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No. 7

FEASIBILITY STUDY REPORT ON TRANS-SUMATERA TERRESTRIAL DIGITAL TRANSMISSION SYSTEM IN THE REPUBLIC OF INDONESIA

(FTA-304)

MARCH 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

FEASIBILITY STUDY REPORT ON TRANS-SUMATERA
TERRESTRIAL DIGITAL TRANSMISSION SYSTEM
IN THE REPUBLIC OF INDONESIA (FTA-304)
MARCH

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ON
TRANS-SUMATERA
TERRESTRIAL DIGITAL TRANSMISSION SYSTEM
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THE REPUBLIC OF INDONESIA

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PREFACE

In response to the request of the Government of Indonesia, the Japanese Government decided to conduct a feasibility study on the Trans-Sumatera Terrestrial Digital Transmission System and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Haruo ISHIZUKA, the Nippon Telecommunications Consulting Co., Ltd. from February 3 to March 1, 1987 and from July 14 to August 24, 1987.

The team had discussions on the Project with the officials concerned of the Government of Indonesia and conducted a field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the nationwide telecommunication system and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

March, 1988

Kensuke Yanagiya
President
Japan International Cooperation Agency

INTRODUCTION

Presented herewith is the **FINAL REPORT** for the feasibility study on **TRANS-SUMATERA TERRESTRIAL DIGITAL TRANSMISSION SYSTEM** through the field surveys, which were carried out by JICA study team in cooperation with PERUMTEL/POSTEL in Indonesia.

The study, thus far carried out, comprises:

1)	Preparatory study in Japan	Jan. 26 - Feb. 2, 1987
2)	Field study (1) in Indonesia	Feb. 3 - Mar. 1, 1987
3)	Analysis (1) in Japan	Mar. 2 - Mar. 28, 1987
		June 24 - July 13, 1987
4)	Field study in Indonesia	July 14 - Aug. 24, 1987
5)	Analysis (2) in Japan	Aug. 25 - Oct. 17, 1987
6)	Presentation and discussion of Interim Report	Oct. 18 - Oct. 30, 1987
7)	Analysis (2) in Japan	Oct. 31 - Dec. 26, 1987
		Jan. 4 - Jan. 9, 1988
8)	Presentation and discussion of Draft Final Report	Jan. 10 - Jan. 22, 1988
9)	Analysis (2) in Japan	Jan. 23 - Jan. 26, 1988
		Feb. 22 - Mar. 26, 1988

The principles to be adopted for the study are:

1) **Selection of an optimum system out of a number of plans including that to utilize existing facilities**
2) **Balanced usage of terrestrial and satellite circuits**
3) **Cost optimization**

Shown in the following pages are:

Organization of the study team and the overall timetable of the study.

ORGANIZATION

Japanese Side:

(1) JICA Advisory Committee

Shinji YOKOYAMA	Chairman Ministry of Posts and Telecommunications
Hideo SATAKE	Member Ministry of Posts and Telecommunications
Kin-ichi UMEYA	Member Ministry of Posts and Telecommunications (up to June, 1987)
Ryutaro TOTSUKA	Coordinator Japanese International Cooperation Agency (up to October, 1987)
Setsuo TAKEMOTO	- ditto - (January, 1988)

(2) Study Team

Haruo ISHIZUKA	Team Leader	/Network Planning
Kazuyuki TSUZUKI	Member	/Network Planning
Noboru YAMANE	ditto	/Radio Engineering
Tatsuo SEKI	ditto	/Transmission Engineering
Jun-ichi KOMADA	ditto	/Demand & Traffic Forecasts
Hiroshi HIRAKAWA	ditto	/Structural Analysis
Hirohito SETO	ditto	/Power Supply Subsystem
Mikio DANNO	Member	/Economic Analysis

Indonesian Side:

(1) DITJEN POSTEL

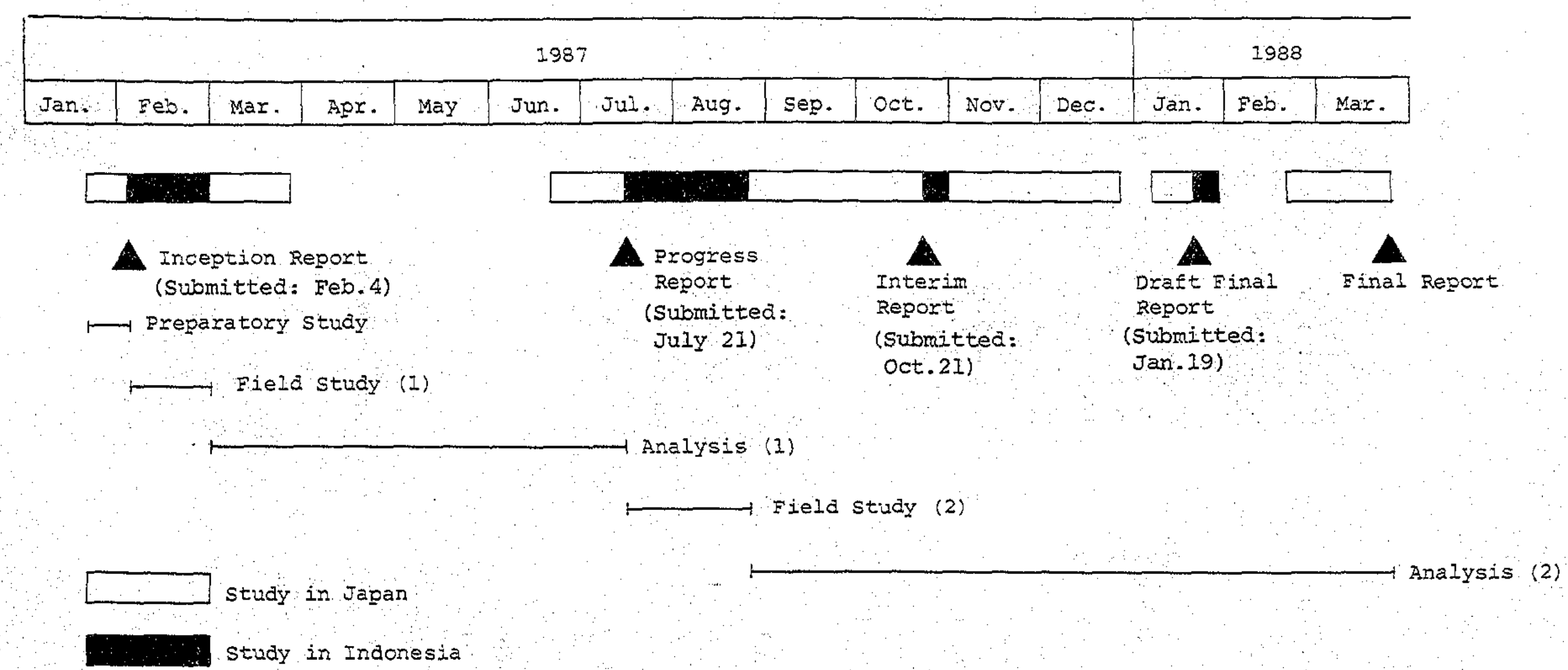
Mr. Rollin	Deputy Director General
Mr. Sri Slameto	Director of Planning
Mr. H.V.R. Saragih	Director of Supply
Mr. Zaenuddin	Director of Frequency Control
Mr. Soeharsono	Director of Operation
Mr. Tjaroso	Director of Engineering
Mr. R.I. Soemardi	Ex-Director of Planning
Mrs. Koesmarihati Sugondo	Planning & Programming Division
Mrs. L. Woerfiendarti	Frequency Control Division
Mr. Samlawi	Telecommunication Planning Division
Mr. Soedarpo	Technique Telegraph Division
Mr. Rachmat Widayana	Engineering Division
Mrs. Tanti Dewi S.	Planning & Programming Division
Mr. Kicky A.M.	- ditto -
Mr. Benyamin Sura	- ditto -
Mr. Bambang Suseno	- ditto -

(2) PERUMTEL

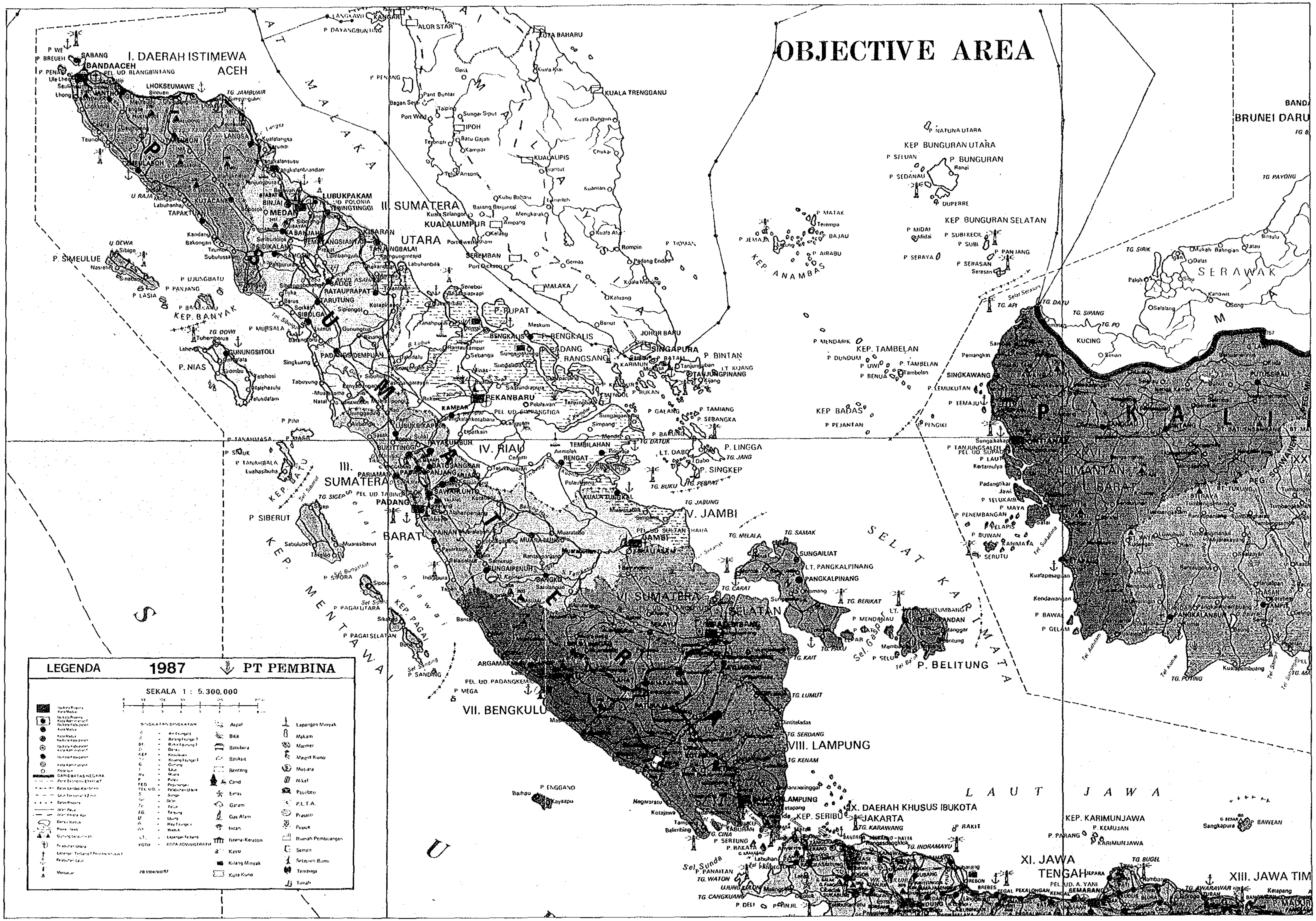
Mr. Syonan Sembiring	Chief of Terrestrial Transmission Planning
Mr. Saleh Effendi	Ex-Chief of Terrestrial Transmission Planning
Mr. Wisnu A. Marantika	Chief of System Engineering Planning
Mr. Adi Prasetya	Vice Chief of Terrestrial Transmission Planning
Mr. Joni Handoyo	Terrestrial Transmission Planning
Mr. Adjisar C.H.	- ditto -
Mr. H.H. Palapessy	- ditto -
Mr. Nurman Burhan	- ditto -
Mr. Amril Ayub	- ditto -
Mr. Imam Soebekti	- ditto -
Mr. Ibnu Slaiman	- ditto -
Mr. Achmad	- ditto -
Mr. Angger Pramuditto	- ditto -
Mr. Soeparto	- ditto -
Mr. Sudiharto	System Engineering Planning
Mr. Indro Wuryanto	- ditto -
Mr. Lumumba Sirait	- ditto -
Mr. Undang Sudirman	- ditto -
Mr. A. Karim	Switching Planning

