscriber to business telephone subscriber.

ii) Calculation of a and m values

By using the figures from 1981 to 1991 in Table 8.2.6-4 and applying the least square method, m and a values are calculated as shown in Table 8.2.6-5.

Table 8.2.6-5 Calculation of m and a values

Y= K / (1 + mEXP(-at)), t=0 in 1986, K = 3%

Year	t	t^2	Y	K/Y-1	log( )	t log( )
1981	-5	25	0.01	374.208	2.573	-12.866
1982	-4	16	0.02	146.804	2.167	-8.667
1983	-3	9	0.07	40.339	1.606	-4.817
1984	-2	4	0.14	21.186	1.326	-2.652
1985	-1	1	0.34	7.900	0.898	-0.898
1986	0	0	0.60	4.022	0.604	0.000
1987	1	1	1.36	1.212	0.084	0.084
1988	2	4	1.92	0.563	-0.249	-0.499
1989	3	9	2.28	0.314	-0.504	-1.511
1990	4	16	2.55	0.179	-0.748	-2.992
1991	5	25	2.73	0.098	-1.008	-5.040
Sum	0	110	12.01	596.83	6.748	-39.857

m = 4.107

a = 0.834

(K= 3)

By substituting above figures into the formula, the final formula is given as follows:

$$D_N = \frac{3}{1 + 4.107 \times EXP(-0.834t)}$$

b) Demand Forecast for Facsimile Network Service

When the values of a and m values are calculated in case of Japan, t was set a zero (0) on 1986. The Study Team, however, sets t as a zero (0) on 1997 in case of Thailand. Because the Study Team assumes the facsimile network service will be begun at least in 1992 in the county.

According to the above reason, the ratio of facsimile network service to business telephone is shown as follows:

$$DN = \frac{3}{1 + 4.107 \times EXP(-0.834t)}$$

where

t : year (t = 0 in 1997)

The number of facsimile network service subscribers are calculated as follows:

$$Y = DN \times Bn$$

where

Y : the number of facsimile network service subscribers,

Bn : the number of business telephones.

The result of the estimation is shown in Table 8.2.6-6.

Table 8.2.6-6 Forecasted Facsimile Network Service

Year	FAX. Net. Service (A)	Business Tel. (x 1,000) (B)	Ratio (C) %	Year	FAX. Net. Service (A)	Business Tel. (x 1,000)(B)	Ratio (C) %
1992	491	507	0.9684	2000	34,026	1,971	1.7263
1993	1,044	691	0.1511	2001	44,255	2,161	2.0479
1994	2,042	876	0.2331	2002	53,477	2,304	2.3211
1995	3,787	1,069	0.3543	2003	62,173	2,454	2.5335
1996	6,682	1,270	0.5261	2004	69,793	2,596	2.6885
1997	11,215	1,480	0.7578	2005	76,366	2,731	2.7963
1998	17,091	1,632	1.0471	2006	81,978	2,858	2.8684
1999	24,788	1,795	1.3809	2007	87,057	2,986	2.9155

Note: A = B x C / 100

8.2.7 Videotex Service

Analysis of Videotex Service

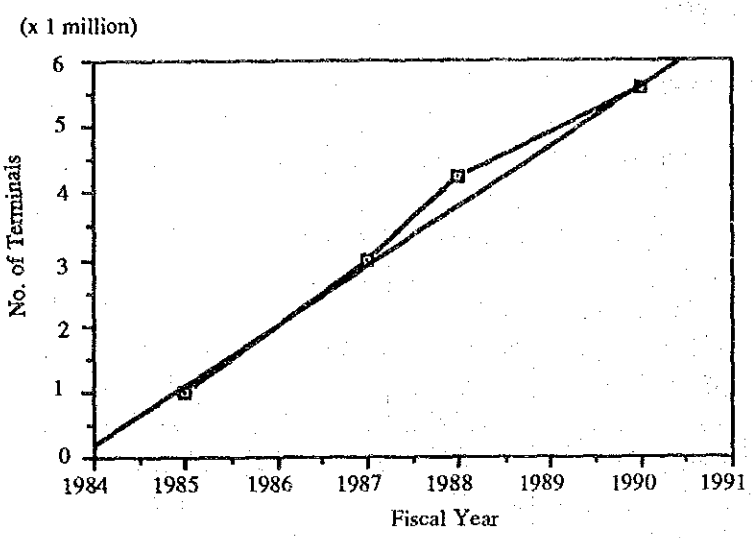
The development of the videotex service in eighteen countries is shown in Table 8.2.7-1.

Table 8.2.7-1 Development of Videotex Service in Eighteen Countries

Country	1985	1987	1988	1990
France	1,000,000	3,000,000	4,228,000	*5,596,000
W. Germany	14,000	96,000	147,000	255,000
UK	51,000	80,000	95,000	n.a.
Netherlands	14,000	30,000	30,000	n.a.
Sweden	6,000	30,000	30,000	n.a.
Austria	n.a.	8,340	9,000	n.a.
Switzerland	n.a.	6,800	10,000	n.a.
Italy	n.a.	5,000	8,000	n.a.
Finland	2,000	4,500	5,000	n.a.
Italy	n.a.	3,900	n.a.	n.a.
Belgium	n.a.	2,500	n.a.	n.a.
Norway	n.a.	1,500	n.a.	n.a.
Denmark	n.a.	1,400	n.a.	n.a.
Ireland	n.a.	900	n.a.	n.a.
Spain	n.a.	300	n.a.	n.a.
Luxembourg	n.a.	200	n.a.	n.a.
USA	n.a.	n.a.	n.a.	2,752,000
Japan	12,000	62,000	89,000	101,000

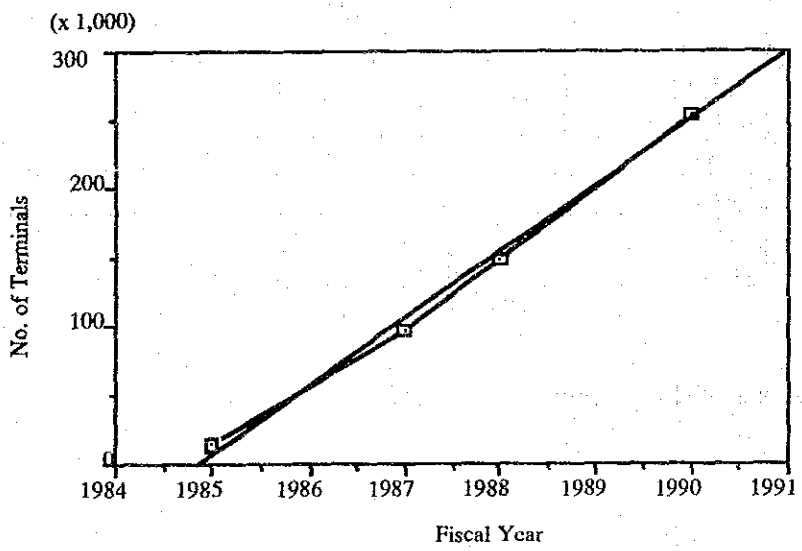
Source: "World Telecom News" issued in Japan

The analyses of three countries are shown in Figure 8.2.7-1, 2, 3.



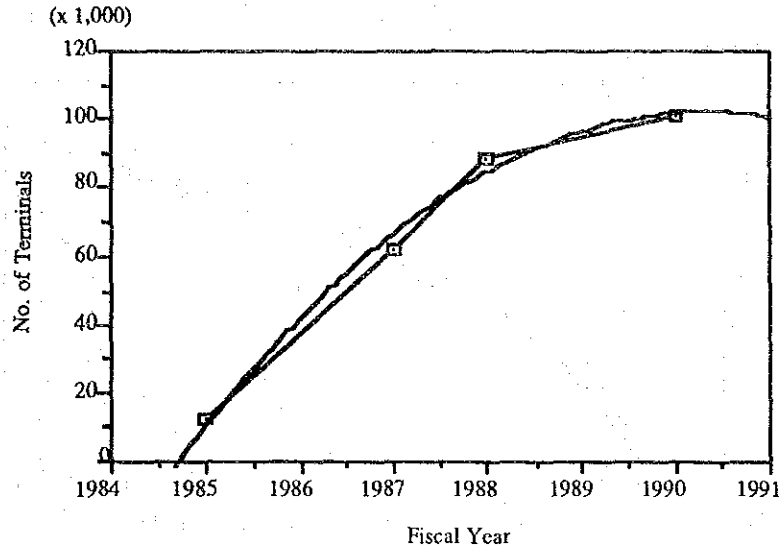
$y = -1.847 \times 10^9 + 9.311 \times 10^5 \times X$
$R = 0.99$

Figure 8.2.7-1 Videotex Service in France



$y = -9.586 \times 10^7 + 4.831 \times 10^5 \times X$
$R = 0.99$

Figure 8.2.7-2 Videotex Service in Germany



$y = -3.601 \times 10^7 + 1.815 \times 10^4 \times X$
$R = 0.96$

Figure 8.2.7-3 Videotex Service in Japan

The development of videotex service is gradual in most countries. The strategies in order to develop videotex service in several countries, are summarized as follows:

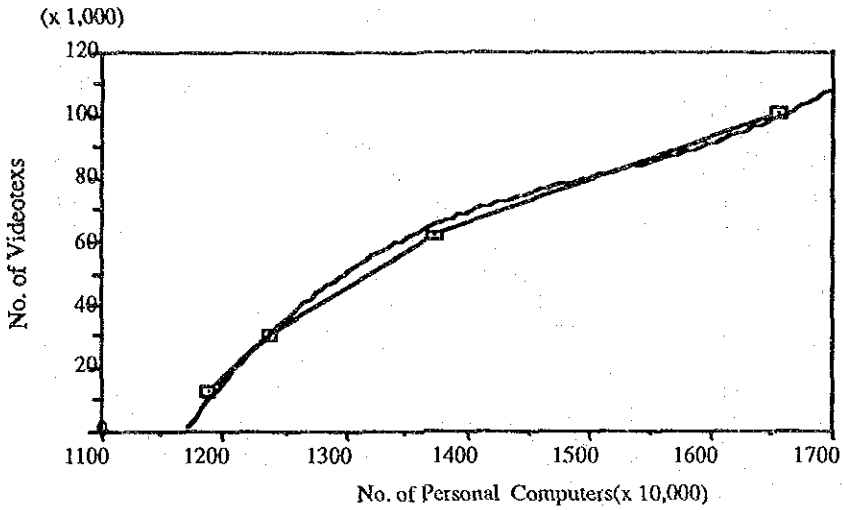
France
a) Substitution for telephone directory books government supported project
b) Free distribution of terminal equipment
c) Easy terminal operation
d) Inexpensive and convenient tariff system
e) Inter-connection with data networks and the ordinary telephone network

Germany, USA, Japan

Inter-connection with computers of other sectors (gate way service)

It seems that, the gate way service will be indispensable for the videotex service. Establishments will be the largest users. Therefore, two methods are considered to estimate the demand; a) using the number of telephone lines and, b) using the number of personal computers .