(3) PARPOSTEL

Mr. Rai Sardjana



Timetable for Feasibility Study on Trans-Sumatera
Terrestrial Digital Transmission System



OBJECTIVE AREA
I. DAERAH ISTIMEWA ACEH
II. SUMATERA UTARA
III. SUMATERA BARAT
IV. RIAU
V. JAMBI
VI. SUMATERA SELATAN
VII. BENGKULU
VIII. LAMPUNG
X. DAERAH KHUSUS IBUKOTA JAKARTA
XI. JAWA TENGAH
XIII. JAWA TIM
KALIMANTAN BARAT
BRUNEI DARU
SERAWAK
BANDAACEH
SABANG
LHOKSEUMAWE
MEDAN
BINJAI
TEBINGTINGGI
SIBOLGA
PADANG
PEKANBARU
BENGKALIS
JAMBI
PANGKALPINANG
SINGAPURA
KUALALUMPUR
KUALA TRENGGANU
MALAKA
JOHOR BARU
P. SIMEULUE
P. NIAS
P. SIBERUT
P. ENGGANO
P. BELITUNG
P. BINTAN
P. LINGGA
P. SINGKEP
P. RUPAT
KEP. BANYAK
KEP. MENTAWAI
KEP. PAGAI
KEP. ANAMBAS
KEP. TAMBELAN
KEP. BUNGURAN UTARA
KEP. BUNGURAN SELATAN
KEP. SERIBU
KEP. KARIMUNJAWA
SELAT MALAKA
SELAT KARIMATA
LAUT JAWA
LEGENDA
1987
PT PEMBINA
SEKALA 1 : 5.300.000

FEASIBILITY STUDY REPORT

ON

TRANS-SUMATERA

TERRESTRIAL DIGITAL TRANSMISSION SYSTEM

IN

THE REPUBLIC OF INDONESIA

(FTA-304)

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(Performance)

(Power Supply)

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(Economic/Financial Analysis)

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ABBREVIATIONS

BINPROTRATEL	:	Terrestrial Transmission Planning Division of PERUMTEL
BINPROSATTEL	:	Satellite Transmission Planning Division of PERUMTEL
BINPROSENTEL	:	Switching Planning Division of PERUMTEL
BINPROSISTEL	:	System Engineering Planning Division of PERUMTEL
CCIR	:	International Radio Consultive Committee
CCITT	:	International Telegraph and Telephone Consultive Committee
CEPT	:	Conférence Européenne des Postes et Télécommunication
CODEC	:	Coder-decoder
D.A.	:	Demand Assignment
DEG	:	Diesel Engine Generator
DITJEN POSTEL	:	Directorate General of Post and Telecommunications
EIRR	:	Economic International Rate of Return
FIRR	:	Financial International Rate of Return
FO	:	Fiber Optics
FTP '85	:	Fundamental Technical Plan (DITJEN POSTEL/PARPOSTEL, 1985)
G.O.S.	:	Grade of Service
ISC	:	International Switching Center
ISDN	:	Integrated Services Digital Network
JICA	:	Japan International Cooperation Agency
LE	:	Local Exchange
Long-term Plan	:	Long-term Planning for Development of Telecommunications System in the Republic of Indonesia (JICA, 1987)
PALAPA	:	Indonesian Domestic Satellite Communications System
PAMS	:	Pre-selected Alternate Master-Slave Synchronization
PARPOSTEL	:	Ministry of Tourism, Post and Telecommunications
PC	:	Primary Center
PELITA-IV	:	4th 5-Year Development Plan (1994-1999)
PERUMTEL	:	Indonesian Telecommunications Public Corporation
REPELITA-V	:	5th 5-Year Development Plan (2000-2004)
SBB	:	Large-size Earth Station
SBS	:	Medium-size Earth Station
SBK	:	Small-size Earth Station
SC	:	Secondary Center
SCPC	:	Single Channel per Carrier
SLDD	:	Subscriber Long Distance Dialing
S/V & CONT	:	Supervisory and Control
TC	:	Tertiary Center
TDMA	:	Time Division Multiple Access
TSDMS	:	Trans-Sumatera Digital Microwave Transmission System
TSMS	:	Trans-Sumatera Microwave Transmission System (analog, existing)
WITEL	:	Regional Bureau of PERUMTEL

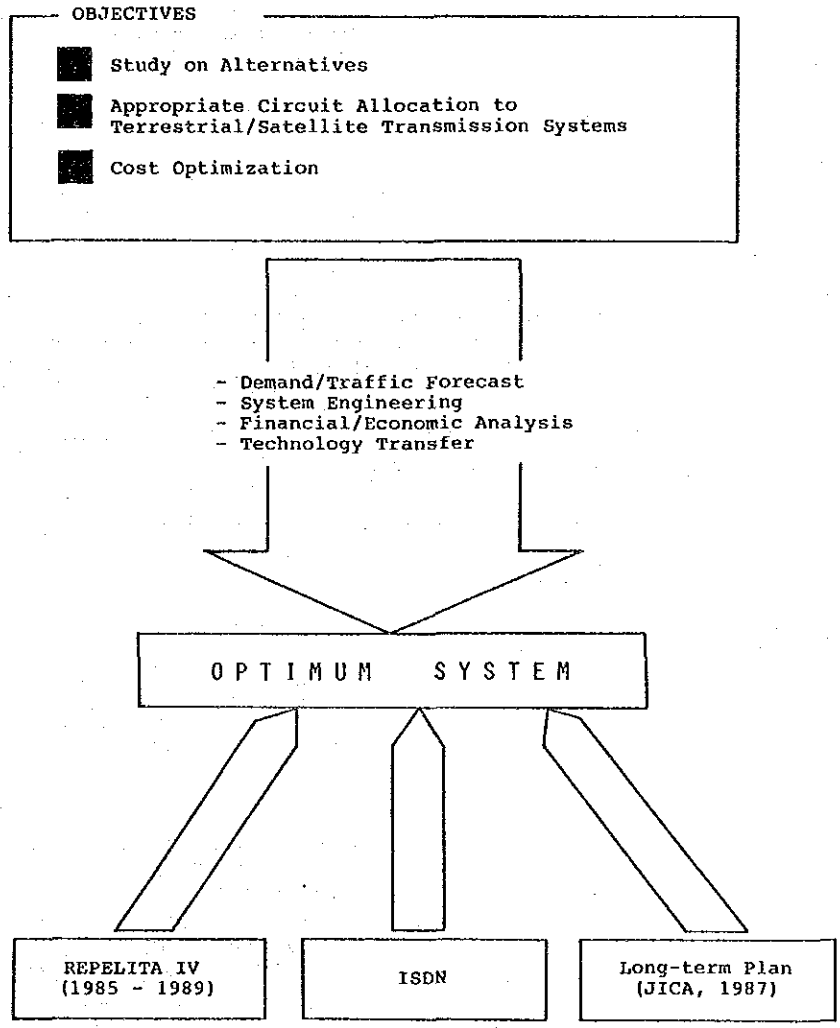
EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

□ Framework of the Study

The study is to verify technical/economic feasibility for TRANS-SUMATERA TERRESTRIAL DIGITAL TRANSMISSION SYSTEM that links major cities in Sumatera island and Jakarta.

The framework of the study is shown as under:



Feasibility Study on Terrestrial Digital Transmission System

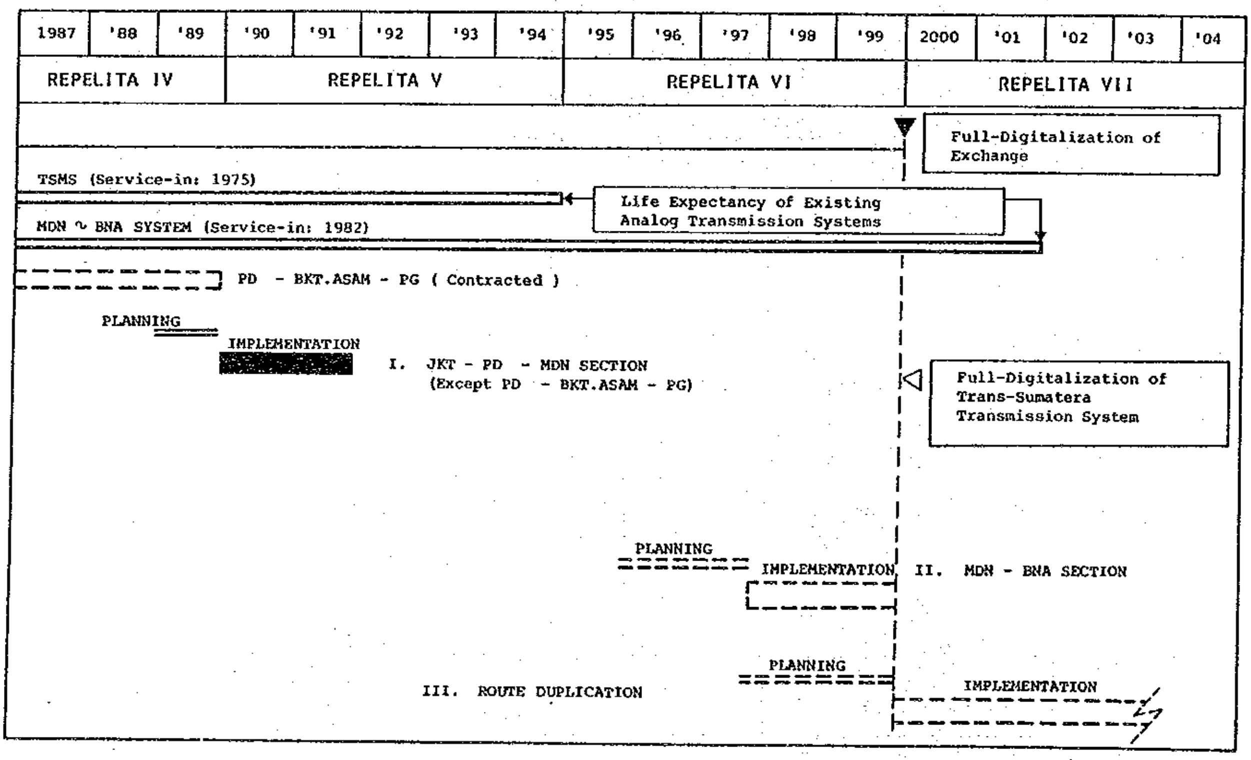
□Recommendation

It is concluded that the digitalization project over Sumatera island should be implemented in the following manner from the viewpoint of its viability:

(1) **Top priority** shall be given to the implementation of digitalization project for the section **between Jakarta and Medan.**

(2) Digital transmission links will be routed along the existing analog transmission links in order **to utilize the existing facilities,** such as towers, station buildings, to full extent.

(3) The project will be implemented in accordance with the schedule as depicted below:



Implementation Schedule
for
Trans-Sumatera Terrestrial Digital Transmission System

☐ Demand/Traffic Forecast

(1) Telephone Demand Forecast

Forecasting method is, in principle, based upon "JICA Long-term Plan, 1987".

However, "Demand Function" used for forecasting has been modified taking account of actual data collected and examined through field surveys.

Forecasted results follow:

Telephone Demand (x1,000 l.u.)

Year	Indonesia Total	Sumatera
1994	3,378	536 (16%)
1999	5,237	860 (16%)
2004	7,516	1,279 (17%)

(2) Non-Voice Services Demand Forecast

Demand for data communications, telex and Gentex services has been derived taking the procedures in "JICA Long-term Plan".

Non-Voice Services Demand in Sumatera

Year	Data Com.	Telex	Gentex
1994	293	6,891	272
	(2,087)	(38,281)	(994)
1999	615	11,289	334
	(4,418)	(59,412)	(1,167)
2004	1,086	16,649	415
	(7,791)	(83,245)	(1,449)

(Note) Figures in parentheses indicate those for whole Indonesia.

(3) Supply Plan

The telephone supply plans throughout Indonesia as well as in Sumatera are as shown in the following table:

Supply Plan (x1,000 l.u.)

Planning Period		Indonesia Total	Sumatera
REPELITA-IV	(1985-1989)	1,069	172 (16%)
REPELITA-V	(1990-1994)	968	88 (9%)*
REPELITA-VI	(1995-1999)	1,650	292 (18%)
REPELITA-VII	(2000-2004)	1,900	341 (18%)

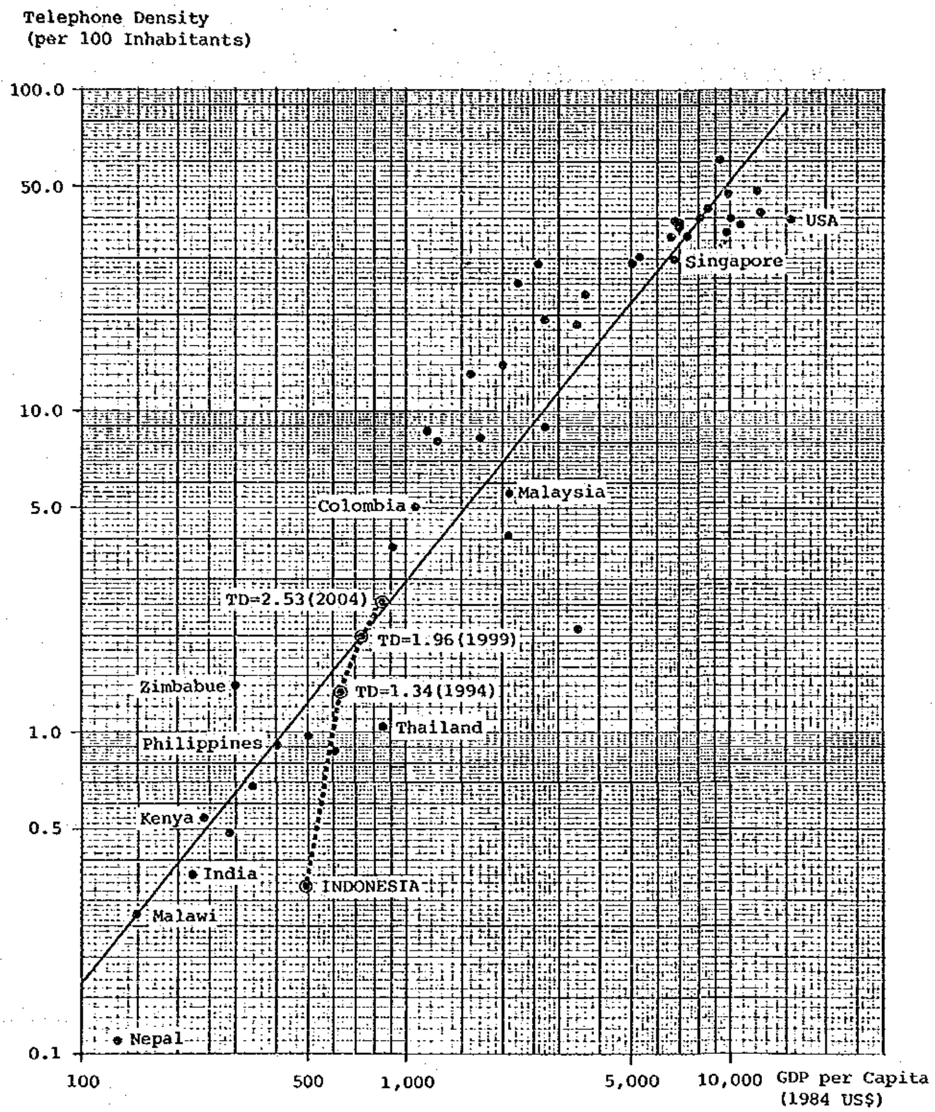
Note *) 60% of total supply volume is allocated to WITEL IV, mainly to Jakarta area.

Provided "supply plans" be implemented as shown in the table above, telephone density (penetration) would be:

Telephone Density (per 100 inhab.)

Year	Nationwide Average	Sumatera
1994	1.34	.92
1999	1.96	1.38
2004	2.53	1.77

The telephone density at the national level will reach 1.33, POSTEL's target, by the year 1994 as shown below:



Telephone Density vs. GDP per Capita

(4) Traffic Forecast

SLDD traffic intensity has the upward trend as shown below:

SLDD Traffic Intensity

	1985(*)	1994	1999	2004
Nationwide	3.95mE	5.51	5.70	5.80
Sumatera Av.	4.43	6.07	6.24	6.33

Note *) Actual data.

(5) Required No. of Circuits

Required No. of circuits has been derived taking account of "forecasted demand", "supply plan" and forecasted traffic intensity.

Basic conditions for circuit calculation are as under:

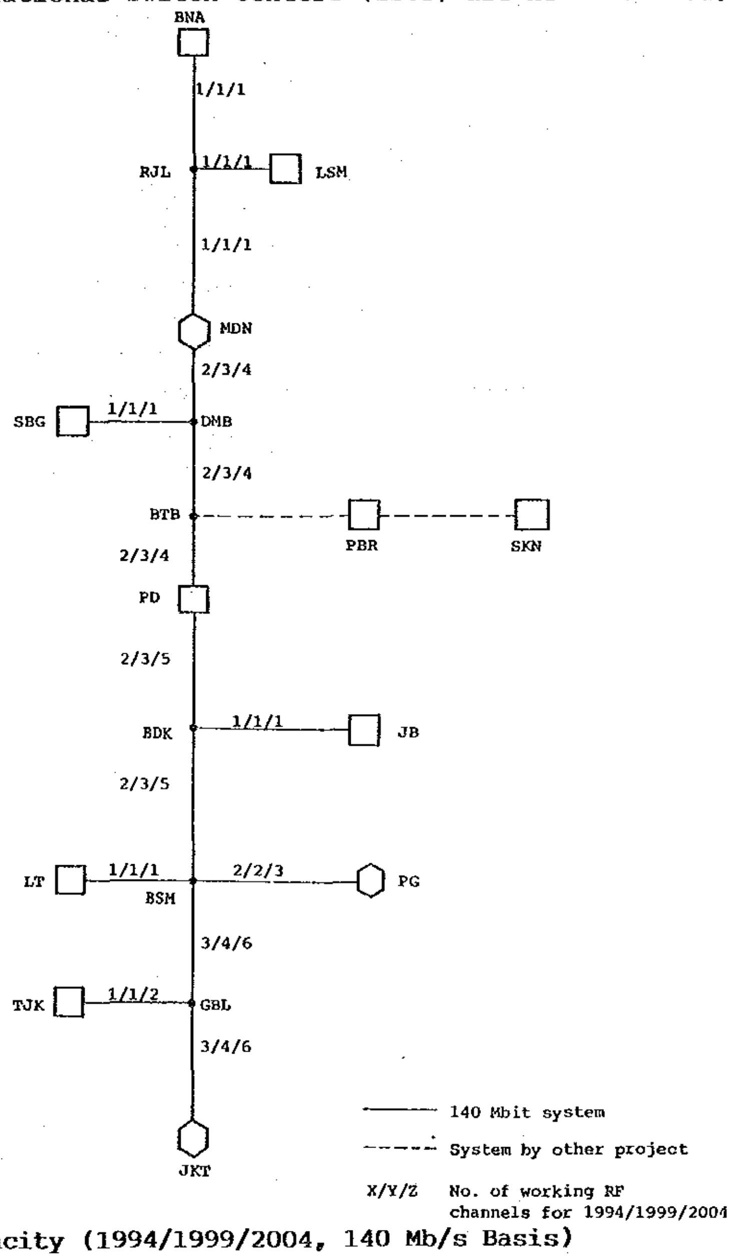
1) Routing : Alternate routing
   Other conditions are based upon "JICA Long-term Plan"
2) Circuit Cost : Proportional to "transmission distance"
3) G.O.S. of Final Circuit: .01
4) Establishment of
   High Usage Circuit: Required No. of Circuits>=15
5) Circuit Allocation among Terrestrial
   and Satellite Transmission Systems: JICA Long-term Plan

Totally required number of circuits is assumed 110% of the derived number of circuits; **10% additional circuits are assigned to non-voice services.**

(6) Circuit Grouping

In the next step, the required number of circuits is grouped into a bunch of 2 Mb/s tributaries with 10% additional included for leased circuits.

The system configuration to meet the circuit requirement above is shown as under on 140 Mb/s basis; back-up circuits between Jakarta and Medan International Switch Centers (ISCs) are not included.