Figure 8.2.7-4 shows a relationship between the number of videotex subscribers and the number of personal computers in Japan.



$$y = -3.688 \times 10^6 + 7.353 \times 10^3 \times X - 4.859 \times X^2 + 0.001 \times X^3$$
$$R = 1.0$$

Figure 8.2.7-4 Relationship between the Number of Videotex Subscribers and the Number of Personal Computers in Japan

Table 8.2.7-2 Development of Personal Computer in Thailand

Year	1988	1989	1990	1991
No. of Personal Computers	34,874	49,134	69,500	91,000
Growth Ratio		41%	41%	31%

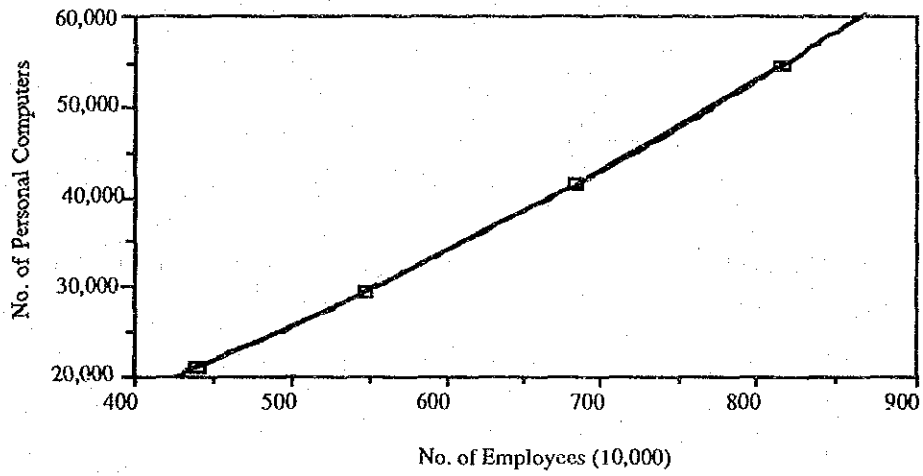
Source: AR Business Consultant Co. in Thai land

Two assumptions are made to estimate the demand. 60% of total number of personal computers will be in a source of the potential demand. People whose monthly income level over 12,000 Baht is another source of the potential demand because they can purchase personal computers. Table 8.2.7-3 shows the estimated number of persons who earn over 12,000 Baht per month.

Table 8.2.7-3 Estimated Number of Persons (Over 12,000 Baht) in the Study Area

Y1988	Y1989	Y1990	Y1991	Y1992	Y1993	Y1995	Y1997
440,914	549,266	683,306	815,465	962,834	1,130,773	1,500,551	1,958,910
Y1998	Y1999	Y2000	Y2001	Y2002	Y2003	Y2005	Y2007
2,207,637	2,470,430	2,746,252	3,031,609	3,275,850	3,527,250	4,024,978	4,534,162

The following figure shows the relationship between the number of personal computers and the number of employees from 1988 to 1991 in the study area. It seems to have a strong linear correlation between them. According to the above result, the number of personal computers was estimated as shown in Table 8.2.7-4.



$y = 1.561 \times X^{1.561}$
$R = 1.0$

Figure 8.2.7-5 Relationship between the Number of Personal Computers and per 1,000 Employees in the Study Area

Table 8.2.7-4 The Estimated Number of Personal Computers

Year	1988	1989	1990	1991	1992	1993	1995	1997
Study Area	0,909	29,539	41,541	54,736	70,910	91,168	141,869	215,057
Other Area	13,965	192,595	27,959	35,264	47,273	60,778	94,580	143,371
Total	34,874	49,134	69,500	90,000	118,183	151,946	236,449	358,428
Year	1998	1999	2000	2001	2002	2003	2005	2007
Study Area	259,367	309,152	364,701	425,562	480,285	539,054	662,418	797,808
Other Area	172,911	206,101	243,134	283,708	320,190	359,370	441,612	531,872
Total	432,279	515,253	607,835	709,271	800,475	898,424	1,104,029	1,329,680

By using the number of personal computers at FY 2007, demand of the videotex service is estimated, too.

Table 8.2.7-5 shows the number of videotex subscribers per telephone line in five countries. In case of Thailand, at FY 2007, the number of videotex subscribers is assumed to be the same as those of France and U.S.A to estimate the demand.

Table 8.2.7-5 Videotex per Telephone Line

	Videotex per Telephone Lines
France	0.22
Germany	0.01
Japan	0.002
U.S.A	0.02
UK	0.004

The following model is applied as well as for the cellular mobile telephone service demand forecast.

$$\frac{Dt}{Nt} = \frac{K}{1 + m \times EXP(-at)}$$

where

Dt	:	the number of people who have potential to subscribe the videotex service
Nt	:	the number of telephone subscribers in period t
K	:	saturation level (number of videotexs per telephone)
BMA		0.22 per telephone line
Province		0.004 per telephone line
m, a	:	coefficients

8.2.7 ISDN Services

In order to understand customers needs toward telecommunications services, a marketing research has been conducted. The result is stated in Chapter 11 and the detail data is attached in the ANNEX 8.

1) Examination of the Marketing Research Results

The following method is applied to examine the result of the marketing research.

a) Statistical Analysis of Customers Responses

Chi-square (c2) analyses are made on the responses of the questions in the questionnaire for the marketing research described in ANNEX 8. The responses of Question A and Question B are arranged in the following manner as a cross-table.

	Item B				
Item A	1	2	j	J	Total
1	N11	N12	N1i	N1J	N1.
2	N21	N22	N2j	N2J	N2.
i	Ni1	Ni2	Nij	NIJ	Ni
I	NI1	NI2	NIj	NIJ	NI
Total	N.1	N.2	N.j	N.j	N

The c2 value of the cross-table can be estimated by using the following formula.

$$X^2 = \sum_{i=1}^{I} \cdot \sum_{j=1}^{I} \frac{(Nij - Fij)}{Fij} ,$$

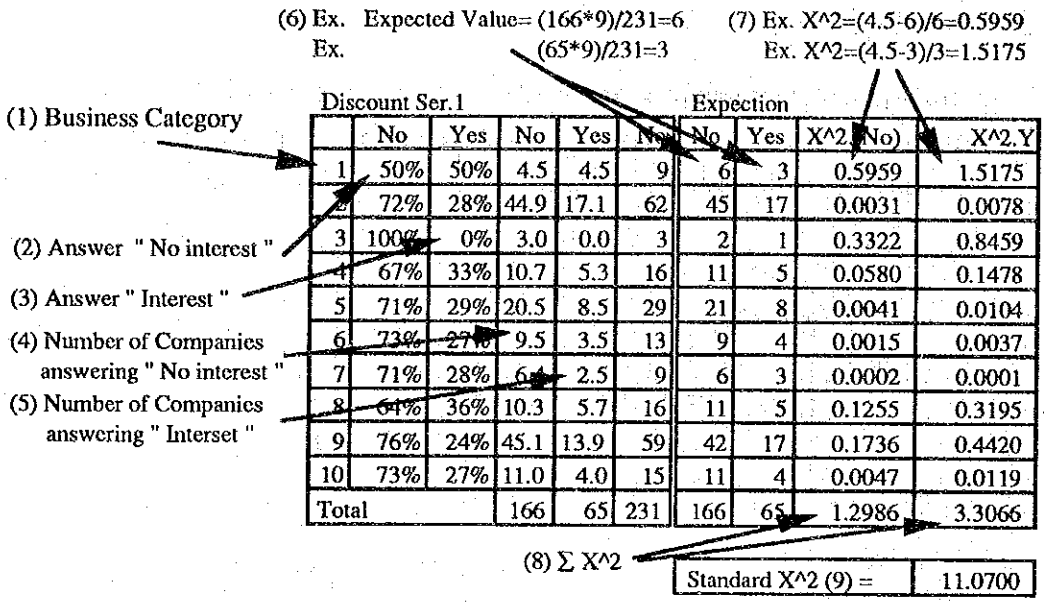
Where

Nij: the number of responses on the ith item of Question A and the jth item of Question B,

Fij: the expected number of responses on the ith item of question Q and the jth item of Question B.

Figure 8.2.8-1 shows an example of the estimated c2 value. In Figure 8.2.8-1, the estimated c2 value is not significant at 5% level with 9 degrees of freedom. This means that there is no significant difference in the answering patterns among the respondents.

All responses from the customers in the questionnaire are examined in the same manner. The examination results are shown in Table 8.2.8-1. The detail data is attached in ANNEX 8.