System Capacity (1994/1999/2004, 140 Mb/s Basis)

□ Optimum Digital Transmission System

(1) Performance Objectives

According to the CCIR Rec. 594-1 (Geneva, 1986):

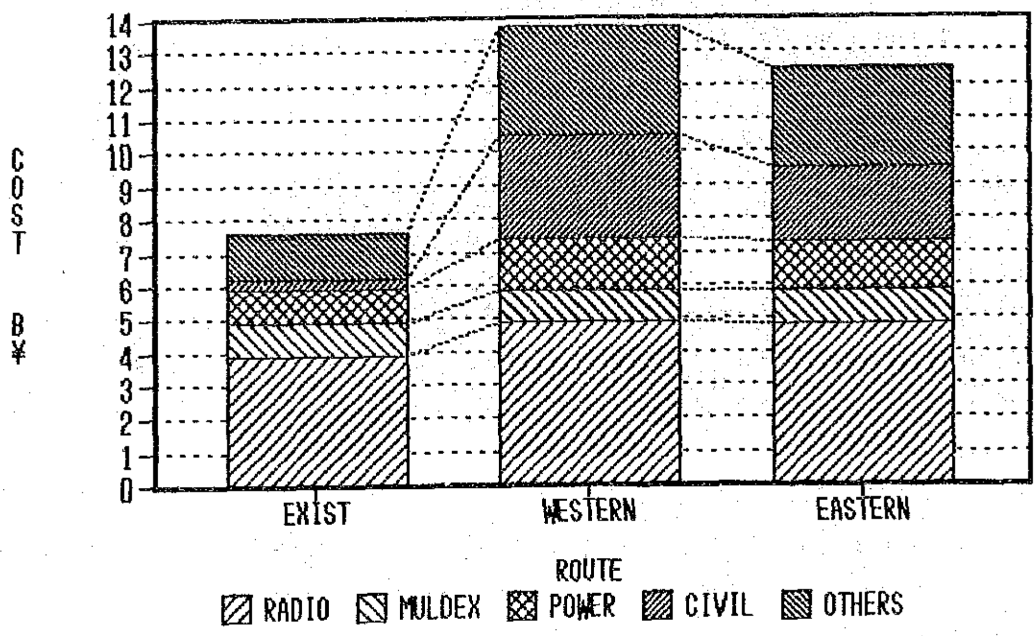
1) The following objectives are stated for each direction of the 64 Kb/s hypothetical reference digital path (HRDP) specified in Recommendation 556;
2) Fading, interference and all other sources of performance degradation are taken into account in establishing the values given below;
3) The bit error ratio should not exceed the following values:
    1. 1×10^{-6} during more than 0.4% of any month; integration time 1 min.; (minutes of **degraded performance**)
    2. 1×10^{-3} during more than 0.054% of any month; integration time 1 sec. (**severely errored seconds**);
4) The total of errored seconds should not exceed 0.32% of any month.

(2) Routing Alternatives (JKT - MDN - BNA)

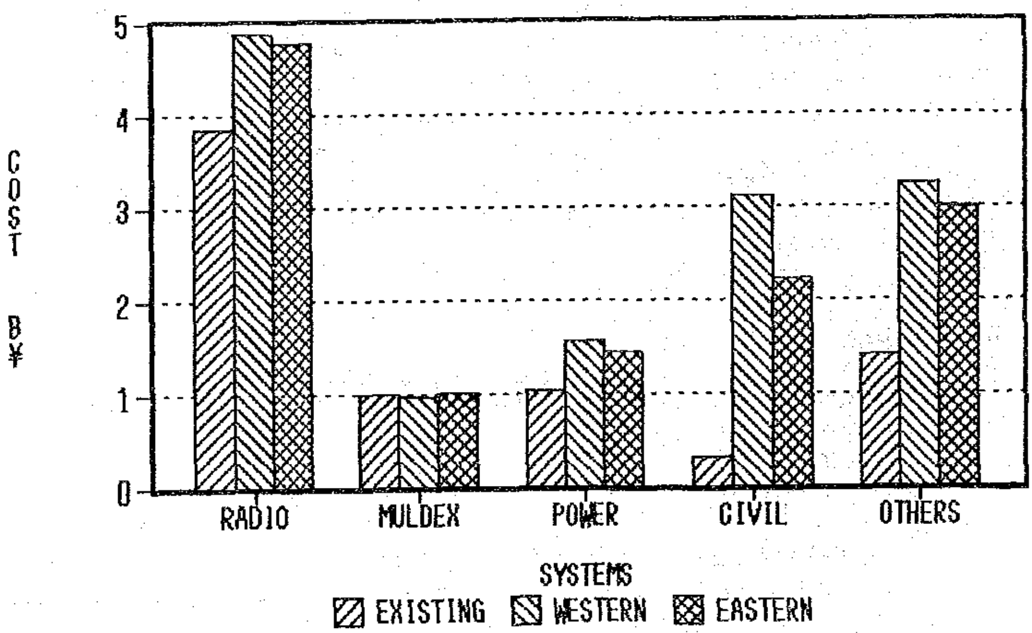
Three routing alternatives, i.e., existing, western and eastern route plans are considered and compared:

Item	Existing Route Plan	Western Route Plan	Eastern Route Plan
Total Link Length	2,495.6 km	3,215.8	3,196.0
No. of Hops	64	96	89
>=30 km	45	60	66
< 30 km	19	36	23
Existing Hops	60(94%)	32(33%)	41(46%)
Av. Hop Length	39.0 km	33.5	35.9
No. of towers/**New:**	5	61	47
Existing:	60	36	43
Land Procurement	8,800 m^2	106,000	97,500
New Access Road	2 km	36	6
Road Rehabilitation	5 km	250	159
Station Bldg.	1,200 m^2	9,100 m^2	6,300 m^2
Investment (1994 requirement)	¥7.6 Billion	13.8	12.5
Accessibility			
1. Transport Accessibility	Excellent	Very poor	Poor
2. Geographic Conditions	Good	Bad	Bad
3. Exchange Accessibility	Good	Poor	Moderate

Project Cost
Existing, Western and Eastern Route Plans



Project Cost (Subsystem-wise)
Existing, Western and Eastern Route Plans



(3) Transition from Analog to Digital Network

It is practical to digitalize the network gradually taking into account:

- **Life expectancy of existing facilities;**
- **Digitalization program of exchanges.**

1) PAMS (Preselected Alternate Master-Slave Synchronization) scheme is employed for Indonesia as set out in FTP '85; MEDAN in Sumatera island could be the sub-master station to supply master clock.
2) Existing analog transmission system over Sumatera island will be utilized as long as its service life lasts; co-existence period of analog and digital transmission systems along JKT-MDN section might be three years.
3) Interworking conditions are examined carefully in the transition period.

☐ Choice of Transmission System

(1) Frequency Band and Modulation Scheme

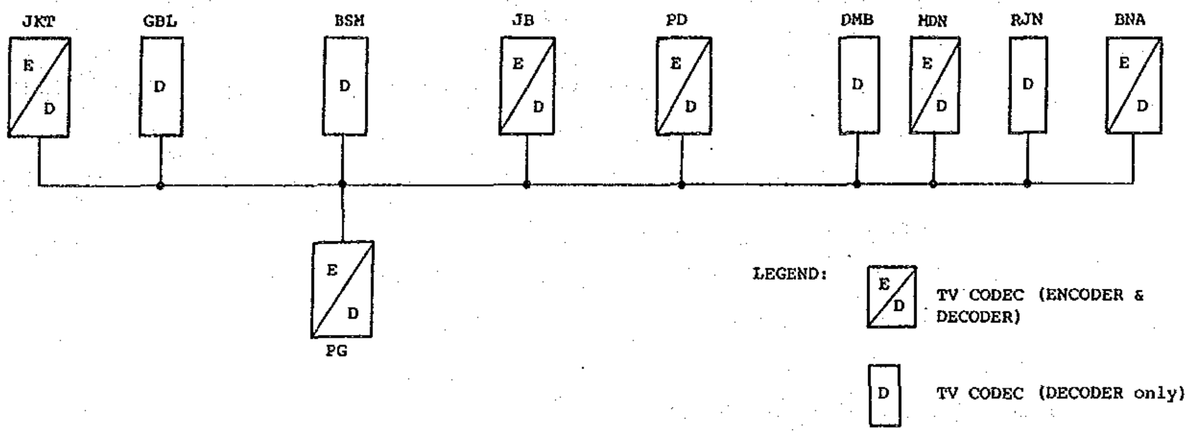
Following are recommendable:

Frequency Band:	Upper 6 GHz (6430-7110 MHz, CCIR Rec. 384-4)
Transmission Rate:	140 Mb/s
Modulation Scheme:	16 QAM (Quadrature Amplitude Modulation)

(2) TV/Radio Broadcast CODEC

The stand-by bearer of digital radio transmission system at the bit rate of 68 Mb/s will be utilized as a back-up for Palapa **TV program** transmission.

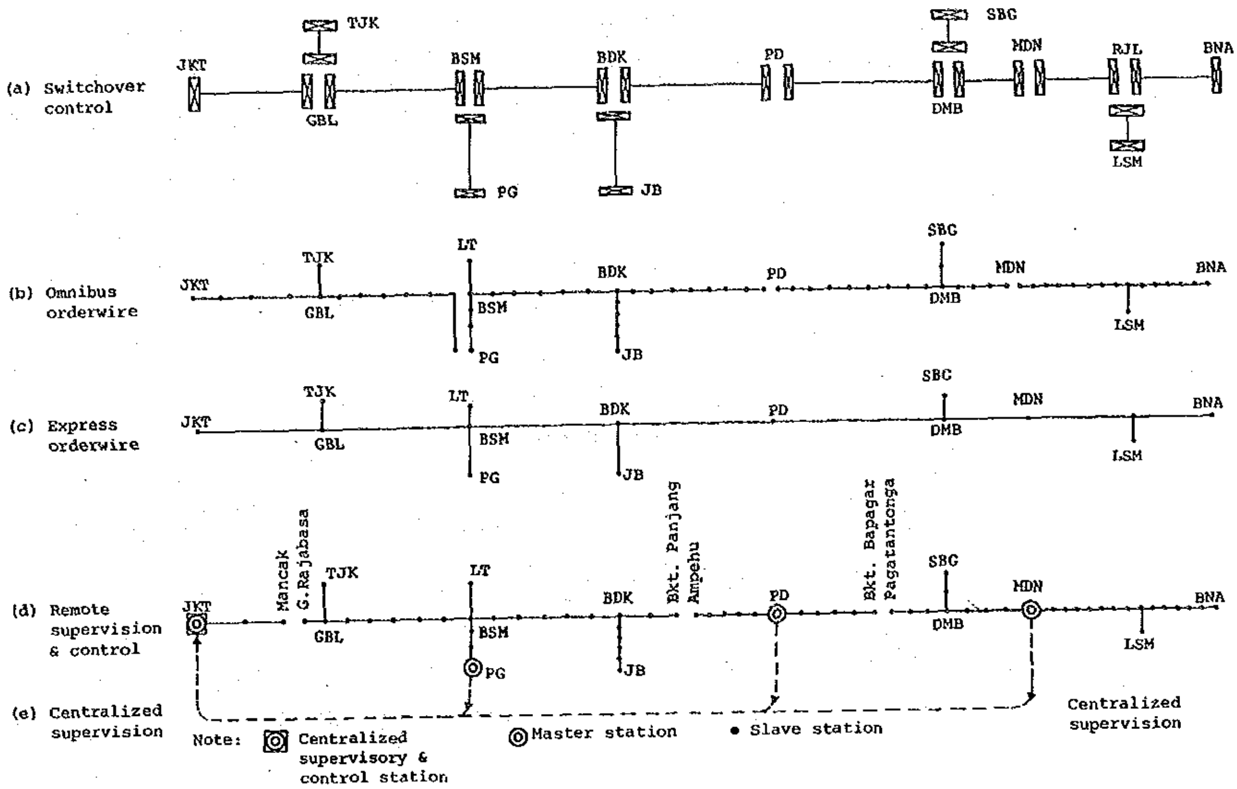
Radio program is also routed over the transmission system at the bit rate of 2 Mb/s.



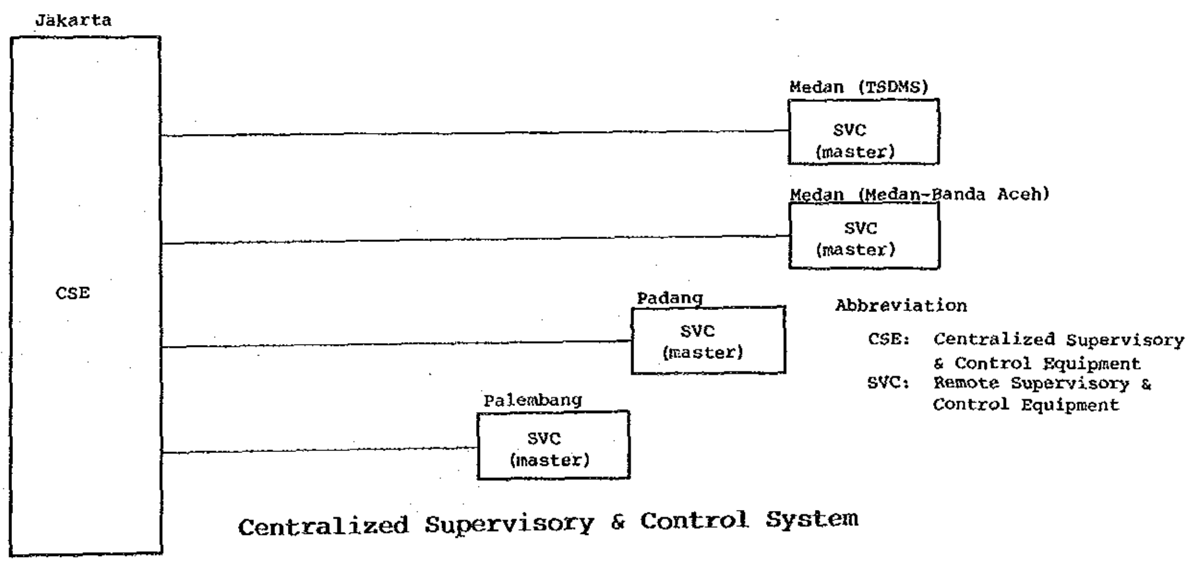
TV Codec Arrangement

(3) Centralized Supervisory and Control System

Centralized S/V and control system is placed at Jakarta (GATSU) together with the conventional master-slave S/V & cont. system for the efficient operation and maintenance of Trans-Sumatera Digital Microwave Transmission System.



Switchover, Engineering O/W and Master-Slave S/V & Control Systems



Centralized Supervisory & Control System

(4) Tail Links in Jakarta and Medan

Radio gateways are recommended ot be established in Jakarta and Medan; this requires to link existing stations with gateways by means of fiber optics transmission systems.

(5) Power Supply Subsystem

Following types of power supply systems are taken into consideration:

- Single stand-by DEG system
- Dual prime DEG system
- Dual charge-discharge DEG system
- Photovoltaic (PVS) system

Photovoltaic (solar PS) system will find its applicability where required capacity of PS system is less than **500 W.**

☐ Supporting Facilities

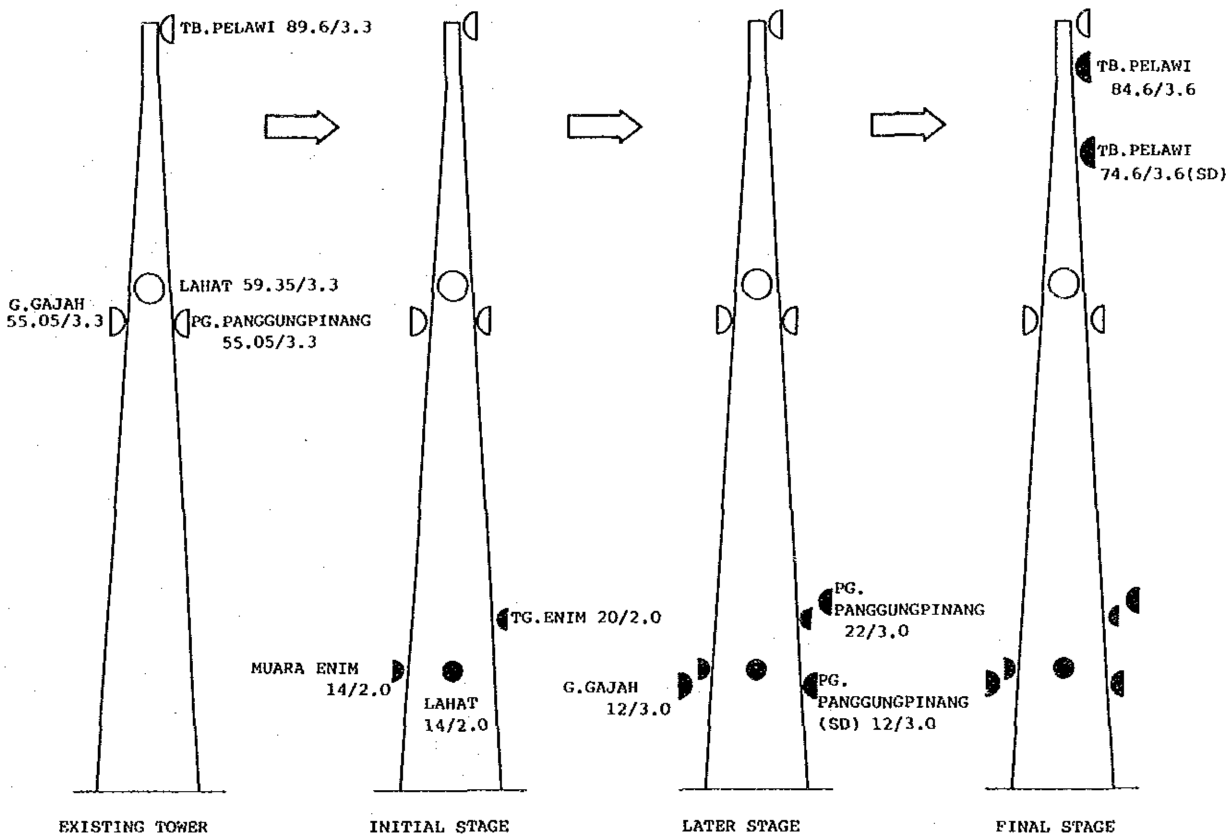
(1) Tower

The possibility to utilize the existing towers along the existing route is examined through model analyses at Bukit. Asam and Rasamtapanggang.

It is concluded that 43 out of 63 existing towers could be used without reinforcement, 17 existing towers with **reinforcement work** even for Trans-Sumatera Digital Microwave System.

(2) Station Building and Access Road

Civil work cost required for eastern as well as western route plans is 8 to 10 times as much as compared with the existing route plan.



Tower Utilization Plan at Bkt. Asam

☐Operation and Maintenance

(1) O&M of existing analog transmission links have been carried out successfully with the manpower arrangement detailed in Chapter 6.

(2) Digital transmission systems will be overlaid over the existing analog transmission system, resulting in nearly the same number of stations to be maintained except for newly Installed radio gateways.

(3) Judging from the above, it is not necessary to increase the number of personnel engaged in O&M, provided that appropriate training course is arranged for O&M staff.

☐ Financial/Economic Analysis

(1) Cost Estimate

1) JKT-MDN-BNA (1994 requirement)

Existing Route Plan: Approx. ¥ 7.6 Billion

Western Route Plan: Approx. ¥13.8 Billion

Eastern Route Plan: Approx. ¥12.5 Billion

2) Top-priority Section (JKT-MDN)

Including PD-PG: Approx. ¥ 6.4 Billion (1994 requirement)
Approx. ¥ 7.1 Billion (1999 requirement)

Excluding PD-PG: Approx. ¥ 4.9 Billion (1994 requirement)
¥ 5.4 Billion (1999 requirement)

(2) F.I.R.R. for Alternative Route Plans

1) Existing Route Plan (JKT-MDN, 1994 MDN-BNA, 1999): 23%

2) Western Route Plan (JKT-MDN-BNA, 1994): 14%

3) Eastern Route Plan (JKT-MDN-BNA, 1994): 15%

(3) F.I.R.R. for Alternative Implementation Plans of Existing Route Plan

1) Top-priority Section (JKT-MDN, with PD-PG, 1994) : 21%

2) Top-priority Section (JKT-MDN, without PD-PG, 1994): 19%

Note) All the cost quoted here covers the whole cost required for the implementation of respective projects except for land procurement.

(4) Economic Evaluation

1) Total consumer surplus in 1994/2004

- Surplus rate (=Realized surplus ÷ Paid amount): 1.26/3.53
- Reservation price (=Realized surplus ÷ Number of supply volume)

: Rp. 240,000/690,000

2) E.I.R.R.

- Existing Route Plan (JKT-MDN, 1994: MDN-BNA, 1999): 25%

☐ Implementation Program

(1) Strategy

Following shall be taken into account:

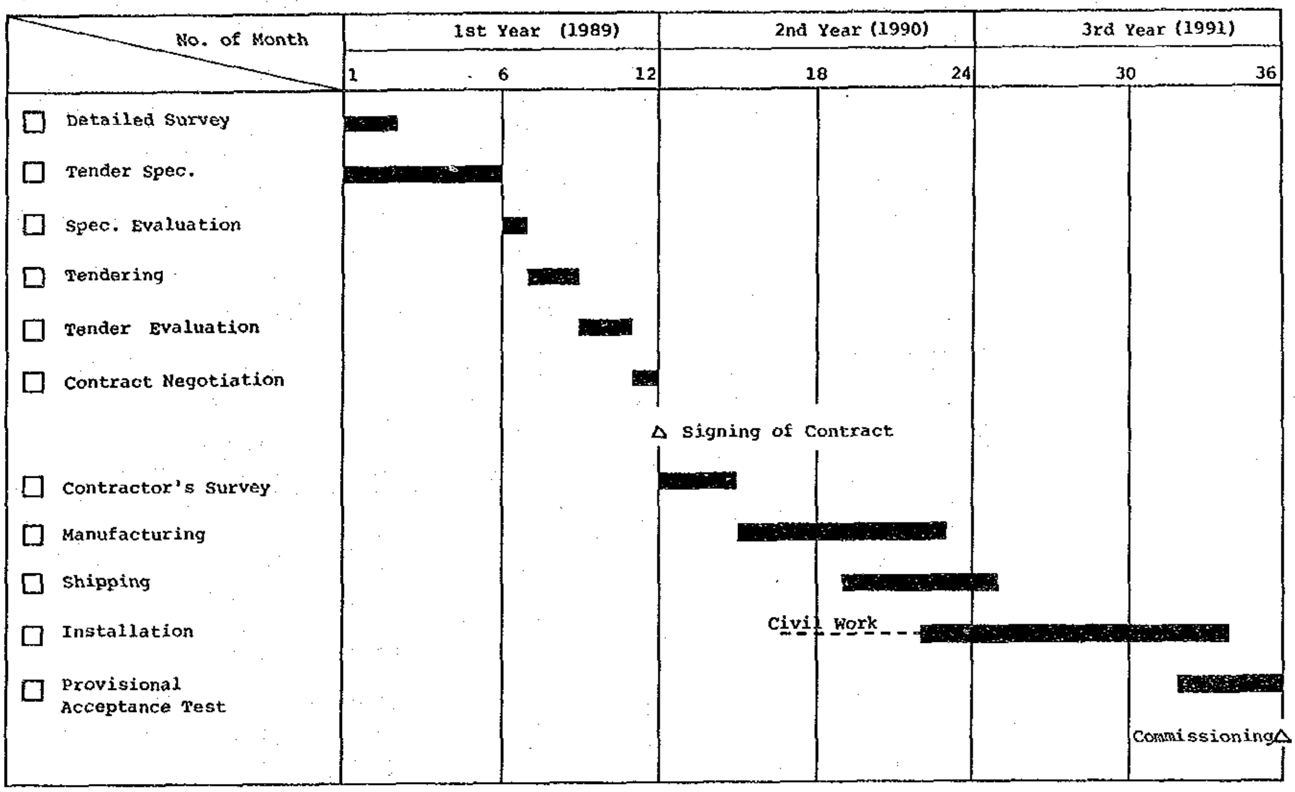
1) Digitalization Program of Exchanges
2) Optimum Network Planning
3) Optimum Investment Scale/Scheduling

For instance, trunk exchanges in Sumatera island as well as in Jakarta are planned to be digitalized during 1987-1990 as shown in the following table:

Exchange	Capacity	Implementation	Program Packet
Medan Trunk	5,200 cct.	1987	Digital Phase IV
Padang Centrum	1,500	1988	Digital Phase IV
Palembang Trunk	3,400	1988	Digital Phase IV
Pakanbaru Centrum	720	1989	Digital Phase IV
Jambi Trunk	500	1989	Digital Phase Vb
Bukittinggi Trunk	300	1990	Digital Phase VI
Batam Sekupang	720	1987	STO DIG. P. BATAM*
Jakarta (SG II)	12,000	1987/1988	Digital Phase II/IV

Note *) Central Trunk Digitalization Program

Top-priority shall be given to the implementation of digitalization of JKT-MDN section along the existing analog transmission route; recommendable implementation schedule is given as under:



Implementation Schedule
(Top-priority Section)

(2) Breakdown of Cost Estimate

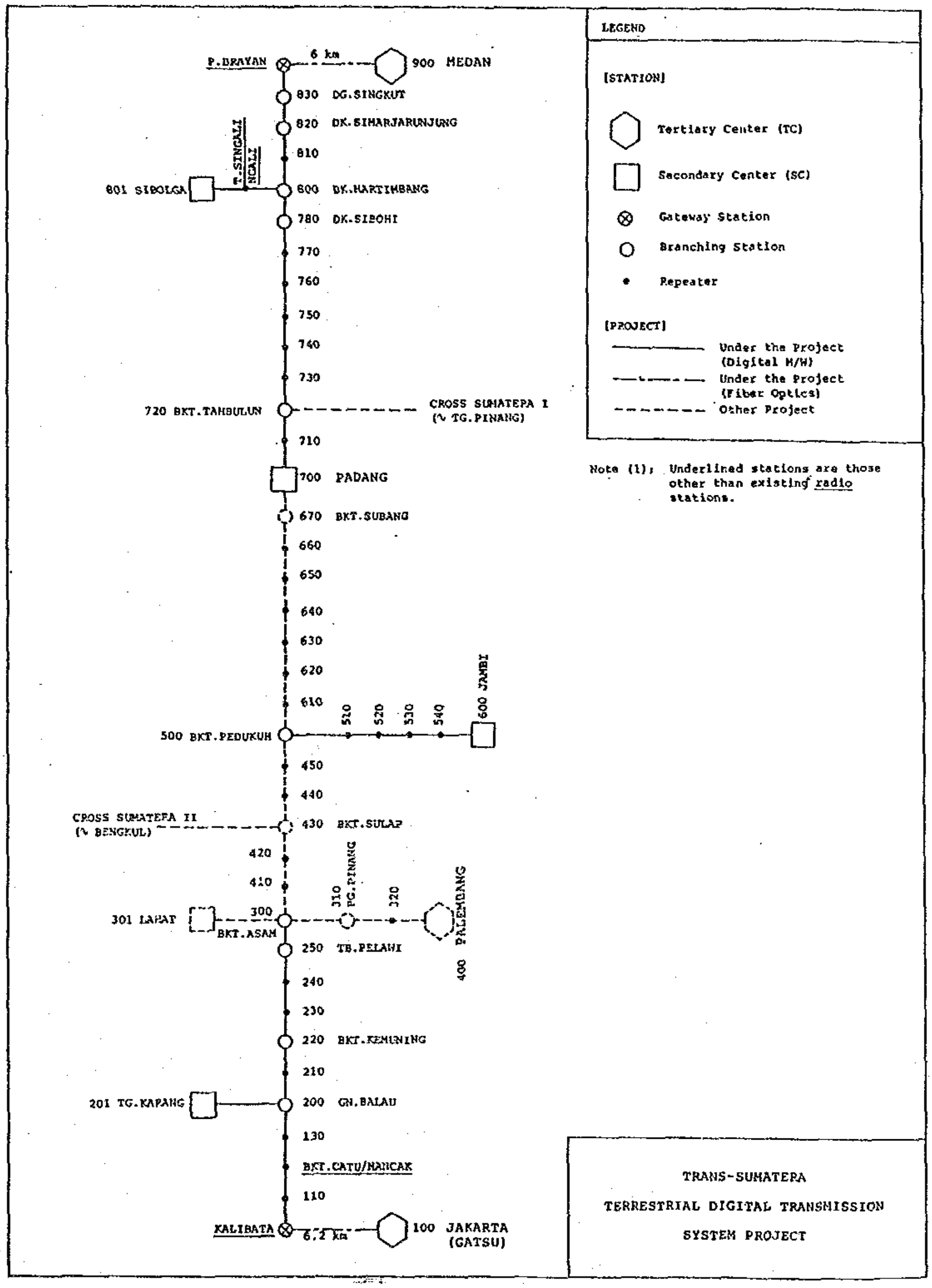
Breakdown of the required cost for top-priority section is given in the following table:

(1)FOREIGN CURRENCY PORTION

ITEM	JKT-MDN INCLUDING PD-PG 1994 (M¥)	JKT-MDN INCLUDING PD-PG 1999 (M¥)	JKT-MDN EXCLUDING PD-PG 1994 (M¥)	JKT-MDN EXCLUDING PD-PG 1999 (M¥)
1.EQUIPMENT				
1-1 RADIO SUBSYSTEM	1,603	1,877	1,103	1,276
1-2 MULDEX SUBSYSTEM	370	441	308	358
1-3 TAIL LINK(FO CABLE + OTE)	177	199	177	199
1-4 S/V & CONTROL SUBSYSTEM	146	146	114	114
1-5 POWER SUPPLY SUBSYSTEM	545	545	389	389
1-6 TOWER	52	52	52	52
1-7 TRAINING EQUIPMENT	44	44	44	44
1-8 VEHICLE (O & M)	63	63	45	45
(SUB TOTAL)	3,000	3,367	2,232	2,477
2.INSTALLATION MATERIAL	433	488	320	357
3.MANUAL/DOCUMENT	28	28	20	20
4.MEASURING EQUIPMENT	342	342	223	223
5.TOOL	14	14	9	9
6.SPARE PARTS	201	237	160	185
(SUB TOTAL)	1,018	1,109	732	794
7.FREIGHT & INSURANCE	161	179	119	131
8.INLAND TRANSPORTATION	40	44	29	32
(SUB TOTAL)	201	223	148	163
9.INSTALLATION/TEST	859	969	634	707
10.CIVIL WORK	285	285	280	280
11.TRAINING	84	84	84	84
12.ONE-YEAR GUARANTEE	108	108	108	108
(SUB TOTAL)	1,336	1,446	1,106	1,179
13.CONSULTING SERVICES	432	482	328	361
14.CONTINGENCY	458	510	347	383
GRAND TOTAL	6,445	7,137	4,893	5,357
(2)LOCAL CURRENCY PORTION				
1.LAND PROCUREMENT (MRP)	168	168	168	168

Required Investment for Top-priority Section

The figure shown below indicates the system configuration of the top-priority section; fiber optics cable links are required in **Medan and Jakarta** to interconnect existing stations with new radio gateways.



1. OVERVIEW OF THE STUDY

1. OVERVIEW OF THE STUDY

The study has been carried out in the formation of study team and timetable as described in INTRODUCTION and ORGANIZATION.

The framework of the study follows:

Background

- Digitalization toward ISDN
- JICA Long-term Plan, 1987
- Expansion of 872,000 l.u. (REPELITA-IV)

Objectives

- Selection of an optimum system out of plans including that to utilize existing facilities
- Balanced usage of terrestrial and satellite circuits
- Cost optimization

As for the alternatives, the conditions for new route plans (**route duplication**) are:

- Transport Accessibility (→O & M, Construction)
- Geographic Conditions (→O & M, Construction)
- Exchange Accessibility (→Revenue)

Study Flow (Refer to the Flow Chart on Page 25.)

1) The study is centered around the features of these alternatives from viewpoint of construction cost as well as reliability; method for **allocating circuits to terrestrial or satellite** communication system will follow the procedures taken in **JICA Long-term Plan** (Long-term Planning for Development of Telecommunications System, JICA, 1987).