	No	Yes	No	Yes	No	No	Yes	X^2.(No)	X^2.Y
1	50%	50%	4.5	4.5	9	6	3	0.5959	1.5175
2	72%	28%	44.9	17.1	62	45	17	0.0031	0.0078
3	100%	0%	3.0	0.0	3	2	1	0.3322	0.8459
4	67%	33%	10.7	5.3	16	11	5	0.0580	0.1478
5	71%	29%	20.5	8.5	29	21	8	0.0041	0.0104
6	73%	27%	9.5	3.5	13	9	4	0.0015	0.0037
7	71%	28%	6.4	2.5	9	6	3	0.0002	0.0001
8	64%	36%	10.3	5.7	16	11	5	0.1255	0.3195
9	76%	24%	45.1	13.9	59	42	17	0.1736	0.4420
10	73%	27%	11.0	4.0	15	11	4	0.0047	0.0119
Total			166	65	231	166	65	1.2986	3.3066

Business Category:

1. Agriculture and Mining
2. Manufacturing
3. Utilities
4. Construction
5. Wholesale
6. Retail
7. Restaurant and Hotel
8. Transport
9. Finance
10. Private Service and Government

Figure 8.2.8-1 An Example of the c2 Analysis

Table 8.2.8-1 Estimated c2 Values

Service No.	Service Description	Estimates (c2)	c2 Table Value (5% Significance level with d.f. of 9)
1	Discount Service 6: Back up line of data transmission at lower charge	19.5	
2	Simple Resale: Linking of telephone lines and leased circuits	13.13	
4	Voice Mail Service: Message stored into a switching system at a telephone office and can be accessed by registered.	18.27	
5	High Speed Leased Circuit Service (more than 2Mb/s)	13.83	
6	Information Providing Service through telephone call and facsimile	17.49	
7	Agency Business Service: Collecting Telephone Charge	115.25	
8	ISDN Service Diagram-3: G4 facsimile and TV-conference	11.41	11.07
9	ISDN Service Diagram-4: TV-phone & G4 facsimile	38.36	
10	ISDN Service Diagram-5: Guide-phone	12.84	
11	ISDN Service Diagram-5: G4 facsimile	19.58	
12	ISDN Service Diagram-5: Digital PBX	11.65	
14	ISDN Service Diagram-6: G4 facsimile	14.12	
15	ISDN Service Diagram-8: Studying by using monitor camera	13.05	
16	ISDN Service Diagram-9: TV-conference	12.13	
17	ISDN Service Diagram-10 Computer communication	16.49	

17 services among of 37 services were judged to have different responses among the respondents. As the next step, who has a strong interest for each services is examined. The result is shown in Table 8.2.8-2.

Table 8.2.8-2 Business Category having Strong Interest in Each Service

Services shown in Questionnaire	Business Category having High Interest
Discount Services	Finance and Real Estate, Manufacturing
Simple Resale	Finance and Real Estate, Agriculture & Mining
Voice Mail Service	Manufacturing, Finance and Real Estate, Retail and Hotel
High Speed Leased C.	Utilities, Construction
Information Providing Service	Hotel and Real Estate, Wholesale, Construction
Agency Service	Finance and Real Estate, Wholesale
ISDN Services G4 Fax & TV-Conference	Hotel and Real Estate, Agriculture & Mining
ISDN Service G4 Fax & TV-phone	Manufacturing
ISDN Service Guide-phone	Manufacturing
ISDN Service G4 Fax	Agriculture & Mining
ISDN Service Digital PBX	Agriculture & Mining
ISDN Service G4 Fax	Agriculture & Mining
ISDN Service Monitor Camera	Retail, Agriculture & Mining
ISDN Service TV-Conference	Agriculture & Mining
ISDN Computer Communication	Agriculture & Mining

2) Population for New Services

The population of potential new services users is set as Table 8.2.8-3 shows.

Table 8.2.8-3 The Number of Establishments in Thailand

Business Category	No. of Establishments	
	Whole Kingdom	Study Area
Mining and Quarrying	1,036	80
Manufacturing	53,622	29,463
Utilities	1,129	360
Construction	3,650	2,526
Wholesale, Retail, Hotel, Restaurant	67,088	31,194
Transport, Communication	4,910	2,770
Financial, Real Estate	7,001	4,328
Public Services	23,959	9,762

Source: Year Book of Labor Statistics, Department of Labour, Ministry of Interior Thailand

As one business category to aggregate wholesale, retail, restaurant and hotel business in order to match with the business category in the marketing research , one-third of the total number of wholesale, retail, hotel and restaurant establishments is used as a population of this category.

3) Analysis of ISDN Services

Regarding ISDN services, although the questionnaire listed various service combinations such as G4 Fax and TV-conference, monitor camera and computer, these services are aggregated into two service classes. One is the Basic Rate Interface Service (hereinafter referred to as "BRI") at 64 kb/s and the other is the Primary Rate Interface Service (hereinafter referred to as "PRI") at maximum 2 Mb/s. Therefore, ISDN services demand forecasts are conducted in the two service classes. They are categorized in the following Table 8.2.8-4.

Table 8.2.8-4 Categorization by the Services on Transmission Speed

Service	BRI (64 kb/s)	PRI (2Mb/s)
G4 Fax	•	
Guide-Phone	•	
Monitor Camera	•	
TV-Conference		•
Computer Communication		•
Digital PBX		•

a) Examination of Potential Demand of New Services based on the Marketing Research

The potential demands of the ISDN services are shown in Table 8.2.8-5. These figures are estimated by the following procedure:

i) From the results of the estimated c2 values attached in ANNEX 8, a figure which shows the highest positive response in each service is used as the potential demand source of the service,

ii) Each potential demand is calculated by the same way as the item i),

iii) All potential demand source for the new service are listed in Table 8.2.8-2,

iv) According to the ISDN services categorization, the highest positive response is adopted as the potential demand source,

v) The following formula is used to forecast demands for new services:

$$Si = Pi \cdot Ni$$

Where

Si : the number of potential users of the ith new service,

Pi : the portion of the respondents who answered "yes" for the ith new service in the market research,

Ni : the number of establishments the business category which showed the highest interest for the ith new service in the market research.

In responses, the agriculture sector shows the highest interest in most questions. Since the number of establishments of the agriculture sector is not clear, the business category which shows the second highest interest is used for calculating the potential demand.

Table 8.2.8-5 Potential Demand of ISDN Services at Initial Stage

Service	Whole Kingdom	Study Area
BRI		
ISDN Service G4 Fax & TV-phone	3,640	2,250
ISDN Service Guide-phone	9,392	4,367
ISDN Service G4 Fax	2,700	1,523
ISDN Service Monitor Camera	3,290	1,855
PRI		
ISDN Service Digital PBX	11,181	5,199
ISDN Services G4 Fax & TV-Conference	1,129	360
ISDN Service TV-Conference	14,982	6,966
ISDN Computer Communication	7,379	3,431

b) ISDN Services in Japan

The development of ISDN services in Japan is shown in Table 8.2.8-6 and Figure 8.2.8-2, 3.

Table 8.2.8-6 Development of ISDN Services in Japan

BRI (64 kb/s)

	1988 Jun.	1989 Mar.	1990 Mar.	1991 Mar.	1991.Nov.
No. of Lines	221	1,198	6,574	27,313	62,635
No. of Users	56	244	1,153	6,009	n.a.

PRI (1.5 Mb/s)

	1989 Jun.	1989 Sep.	1989 Dec.	1990 Mar	1990 Jun.
No. of Lines	21	49	72	117	187
No. of Users	10	14	21	33	55
		1990 Sep.	1990 Dec	1991 Mar.	1991 Nov.
		284	402	560	1,176
		91	123	209	n.a.

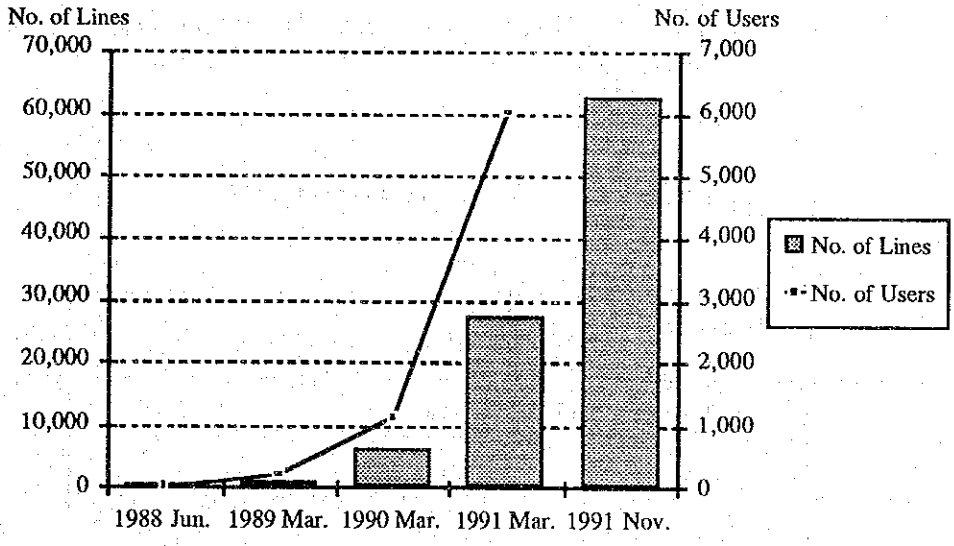


Figure 8.2.8-2 Development of ISDN-BRI Services in Japan

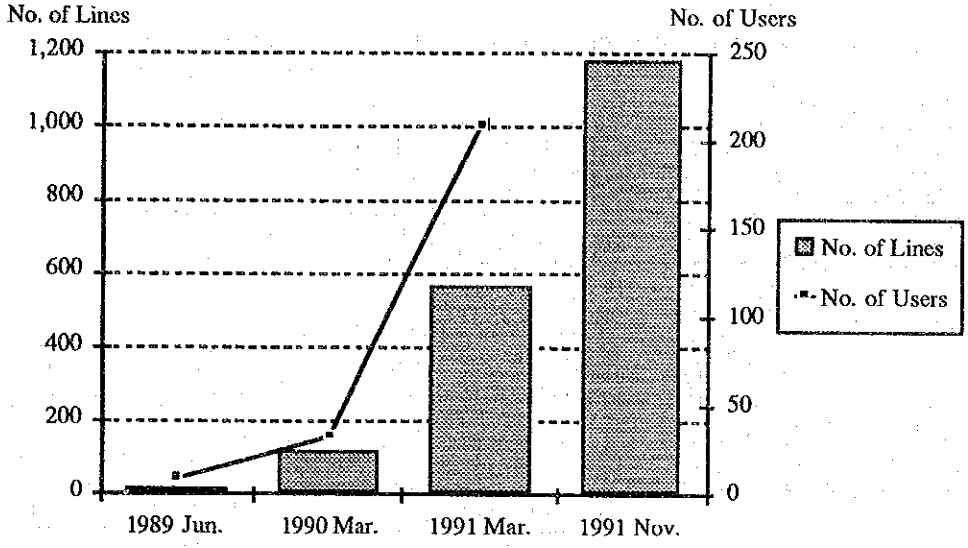


Figure 8.2.8-3 Development of ISDN-PRI Services in Japan

How many lines for the ISDN services are subscribed by business users in March 1991 is shown in Table 8.2.8-7.