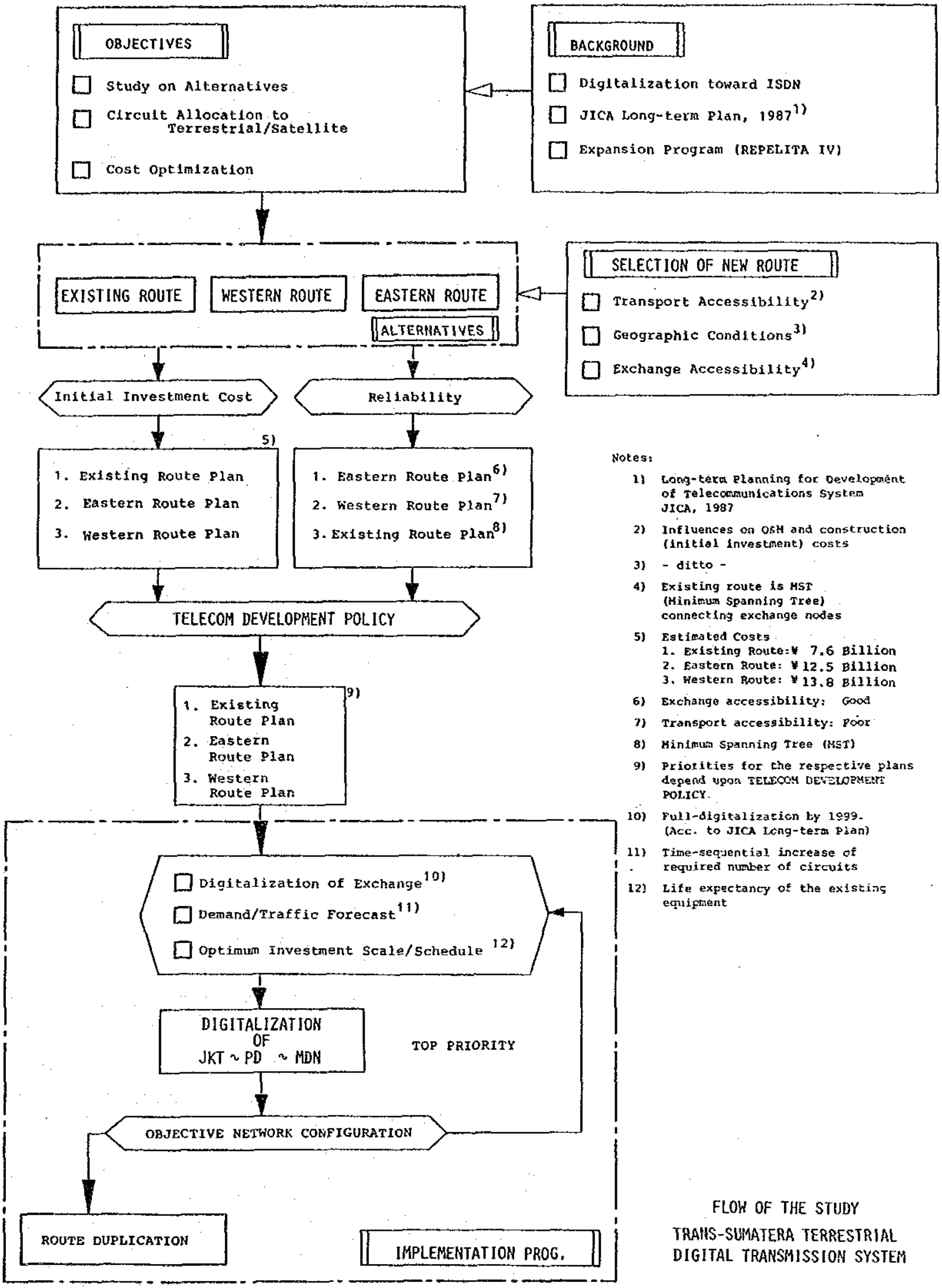
2) Indonesian telecommunications **development policy** is superimposed on the comparative study of the alternatives.

3) Pragmatic **IMPLEMENTATION PROGRAM** is established taking account of the following:

- **Progress of Exchange Digitalization**
  Full-digitalization of exchange, by 1999, is set forth in JICA Long-term Plan.

- **Demand/Traffic Forecast**
  "Supply stimulates Demand." It is expected that the required number of circuits over Trans-Sumatera backbone link will increase drastically in accordance with the supply plan.

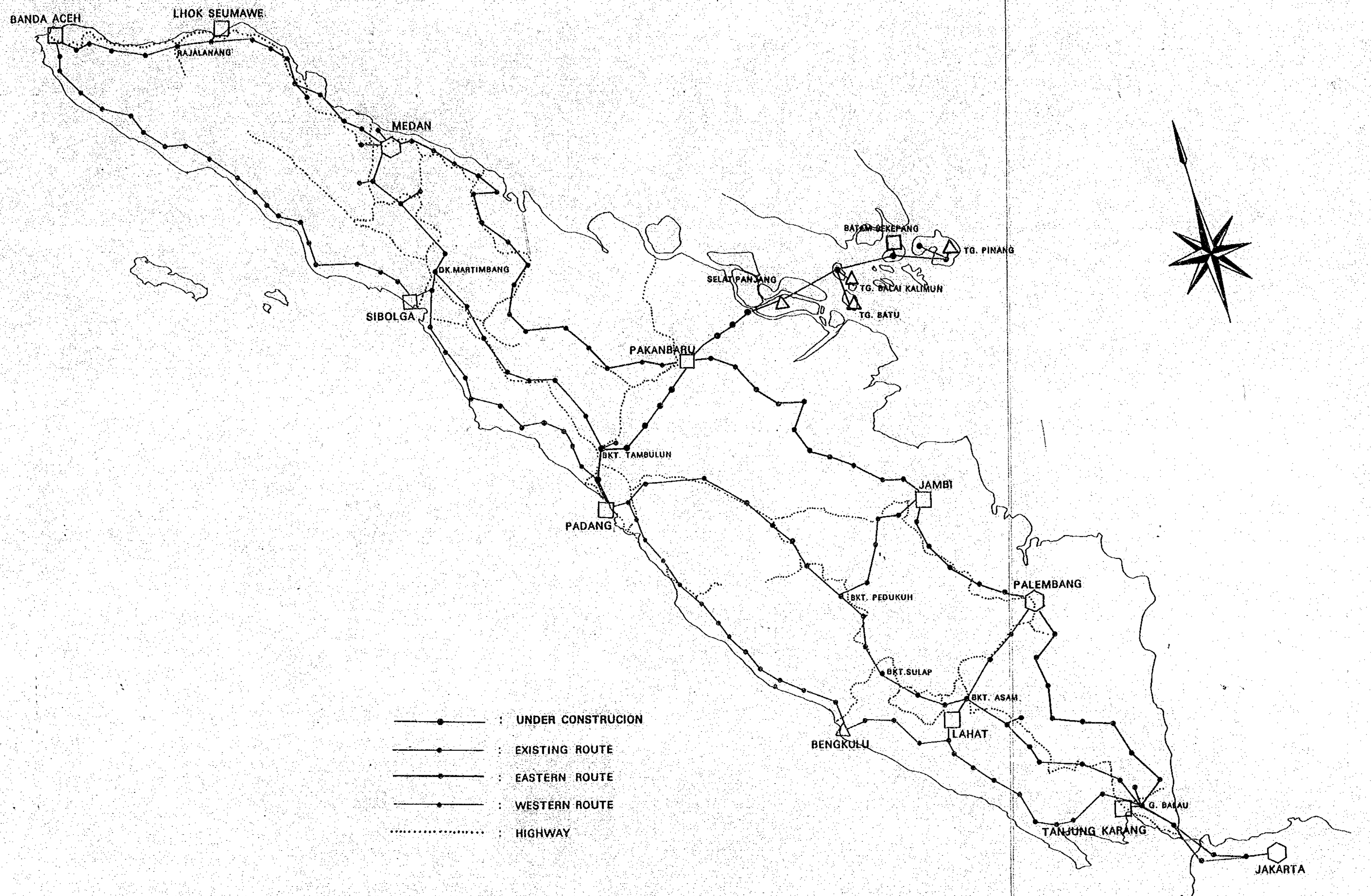
- **Cost Optimization**
  An appropriate amount of investment and optimum scheduling is the prerequisite for the successful implementation of the projects.



Notes:

1) Long-term Planning for Development of Telecommunications System JICA, 1987
2) Influences on O&M and construction (initial investment) costs
3) - ditto -
4) Existing route is MST (Minimum Spanning Tree) connecting exchange nodes
5) Estimated Costs
   1. Existing Route: ¥ 7.6 Billion
   2. Eastern Route: ¥ 12.5 Billion
   3. Western Route: ¥ 13.8 Billion
6) Exchange accessibility: Good
7) Transport accessibility: Poor
8) Minimum Spanning Tree (MST)
9) Priorities for the respective plans depend upon TELECOM DEVELOPMENT POLICY.
10) Full-digitalization by 1999. (Acc. to JICA Long-term Plan)
11) Time-sequential increase of required number of circuits
12) Life expectancy of the existing equipment

FLOW OF THE STUDY
TRANS-SUMATERA TERRESTRIAL DIGITAL TRANSMISSION SYSTEM



ROUTING PLANS

2. DEMAND/TRAFFIC FORECAST

2. DEMAND/TRAFFIC FORECAST

2-1 Telephone Demand

2-1-1 Forecasting Methods

Forecasted demand and supply volume are defined and correlated with each other in JICA Long-term Plan (1) and Fundamental Study on Rural Telecom. (2).

(1) Long-term Planning for Development of Telecommunications System
JICA, 1987

(2) Fundamental Study on Rural Telecommunications Network
JICA, 1985

Supply volume used to be determined in accordance with the growth of demand. On the contrary, supply volume will stimulate the growth of demand according to these reports above.

In JICA Long-term Plan, "Demand Function (International Model)", which correlates the assumed supply level with the stimulated demand, is introduced based upon the worldwide cross-section data; Macroscopic demand is forecasted by applying this model to Indonesian case.

In principle, the same logic and forecasting method as described above are employed for this study in a coordinated manner. On the other hand, "ITU Model", which has been employed as a conventional forecasting method, is used just for comparison; "ITU Model" is justified, based upon the fact that telephone density (excluding explicit/potential demand) is closely correlated with an economic index, i.e., GDP/GNP per capita. It could be said that ITU model is fit for estimating target supply volume.

2-1-2 Supply Plan

(1) Nationwide Telephone Supply

PELITA-IV, which places much importance on telecommunications development, declares that expansion of 1,069 thousands l.u. including carry over of 197 thousands l.u. from PELITA-III be carried out.

In "Strategic Development Plan" by POSTEL, stipulated is that the least objective telephone density should reach 1.2 by the year 1995; that is drastic increase of l.u. as much as three times intended during PELITA-IV and V.

In response to POSTEL's policy above, PERUMTEL is to draft the framework of REPELITA-V Program, aiming at expansion of telephone supply of around 1,000 thousands l.u.

In due consideration of the above, the study sets forth the nationwide telephone supply volume as follows:

Table 2-1-1 Nationwide Supply Volume

(Unit: 1,000 l.u.)