Table 8.2.8-7 ISDN Service Subscription in Japan

BRI

Business Category	Number of Lines	Ratio
Finance	9,505	35%
Manufacturing	7,538	28%
Services	3,687	14%
Trade, Sales	2,431	9%
Public Ser.	1,994	7%
Const.,Real Est.	1,284	5%
Publishing	874	3%
Total	27,313	100%

PRI

Business Category	Number of Lines	Ratio
Finance	52	9%
Manufacturing	246	44%
Services	154	28%
Trade, Sales	27	5%
Public Ser.	39	7%
Const.,Real Est.	27	5%
Publishing	15	3%
Total	559	100%

c) ISDN Services Subscription in the World

How many lines for the ISDN services are subscribed in five countries is shown in Table 8.2.8-8.

Table 8.2.8-8 Present State of ISDN Services in the World

Country Name	Carrier	No. of Lines		as of
England	British Telecom	BRI	900	1991.6
France	France Telecom	BRI PRI	7,500 2,000	1991.6
Germany	DBPT	BRI PRI	36,409 3,205	1991.5
USA	Pacific Bell	BRI	1,400	1990.12
Singapore	Singapore Telecom	BRI	260	1991.5

d) Review of the Marketing Research Study on ISDN Services

Though the demands of the ISDN services were estimated in section 8.2.8.3), the forecasted figures seem to be larger than the present subscription figures of developed countries in the ISDN services. Therefore, the forecasts are reviewed.

In section 8.2.8.3), the highest positive response rate among all responses regardless of the business categories was used as the potential demand source. The business category having the highest positive response rate is the transports and communications sector. While, in case of Japan, banks and finances are the large users of both BRI and PRI services.

They are always in the top-ten lists of user rankings. Therefore, banks and financial companies are selected as the major users for the ISDN services. The revised result is shown in Table 8.2.8-9.

However, the revised result is still high compared with other countries for the initial stage. In order to forecast, the another way should be discovered, and this will be reconsidered later.

Table 8.2.8-9 Reviewed Potential Demand of ISDN Services at Initial Stage

Service	Responses of Finance	Demand in Whole Country	Demand in Study Area
ISDN Service G4 Fax	22%	1,470	952
ISDN Service G4 Fax & TV-phone	52%	**3,640** for BRI	**2,250** for BRI
ISDN Service Guide-phone	28%	1,960	1,211
ISDN Service G4 Fax	28%	1,960	1,211
ISDN Service Digital PBX	35%	**2,450** for PRI	**1,514** for PRI
ISDN Services G4 Fax & TV-Conference	21%	1,470	909
ISDN Service Monitor Camera	31%	2,170	1,341
ISDN Service TV-Conference	21%	1,470	908
ISDN Computer Communication	12%	700	519

e) Demand Forecast Model

Since financial companies including banks are big ISDN services users as shown in Table 8.2.8-7, the ISDN services demand forecasts of Thailand are conducted by using the number of companies in this sector.

The Potential demand model is expressed as follows:

$$\frac{Dt}{Nt} = \frac{K}{1 + m \cdot EXP(-at)}$$

where

Dt : the number of telephones in period t,

Nt : the number of telephone line (unit: 100 lines) in period t,

K : saturation level (the number of ISDN telephones per 100 telephone lines),

BRI

BMA 3 0 per 100 telephone lines,

Provincial area 1.5per 100 telephone lines,

PRI

BMA 0.06 per 100 telephone lines,

Provincial area 0.03per 100 telephone lines,

m,a : Constants.

In this study, the following parameters were used:

$$m : \frac{KNt - Dt}{Dt \cdot EXP(-at)}$$

BRI

BMA	297,
Provincial area	452,

PRI

BMA	22,
Provincial area	40,

a : Estimated,

BMA	0.5,
Provincial area	0.5.

3) Demand Forecast

a) Logistic Curve Model

50.2 % companies with 429 financial companies including banks in the BMA listed in the Telephone Directory are decided as the potential customers in 1992 for the BRI and PRI services, and the potential customers for the PRI are estimated to be one-tenth of that of the BRI referring to the service in Japan. In addition, one user has an average 1 line in the initial stage of the services. Residential users are included in businesses users because their portion is extremely small. Therefore, the demand in the BMA is:

BRI 429 users X 50.2% X 1 line = 215 lines,
PRI 215 lines / 10 =22 lines.

In the provincial areas, the number of business telephones is approximately fifty-seven percent of that the business telephones in the BMA in 1990; therefore, assuming that the BRI is proportioned to the number of business telephone, the demand in the provincial areas is:

BRI 215 X 57% X 1 line = 122 lines,
PRI 122 lines / 10 = 12 lines.

The results are shown in Table 8.2.8-10 and Figure 8.2.8-4, 5.

Table 8.2.8-10 Estimated Result of ISDN Services Demand

	Year	1992	1997	2002	2007
BMA	BRI	215	10,575	85,766	168,506
	PRI	22	1,266	2,823	3,558
Prov.	BRI	122	2,535	25,826	81,822
	PRI	11	334	995	1,462
Total	BRI	337	13,110	111,592	250,328
	PRI	33	1,600	3,818	5,020

Note: Figure of Prov. includes the Surrounding Area's demand

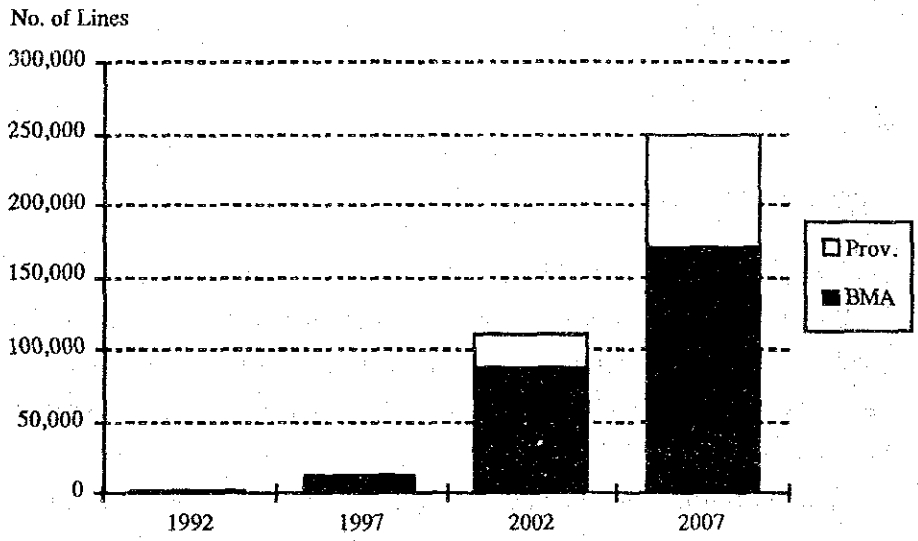


Figure 8.2.8-4 BRI Demand

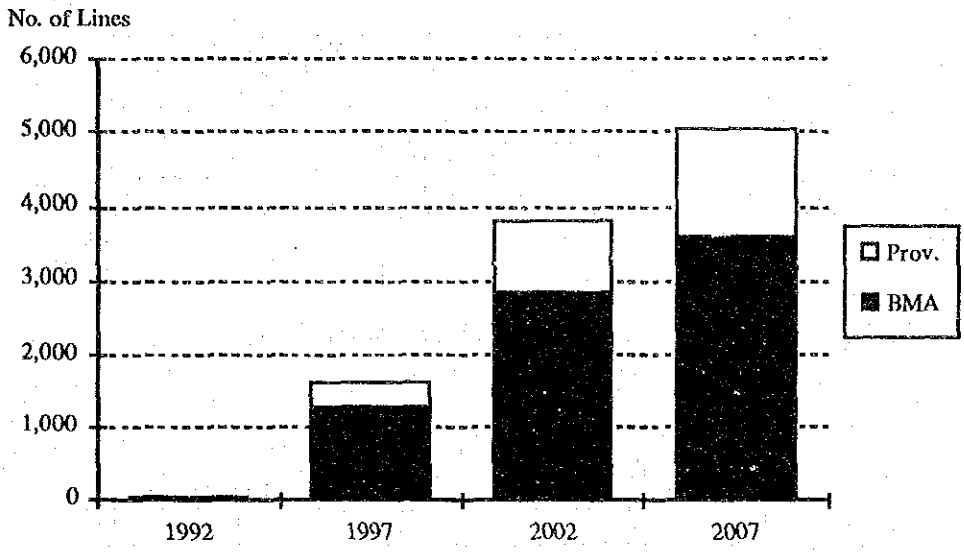


Figure 8.2.8-5 PRI Service Demand

Table 8.2.8-11 shows the average number of the ISDN lines(BRI, PRI) per user in May of 1991 in Japan. At present, most of the lines are used by business users in Japan.

Table 8.2.8-11 Distribution of Number of Lines in Japan

BRI

No. of lines	%
1	12.2
2 to 3	12.4
4 to 5	6.2
6 to 10	10.3
11 to 20	9.3
21 to 50	15.6
51 to 70	6.5
71 to 100	6.6
over 100	20.9

PRI

No. of lines	%
1	15.5
2	16.0
3	4.5
4 to 6	17.8
7 to 9	1.2
10 to 13	12.6
14 to 17	2.9
18 to 20	6.8
over 20	22.7

In Thailand, the ISDN lines will be used in the same way. Therefore, the number is reconsidered for the BMA,

BRI		PRI	
Year	No. of lines per user	Year	No. of lines per user
1992	2	1992	1
1997	2	1997	2
2002	5	2002	4
2007	7	2007	5

For the provincial areas including the Surrounding Area,

BRI		PRI	
Year	No. of lines per user	Year	No. of lines per user
1992	2	1992	1
1997	2	1997	1
2002	3	2002	2
2007	4	2007	3

Table 8.2.8-12 shows the reviewed demand.

Table 8.2.8-12 Reviewed Demand of ISDN Services

	Year	1992	1997	2002	2007
BMA	BRI	430	21,149	428,832	1,179,543
	PRI	22	2,531	11,292	17,790
Prov.	BRI	244	5,071	77,477	327,286
	PRI	11	334	2,985	4,386
Total	BRI	674	26,220	506,309	1,506,829
	PRI	33	2,865	14,277	22,176

Note: Figure of Prov. includes the Surrounding Area,s demand

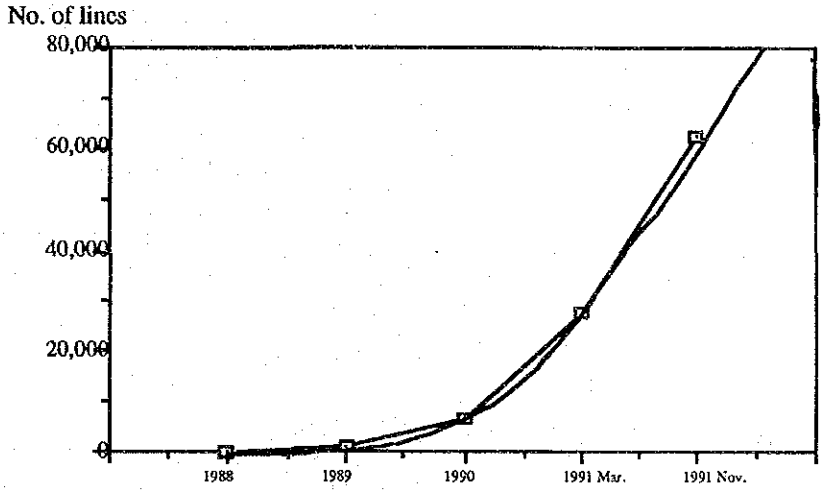
Regarding the potential demand stated before, the figures shown bellow were estimated from large ordinary telephone users. TOT should promote the ISDN services to them. The tariff system not only for the ISDN services but also the existing services should be changed because most respondents expressed that the existing tariff is cheaper and reasonable. That answer "reasonable" can be read "cheaper".

Now, TOT has been preparing for the ISDN services trial in February 1992. At that time, a marketing research about the tariff system should be conducted again.

Services	Demand in Whole Country	Demand in Study Area
BRI (64 kb/s)	3,640	2,250
PRI (2 Mb/s)	2,450	1,514

b) Polynomial Model

The analysis of the BRI service in Japan by a polynomial model is shown in Figure 8.2.8-6.



$y = -19.1 + 39.0 \times X + 25.9 \times X^2 + 6.7 \times X^3 - 0.5 \times X^4$, R=1.00

Figure 8.2.8-6 Analysis of BRI Service in Japan

Table 8.2.8-13 and Figure 8.2.8-7 show the result.

Table 8.2.8-13 Estimation Result of BRI Service

	1992	1997	2002	2007
BMA	215	11,800	89,800	2,960,000
Prov.	122	6,800	693,000	1,726,000

Note: Figure of Prov. includes the Surrounding Area's demand

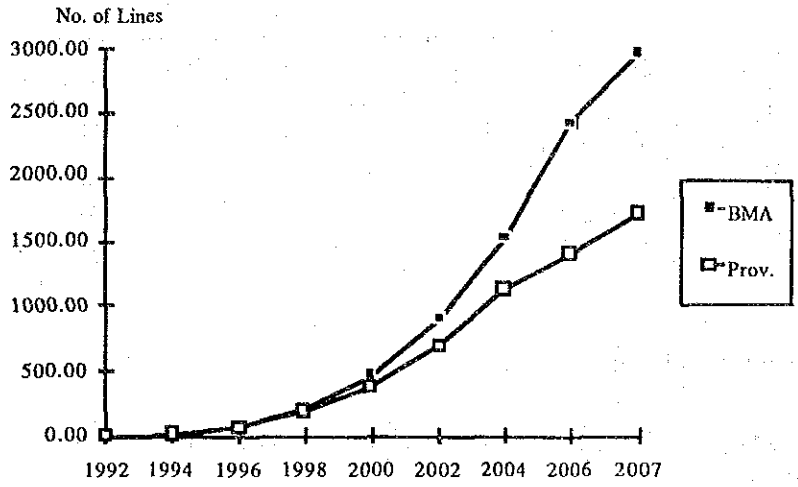


Figure 8.2.8-7 Forecasted Demand for BRI Service

CHAPTER 10 TRAFFIC FORECAST

APPENDIX

APPENDIX

10.1 Statistical Test Results in Calculation of Traffic Forecast

1. Local Traffic

1) BMA

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	9.801699	0.962845	10.179929	0.000
Yt	0.831751	0.074746	11.127721	0.000

Coefficient of Determination (R^2)	0.925276
Adjusted Coefficient (R^2)	0.917804
Coefficient of Correlation	0.961913
Standard Error of Estimate	0.106119

2) Nakhon Pathom

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	8.293853	0.564279	14.698136	0.000
Yt	0.839217	0.066297	12.658495	0.000

Coefficient of Determination (R^2)	0.941259
Adjusted Coefficient (R^2)	0.935364
Coefficient of Correlation	0.970185
Standard Error of Estimate	0.132877

3) Samut Sakhon

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	7.259738	0.803039	9.040332	0.000
Yt	0.971310	0.102405	9.484945	0.000

Coefficient of Determination (R^2)	0.899964
Adjusted Coefficient (R^2)	0.889961
Coefficient of Correlation	0.948664
Standard Error of Estimate	1.999696

4) Ayutthaya

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	7.848622	0.843862	9.298247	0.000
Yt	0.860267	0.106476	8.079432	0.000

Coefficient of Determination (R^2)	0.867158
Adjusted Coefficient (R^2)	0.853873
Coefficient of Correlation	0.931213
Standard Error of Estimate	0.217931

2. Long Distance Traffic

1) BMA

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	-0.404138	0.083920	-4.315756	0.001
Yt	1.522710	0.107721	14.135618	0.000

Coefficient of Determination (R^2)	0.956900
Adjusted Coefficient (R^2)	0.952111
Coefficient of Correlation	0.978213
Standard Error of Estimate	0.103710

2) Nakhon Pathom

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	-0.165111	0.097926	-1.686090	0.123
Yt	1.181494	0.133222	3.868604	0.000

Coefficient of Determination (R^2)	0.887200
Adjusted Coefficient (R^2)	0.875920
Coefficient of Correlation	0.941913
Standard Error of Estimate	0.164862

3) Samut Sakhon

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	-0.1292391	0.046321	-4.153444	0.002
Yt	1.963642	0.063864	21.352386	0.000

Coefficient of Determination (R^2)	0.978537
Adjusted Coefficient (R^2)	0.976391
Coefficient of Correlation	0.989210
Standard Error of Estimate	0.093425

4) Ayutthaya

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	-0.139315	0.077213	-1.804295	0.101
Yt	1.301132	0.116490	11.175209	0.000

Coefficient of Determination (R^2)	0.925869
Adjusted Coefficient (R^2)	0.918449
Coefficient of Correlation	0.962218
Standard Error of Estimate	0.145467

3. International Traffic

1) Whole Country

Variable Name	Coefficient	Std. Err. Estimate	t Statistic	Probability >t
Constant	-1.125931	0.358464	-3.140812	0.026
YT	2.410694	0.395256	6.099074	0.002

Coefficient of Determination (R^2)	0.881513
Adjusted Coefficient (R^2)	0.857816
Coefficient of Correlation	0.938689
Standard Error of Estimate	0.277537

CHAPTER 12 TELECOMMUNICATIONS NETWORK PLAN

APPENDIX

12.2 Operation of Both-way Trunk

1) Operation of Both-way Trunk

Usually signals such as a called a subscriber number in a telephone network are transmitted through trunks which are used as voice paths. Connections of the trunks (e.g., between Switch A and Switch B in Figure 12.2-1) are controlled by out-going trunks. In this system two trunk groups are assigned to connect two exchanges, one out-going trunk group and the other in-coming trunk group. This operation method is called one-way operation.(Fig. 12.2-1)

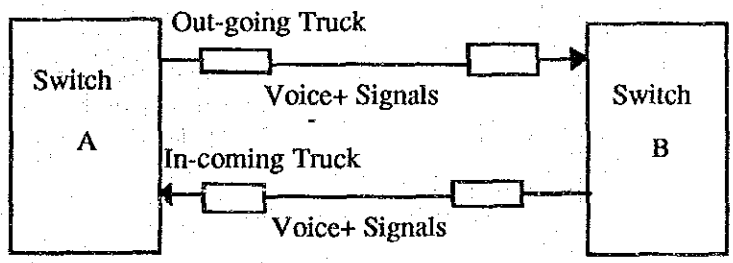


Figure 12.2-1 One-way Operation

Recently by using the Common Channel Signaling System in which the control signals are transmitted through lines used for the signals exclusively, both - way operation for voice paths has been put into practical use. In both-way operation, trunks in a route are used for both out-going and in-coming calls. (Fig.12.2-2)

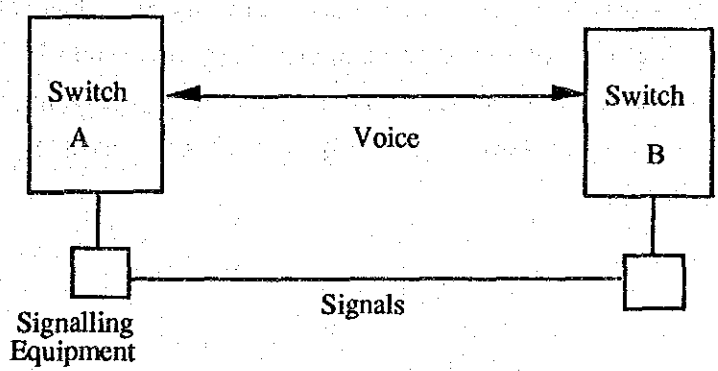
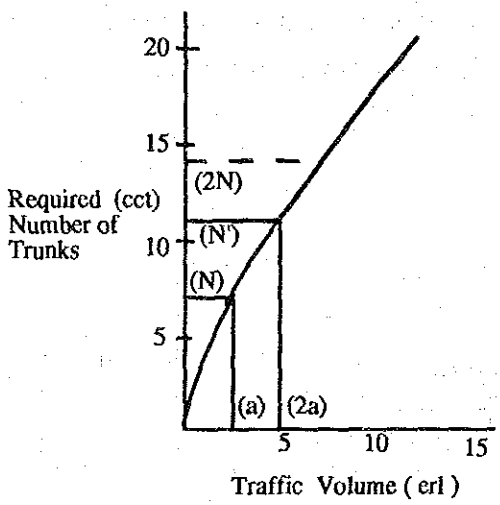


Figure 12.2-2 Both-way Operation

The following are the features of the both-way operation.

a) The Number of Trunks Can be Reduced by Making the Scale of a Trunk Group Larger

In the both-way operation the number of required circuits is calculated according to the total volume of out-going and in-coming traffic. As a result, the number of required trunks is expected to be smaller than that of the one-way operation. (Fig. 12.2-3)



Assumption

Out-going Traffic	2.5erl
Incoming Traffic	2.5erl
Both-way Traffic	5.0erl

The Number of Required Trunks

One-way Operation	
Out-going Route	7cct
In-coming Route	7cct
Total	14cct
Both-way Operation	11cct

Reduction Effect

14 - 11 = 3cct

Figure 12.2-3 Trunk Reduction by Making the Scale of Trunk Group Larger

b) Traffic absorbing effect

In the case that the busy hours of out-going route and in-coming route occure at different time, the number of required trunks in each route for the one-way operation is independently calculated according to the busy hour traffic. However, for the both-way operation, the number of required trunks is calculated according to the sum of the traffic of the two routes; therefore, the number of required trunks of the both-way operation is generally smaller than that of the one-way operation. (Fig. 12.2-4)

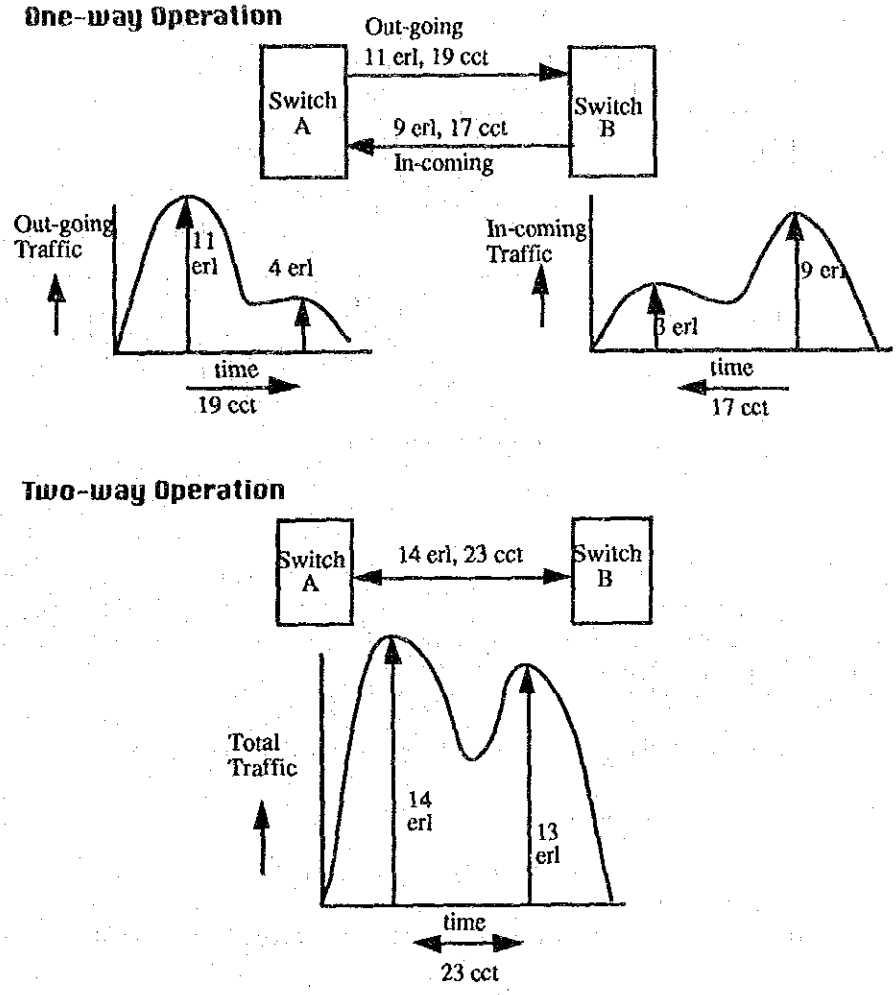


Figure 12.2-4 Traffic Absorbing Effect

c) Improvement of Tolerance Against Traffic Variations

When the traffic of one direction increases unexpectedly, if the traffic of the other direction is smaller than designed value at the moment, the increased traffic can be carried through unoccupied trunks designed for the other direction traffic (Fig. 12.2-5). This means that in the both-way operation, traffic tolerance for abnormal increase to either direction becomes higher than that of the one-way operation.

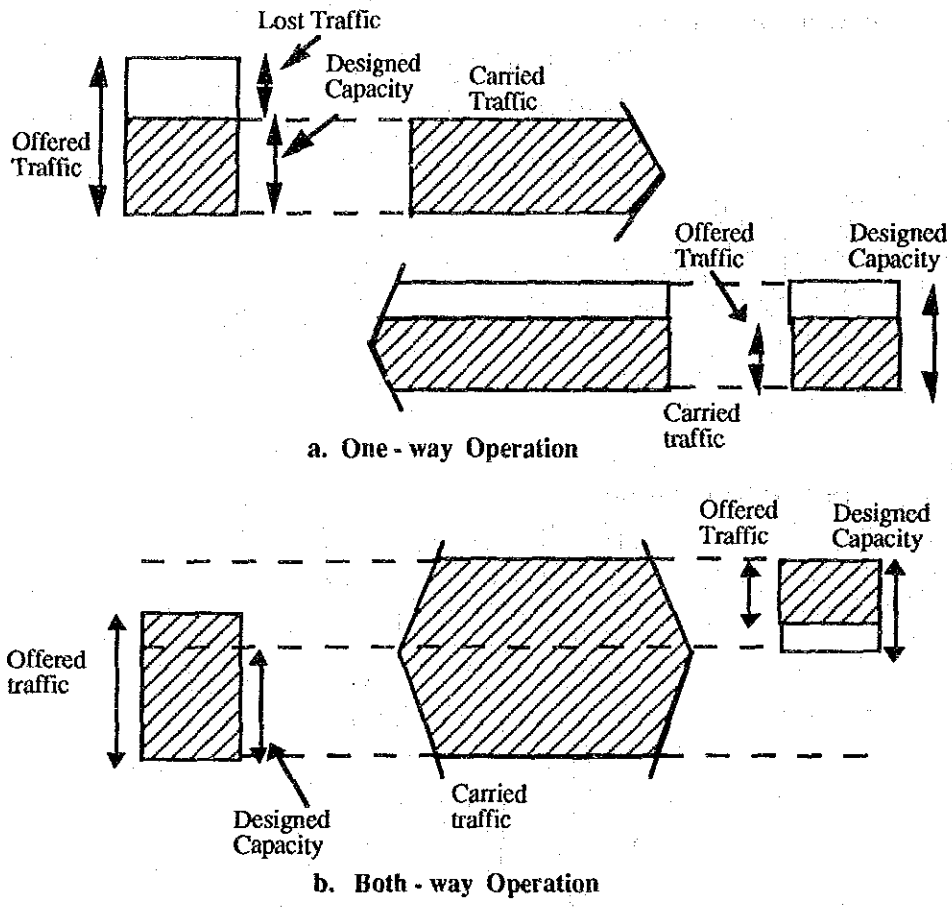
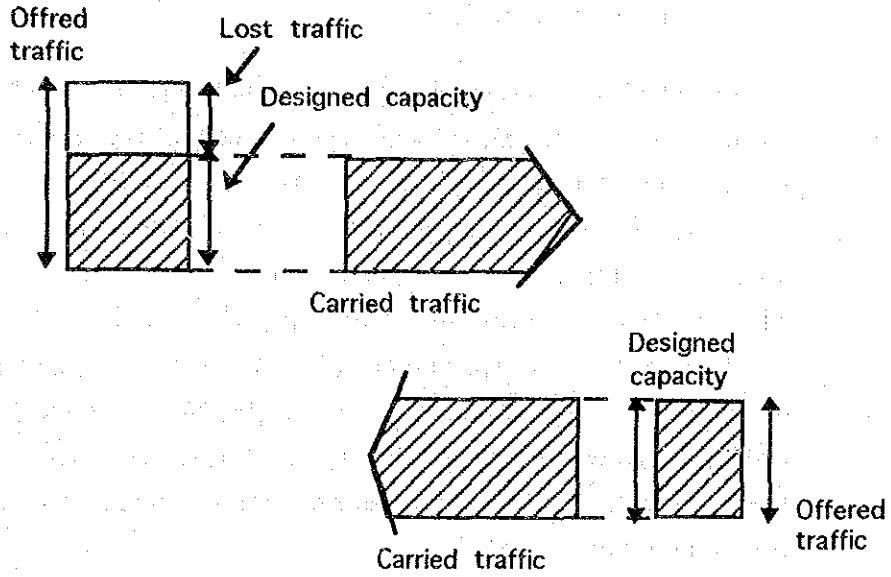
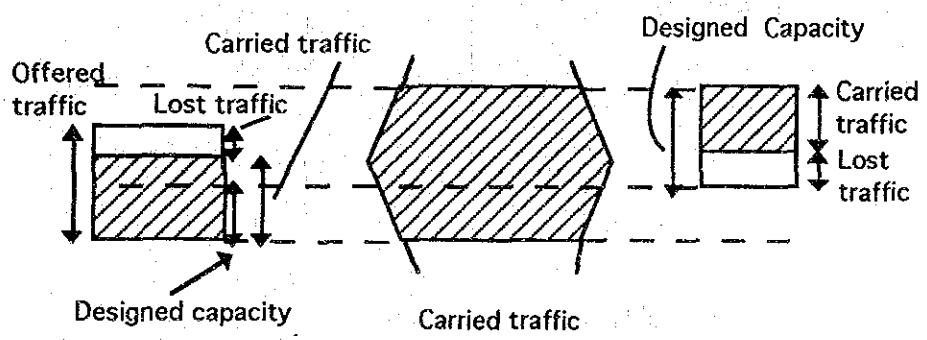


Figure 12.2-5 Improvement of Tolerance Against Traffic Variation

But unexpected traffic increase of one direction may affect the opposite direction traffic, if the opposite direction traffic is also more than the designed capacity. (Fig . 12.2-6). This may affect whole network functions.



a. One - way Operation



b. Both-way operation

Figure 12.2-6 Traffic Oppression for Opposite Direction Traffic

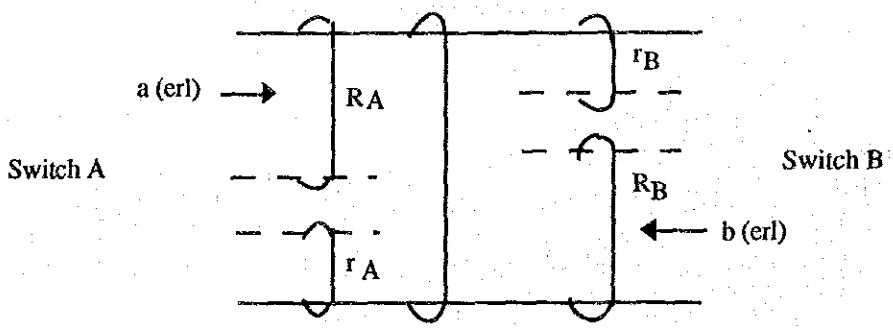
To prevent this problem, the following countermeasures must be considered.

1) Directional reservation method
2)Seizable trunk restriction method
3) Three division method

Directional reservation method is applied generally as a measure against the problem of the both-way operation. Because it is generally superior against traffic fluctuations and in traffic tolerance compared with the other two methods.

i) Directional reservation method

In directional reservation method, some trunks are reserved for out-going traffic and/or in - coming traffic. But in this method, the reserved trunks may be connected to/from neither of the two directions, if no priority rules on reservation are set. To prevent this, a reservation halt value is set for each direction. In Figure 12.2-7, R_A and R_B are the specified number of trunks which can be used for calls from Switch A and Switch B respectively. r_A and r_B are also the specified number of trunks for reservation for opposite direction calls. For example, when the number of busy trunks being used for calls from Switch A is bigger than that of R_A, r_A will be reserved for calls from Switch B. Trunk connection flow and operation status are shown in Figure 12.2-8 and 12.2-9.



n	:	The number of both-way trunks
R_A	:	Threshold number to begin the reservation for calls from switch B
R_B	:	Threshold number to begin the reservation for calls from switch A
r_A	:	The number of trunks for reservation for calls from switch B
r_B	:	The number of trunks for reservation for calls from switch A

Conditions of traffic loss

For calls from Switch A (free lines $\leqq r_B$) $\cap$ (busy lines $\geqq R_A$)

For calls from Switch B (free lines $\leqq r_A$) $\cap$ (busy lines $\geqq R_B$)

Figure 12.2-7 Directional Reservation Method

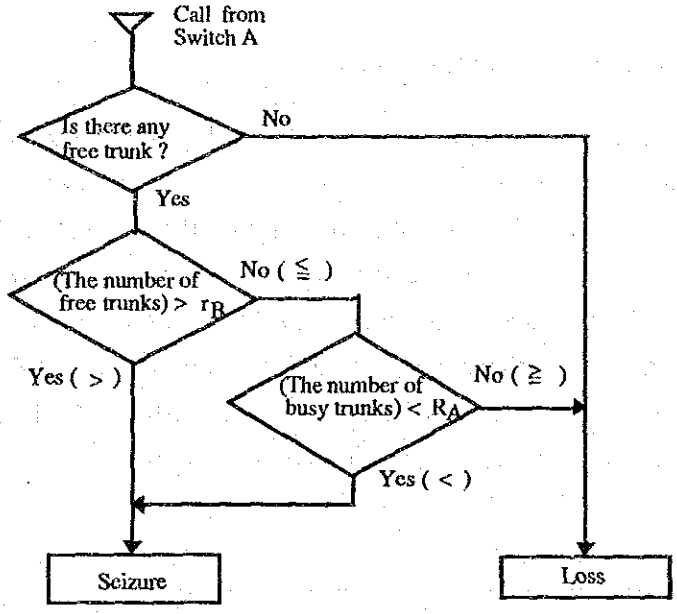


Figure 12.2-8 Trunk Connection Flow

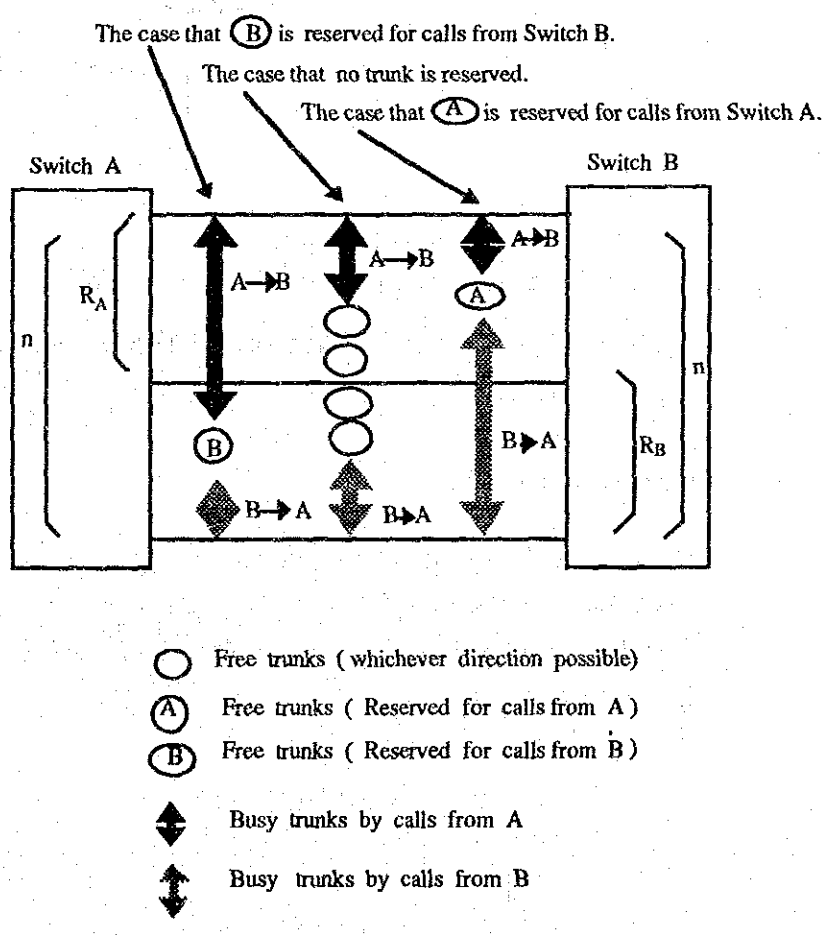
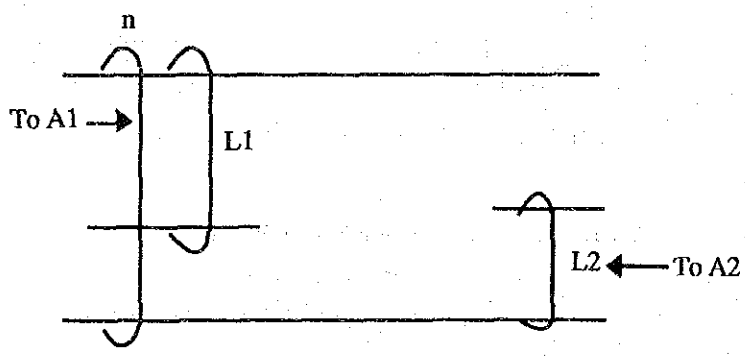


Figure 12.2-9 Operation Status

ii) Seizable trunk restriction method

The maximum number of trunks which can be used for each direction is set at a specified number. In Figgure 12.2-10, calls to the direction A1 can be connected if the number of busy trunks is smaller than L1. Calls to the direction A2 can be connected if the number of busy trunks is smaller than L2. This means that when calls originate on the both - way route, (n - L1) trunks are exclusively used for calls to the direction A1 and (n - L2) trunks are exclusively used for calls to the direction A2 . (L1 + L2 - n) trunks are used commonly for calls from both directions.



n The number of both - way trunks
L1, L2 The number which can be used for each direction

Figure 12.2-10 Seizable Trunk Restriction Method

iii) Three division method

Both-way trunks are divided into three groups. The first group is used for calls to the direction A1. The second group is used for calls to the direction A2 and the third group is commonly used by calls from both directions. (Fig. 12.2-11)

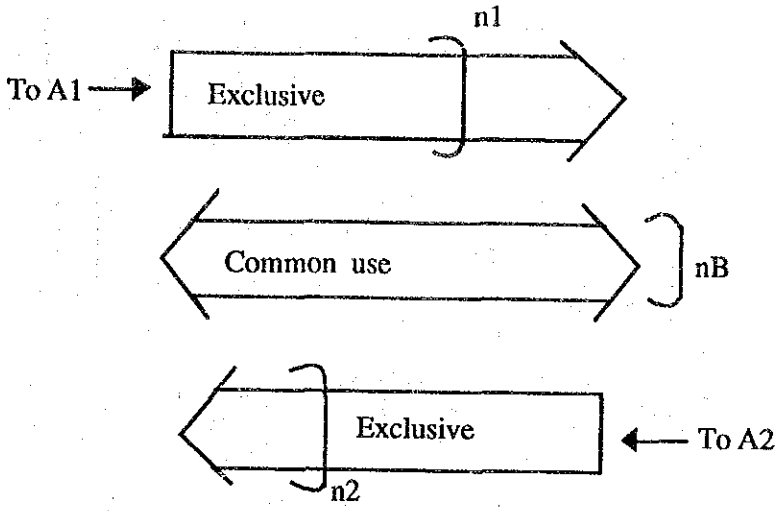


Figure 12.2-11 Three Division Method

2) Traffic Calculation

Figure 12.2-12 shows the calculation process of the number of required both-way trunks according to the far to near rotation method. The calculation of both-way trunks which contain over-flow traffic from preceding routes involves to solve non-linear simultaneous equations. Because the equations contain variables such as traffic intensity, the number of trunks in each switch are not independently determined. So, it is nearly impossible to practice the calculation. To solve the problem, it is required to eliminate the dependent relations of the variables in the calculation. The equivalent overflow method is proposed as a substitute method.

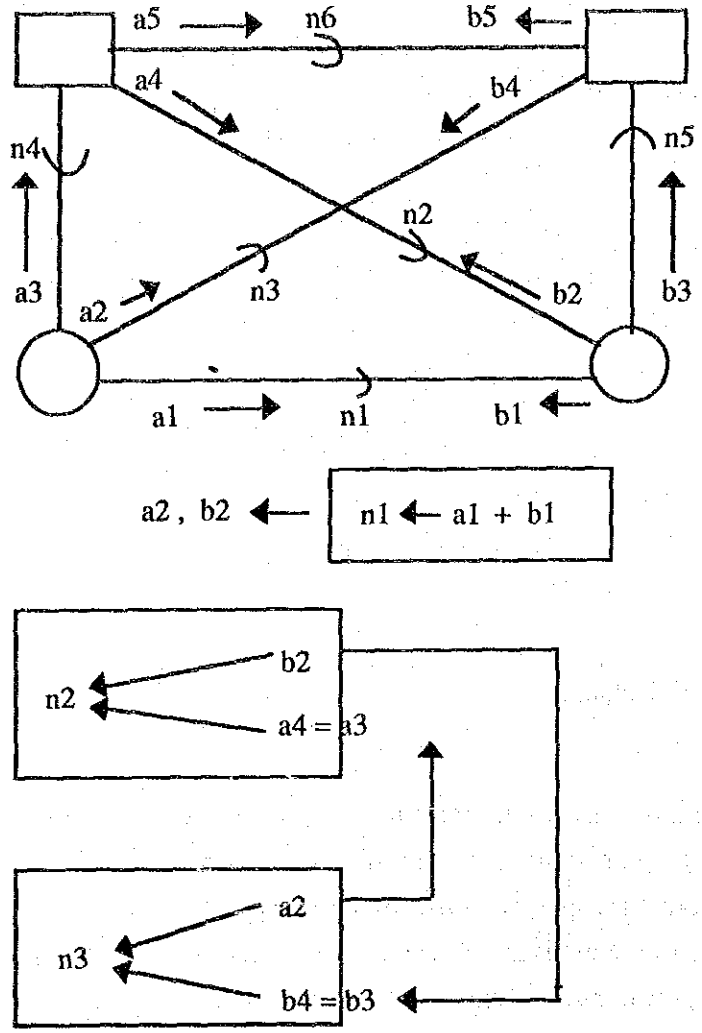


Figure 12.2-12 Calculation Process of the Number of Circuits on Both-way Operation

The method is based on traffic offered and over-flow traffic on the routes in a network which are calculated by the one-way routing method. In the calculation, the value of traffic offered on each both-way route in the network is assumed not to be different from the traffic volume which is calculated by the one-way calculation method.

By the assumption, every route is calculated independently. The following is the calculation process.

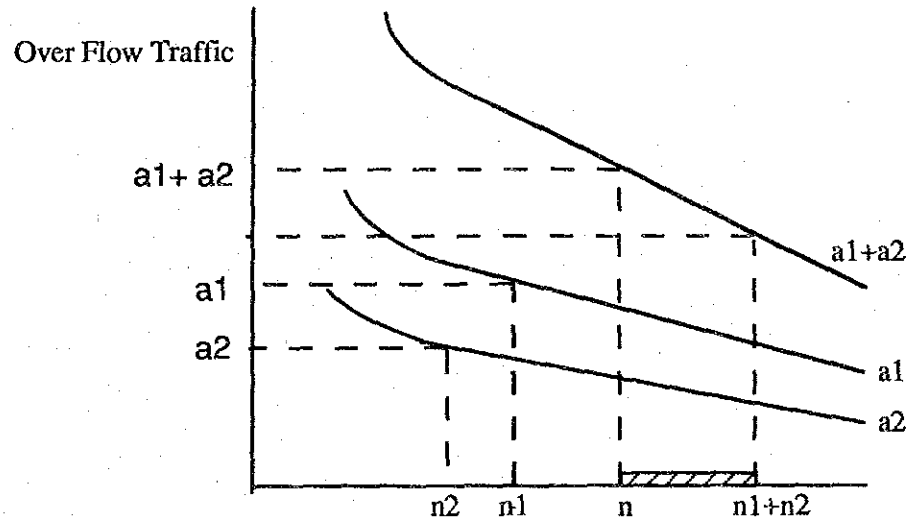
a) Using the present one-way calculation method, traffic offered (a1, a2) and overflow traffic on and from each route (a1,a2) is calculated.

b) As shown in Figure 12.2-13, the number of both-way trunks which is calculated as over flow traffic becomes (a1+a2) when traffic offered is (a1+ a2). (n = n1 + n2) or (n < n1 + n2)

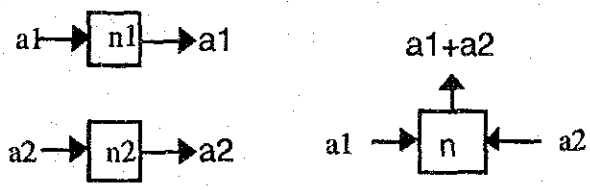
c) The number of circuits in the basic routes is calculated to satisfy the following conditions.

i) traffic offered = out-going over-flow traffic from high usage routes +
out-going first choice traffic on the final route +
in-coming traffic on the final route

ii) blocking rate = 0.01



The Number of Circuits of High Usage Routes



(One-way operation) (Both-way operation)

Figure 12.2-13 Overflow Traffic Equivalent Method

CHAPTER 13 TELECOMMUNICATIONS FACILITY PLAN

APPENDIX

APPENDIX

13.1 Outline of the Facility Plan

13.1.1 Installation Schedule of Main Telephone Lines (Sales Plan)

Table 13.1-1 and Table 13.1-2 show the forecasted demand, the number of subscribers and the number of main telephone lines to be installed for each exchange office in the BMA and the Surrounding Area. The number of subscribers at the end of 1992 is estimated on the basis of the TOT supply plan.

Table 13.1-1 Forecasted Demand and Number of Subscribers for Local Exchange Office in the BMA (1/2)

No.	Staion Code	Local Exchange	ABBR Area		Telephone Demand 1992	1997	2002	2007	Number of Subscriber 1992	1997	2002	2007	Expamsion Plan Phase 1	Phase 2	Phase 3
1	101	Phloen Chit	PNC	1	99,475	157,543	212,118	242,165	55,870	157,543	212,118	242,165	101,673	54,576	30,047
2	102	Samran Rat	SRR	1	63,744	103,037	155,172	203,374	51,617	103,037	155,172	203,374	51,420	52,134	48,203
3	103	Krung Kasem	KKM	1	29,116	52,052	84,264	113,352	23,456	52,052	84,264	113,352	28,596	32,212	29,088
4	104	Surawong	SRW	1	109,203	209,000	326,358	425,870	55,645	209,000	326,358	425,870	153,355	117,358	99,512
5	105	Samsen	SMS	1	21,609	44,064	59,711	62,392	11,865	44,064	59,711	62,392	32,199	15,648	2,680
6	106	Asok Din Daeng	ASD	1	87,479	131,938	156,445	163,060	39,097	131,938	156,445	163,060	92,841	24,507	6,615
7	107	Pathum Wan	PTW	1	27,551	44,670	69,460	94,079	21,710	44,670	69,460	94,079	22,960	24,790	24,620
8	108	Sukhumwit	SKW	1	50,375	56,404	62,535	65,086	31,716	56,404	62,535	65,086	24,688	6,131	2,551
9	109	Chaiyaphruk	CYP	2	34,537	37,570	40,963	41,826	28,880	37,570	40,963	41,826	8,690	3,393	863
10	110	Bang Na	BNA	2	64,015	98,833	135,755	160,678	31,091	98,833	135,755	160,678	67,742	36,922	24,923
11	111	Khlong Chan	KGC	2	81,991	124,537	161,327	179,076	41,006	124,537	161,327	179,076	83,531	36,790	17,749
12	112	Thung Mahamek	TMM	2	32,337	51,481	69,998	81,078	15,511	51,481	69,998	81,078	35,970	18,517	11,080
13	113	Sathupradit	STD	2	20,382	24,741	29,809	33,548	14,791	24,741	29,809	33,548	9,950	5,068	3,740
14	114	Thanon Tok	TNT	2	19,625	30,131	43,202	53,489	16,320	30,131	43,202	53,489	13,811	13,070	10,287
15	115	Bang Chan	BGC	2	44,522	77,135	102,105	116,583	15,741	77,135	102,105	116,583	61,394	24,969	14,478
16	116	Phra Khanong	PKG	2	28,424	44,037	62,509	76,384	22,369	44,037	62,509	76,384	21,668	18,472	13,874
17	117	Hua Mak	HAM	2	46,570	84,304	124,278	149,918	29,286	84,304	124,278	149,918	55,018	39,974	25,640
18	118	Trok Chan	TKC	2	24,478	34,931	49,803	64,709	23,167	34,931	49,803	64,709	11,764	14,872	14,906
19	119	Lat Krabang	LKG	2	10,871	22,400	32,404	39,147	4,098	22,400	32,404	39,147	18,302	10,004	6,743
20	121	Khlong Toei	KTI	2	25,876	50,810	70,258	78,338	12,701	50,810	70,258	78,338	38,109	19,448	8,080
21	123	On Nut	ONT	2	36,717	53,952	67,585	74,988	23,320	53,952	67,585	74,988	30,632	13,632	7,403
22	124	Ramkamhaeng	RKN	2	3,279	12,643	25,917	33,489	5,790	12,643	25,917	33,489	6,853	13,273	7,572
23	301	Samut Prakan	SPK	2	18,128	43,631	83,638	121,757	11,178	43,631	83,638	121,757	32,453	40,007	38,120
24	302	Pu Chao Saming Phrai	PSP	2	56,325	89,246	110,908	122,427	21,105	89,246	110,908	122,427	68,141	21,662	11,519
25	303	Bang Phli	BPL	2	35,924	83,787	127,348	155,068	16,992	83,787	127,348	155,068	66,795	43,561	27,720
26	304	Bang Pu	BGU	2	5,962	12,442	23,813	37,929	3,597	12,442	23,813	37,929	8,845	11,371	14,116
27	305	Bang Phli Bang Bo	BBB	2	7,832	13,615	18,540	22,249	3,901	13,615	18,540	22,249	9,714	4,925	3,709
28	126	Thon Buri	TNB	3	27,180	39,687	57,807	76,032	20,711	39,687	57,807	76,032	18,976	18,120	18,225
29	127	Bang Khae	BKE	3	20,868	33,640	49,761	62,443	15,361	33,640	49,761	62,443	18,279	16,121	12,682
30	128	Dao Khanong	DKN	3	24,991	37,493	52,290	62,365	17,500	37,493	52,290	62,365	19,993	14,796	10,075
31	129	Bang Phlat	BGT	3	76,777	111,486	147,708	171,537	51,208	111,486	147,708	171,537	60,278	36,222	23,830