PELITA-IV	(1985-1989):	1,069
REPELITA-V	(1990-1994):	968
REPELITA-VI	(1995-1999):	1,650
REPELITA-VII	(2000-2004):	1,900

1) PELITA-IV Supply Volume

REPELITA-IV program consists of EXPANSION PROGRAM and REALLOCATION PROGRAM; detailed information as for expansion/reallocation capacities and their implementation schedule are listed in the following table:

Table 2-1-2 (1/2) PELITA-IV Expansion Program

No.	Packet	Volume	Schedule '84	'85	'86	'87	'88	'89	'90	Remarks
1	ARF	15,000	x	x						Completed***
2	DIG. CRASH PROGRAM	1,600				x				Completed
3	DIG. SURABAYA TANDEM	2,000				x				Under manufacturing***
4	DIGITAL I	53,000		x	x					Completed***
5	DIGITAL II	82,000					x			Non-contracted***
6	DIGITAL III-A	42,000		x	x	x				On-going
7	DIGITAL III-B	57,000		x	x	x	x			On-going
8	DIGITAL III-C	3,000					x			Non-contracted
9	DIGITAL III-P	12,000					x			Non-contracted
10	DIGITAL IV	161,800				x	x	x		Contracted
11	DIGITAL Va	100,000						x		Non-financed
12	DIGITAL Vb*	121,200						x		Non-financed
13	DIGITAL VI	237,500							x	Non-financed
14	EMD	9,000	x	x						Completed***
15	EX. HIBAH	3,000		x						Completed
16	MC10C	7,000	x							Completed***
17	PC1000C	45,800						x		Financed/Non-contracted
18	PELITA III LAINNYA	256		x						Completed
19	PRX I	9,500		x						Completed***
20	PRX II	19,400		x						Completed***
21	PRX III	4,000				x				On-going
22	PRX IV-A	22,000			x	x				On-going
23	PRX IV-B	12,000				x				Contracted
24	PRX V	20,000						x		Under negotiation
25	STO 100 SBK**	18,150					x			Contracted(10,000 L.U.)/ Non-financed(8,150 L.U.)
26	STO 5000 SS (MC-10C)	5,000					x			Non-contracted
27	STO DIG. P. BATAM	5,000				x				Contracted
28	STO PELITA IV ARF/ARM	600				x				Non-contracted
	TOTAL	1,068,806								

Note) * Excluding the capacity of 5,000 l.u., allocated for BATAM SEKUPANG (2,000 l.u.) and BATAM BATU AMPAR (3,000 l.u.)
(Source: BINPROSATTEL)

** Further information (Source: BINPROSATTEL)
- For WITEL I/II (5,800 l.u.): Fully contracted (SBK+EWSD)
- For WITEL IX/X/XI (4,200 l.u.): Partially contracted (EWSD only)
- For WITEL III/V/VII/VIII(8,150 l.u.): Non-financed

*** (Carry-over from PELITA-III)

Table 2-1-2 (2/2) PELITA-IV Reallocation Program

No.	Packet	Volume	Schedule '86	'87	'88	'89	'90	Remarks
1	REALOKASI DIGITAL PHASE IV	6,000			x			Source exchange: Non-designated (JKT/BDN/SB/???)
2	REALOKASI DIGITAL PHASE V	8,800			x			- do. -
3	REALOKASI DIGITAL PHASE VI	35,000					x	- do. -
4	REALOKASI EX AKD BATAM	1,500			x			
5	REALOKASI EX EMD BANDUNG CTR	2,000			x			
6	REALOKASI EX EMD KEBAYORAN	1,000			x			
7	REALOKASI EX HIT BDG TURANGGA	1,000			x			
8	REALOKASI EX JATINEGARA 1	4,000		x				
9	REALOKASI EX MCR BATAM	896		x				Completed
10	REALOKASI EX NEC GANDARIA	1,000		x				
11	REALOKASI EX NUSA DUA	600			x			
12	REALOKASI EX PASER REBO	1,000	x					Completed
13	REALOKASI EX UR-49 MEDAN	3,000	x	x	x			On-going
14	REALOKASI PC-1000C	3,000	x					Completed/ Source: Storage
15	REALOKASI PERAKITAN CONT.EMD	700		x				Source: Parts assembled
	Total	69,496						

Source: BINPROSISTEL (July 27, 1987)

2) REPELITA-V Supply Volume

Telephone supply volume to be planned during REPELITA-V period is assumed in due consideration of REPELITA-IV Program by PERUMTEL.

WITEL-wise supply volume of REPELITA-V, which has been obtained through PERUMTEL's own demand forecast on exchange basis, is summarized below; it should be noted that the top priority has been given to WITEL IV; approximately 60% of the nationwide supply volume has been allotted to Jakarta area.

Table 2-1-3 Supply Volume (REPELITA-V)

WITEL	Expansion Capacity (l.u.)	Share (%)
I	34,000	3.51
II	17,800	1.84
III	43,200	4.46
IV	579,000	59.81
V	94,200	9.73
VI	47,000	4.85
VII	67,500	6.97
VIII	31,800	3.28
IX	21,100	2.18
X	23,600	2.44
XI	3,600	0.38
XII	5,280	0.55
Total	968,080	100.00

Source: BINPROSISTEL (Aug. 3, 1987)

3) REPELITA-VI/VII Supply Volume

The supply volume for REPELITA-VI/VII is quoted from Supply Plan-2 in JICA Long-term Plan in a coordinated manner.

(2) SC-level Telephone Supply

Nationwide telephone supply volume set forth in the preceding paragraph is allocated to each SC area.

For REPELITA-VI/VII, nationwide volume is distributed to each SC area, referring to their respective shares of total l.u. (existing + expansion) as of the end of PELITA-IV.

Distributed results and final capacities for each 5-year plan are summarized in Table 2-1-4.

In Table 2-1-4, all the manual exchanges are scheduled to be automatized during REPELITA-VI period.

Table 2-1-4 SC-based Expansion/Total Capacity

Secondary Area		Capacity End of PELITA-IV	During PELITA-V		Capacity for End of Pelita-V			SHARE End of PELITA-IV	During PELITA-VI Supply			Capacity for End of Pelita-VI			PELITA-VII	Capacity for End of Pelita-VII		
Code	Trunk Center	(1990)	Remove	Supply	(1994) Total	D.A	TER+PA	(1990)	Remove	For Auto	Expansion	(1999) Total	D.A	TER+PA	Supply	(2004) Total	D.A	TER+PA
21	JAKARTA	547,800	-800	593,000	1,140,000	0	1,140,000	31.69	-800	800	515,700	1,655,700	0	1,655,700	602,000	2,257,700	0	2,257,700
22	BANDUNG	131,740	-1,500	75,600	205,840	800	205,040	7.62	-2,240	2,200	124,000	329,800	1,300	328,500	144,800	474,600	1,800	472,800
23	CIREBON	18,620	-960	4,600	22,260	0	22,260	1.08	-1,160	1,200	17,500	39,800	0	39,800	20,500	60,300	0	60,300
24	SEMARANG	74,740	-1,850	21,200	94,090	0	94,090	4.32	-1,490	1,500	70,400	164,500	0	164,500	82,100	246,600	0	246,600
27	YOGYAKARTA	56,700	-200	10,600	67,100	0	67,100	3.28	-1,500	1,500	53,400	120,500	0	120,500	62,300	182,800	0	182,800
28	PURWOKERTO	32,530	-2,180	15,200	45,550	0	45,550	1.88	-1,550	1,600	30,600	76,200	0	76,200	35,800	112,000	0	112,000
31	SURABAYA	167,600	-1,150	30,200	196,650	0	196,650	9.69	-150	200	157,800	354,500	0	354,500	184,200	538,700	0	538,700
33	JEMBER	28,460	-1,610	8,400	35,250	0	35,250	1.65	-1,950	2,000	26,800	62,100	0	62,100	31,300	93,400	0	93,400
34	MALANG	32,340	-3,110	15,400	44,630	0	44,630	1.87	-830	800	30,400	75,000	0	75,000	35,500	110,500	0	110,500
35	MADIUM	26,230	-1,250	13,500	38,480	1,000	37,480	1.52	-680	700	24,700	63,200	1,600	61,600	28,800	92,000	2,500	89,500
36	DENPASAR	43,390	-1,480	20,000	61,910	1,000	60,910	2.51	-310	300	40,800	102,700	1,700	101,000	47,700	150,400	2,500	147,900
37	SUMBAWA BESAR	5,796	-480	2,000	7,316	0	7,316	0.34	-390	400	5,500	12,826	0	12,826	6,400	19,226	0	19,226
38	ENDE	3,710	-2,160	6,600	8,150	0	8,150	0.21	-150	200	3,500	11,700	0	11,700	4,000	15,700	0	15,700
39	KUPANG	22,860	-700	3,200	25,360	200	25,160	1.32	-110	100	21,500	46,850	400	46,450	25,100	71,950	600	71,350
41	UJUNG PANDANG	47,890	-2,940	9,000	53,950	4,250	49,700	2.77	-150	200	45,100	99,100	7,800	91,300	52,600	151,700	12,000	139,700
42	PARE-PARE	8,700	-1,900	5,000	11,800	600	11,200	0.50	-600	600	8,200	20,000	1,000	19,000	9,600	29,600	1,500	28,100
43	MANADO	25,990	-1,000	2,600	27,590	800	26,790	1.50	-190	200	24,500	52,100	1,500	50,600	28,600	80,700	2,300	78,400
45	PALU	12,636	-1,736	4,600	15,500	800	14,700	0.73	-100	100	11,900	27,400	1,400	26,000	13,900	41,300	2,000	39,300
40	KENDARI	9,220	-1,220	2,400	10,400	1,800	8,600	0.53	0	0	8,700	19,100	3,300	15,800	10,100	29,200	5,000	24,200
51	BANJARMASIN	30,790	-2,990	11,000	38,800	3,800	35,000	1.78	0	0	29,000	67,800	6,600	61,200	33,800	101,600	10,000	91,600
53	SAMPIT	5,210	-400	600	5,410	350	5,060	0.30	-810	800	4,900	10,300	700	9,600	5,700	16,000	1,000	15,000
54	SAMARINDA	32,500	-400	1,900	34,000	0	34,000	1.88	0	0	30,600	64,600	0	64,600	35,700	100,300	0	100,300
55	TARAKAN	1,970	-520	2,200	3,650	1,650	2,000	0.11	-250	300	2,000	5,700	2,600	3,100	2,200	7,900	3,600	4,300
56	PONTIANAK	15,000	-2,000	5,400	18,400	3,500	14,900	0.87	-600	600	14,100	32,500	6,200	26,300	16,500	49,000	9,200	39,800
61	MEDAN	134,546	-410	22,600	156,736	2,860	153,876	7.78	-1,136	1,100	126,700	283,400	5,250	278,150	147,900	431,300	7,950	423,350
63	SIBOLGA	5,870	0	1,000	6,870	1,990	4,880	0.34	-470	500	5,500	12,400	3,600	8,800	6,500	18,900	5,500	13,400
64	LHOK SEUMAWE	8,650	-500	8,400	16,550	1,200	15,350	0.50	-550	600	8,100	24,700	1,800	22,900	9,500	34,200	2,500	31,700
65	BANDA ACHE	14,546	-240	2,000	16,306	2,386	13,920	0.84	-1,010	1,000	13,700	29,996	4,426	25,570	16,000	45,996	6,776	39,220
71	PALEMBANG	35,670	-750	17,800	52,720	1,200	51,520	2.06	-120	100	33,600	86,300	1,900	84,400	39,200	125,500	2,900	122,600
72	TANJUNG KARANG	24,350	0	17,400	41,750	1,500	40,250	1.41	-350	400	22,900	64,700	2,350	62,350	26,800	91,500	3,400	88,100
73	LAHAT	18,313	-1,350	4,600	21,563	2,150	19,413	1.06	-750	800	17,200	38,813	4,000	34,813	20,100	58,913	6,100	52,813
74	JAMBI	13,600	-1,000	3,400	16,000	4,000	12,000	0.79	0	0	12,800	28,800	7,200	21,600	14,900	43,700	10,900	32,800
75	PADANG	25,430	-940	10,800	35,290	4,250	31,040	1.47	-290	300	23,900	59,200	7,150	52,050	27,900	87,100	10,550	76,550
76	PAKANBARU	18,186	-1,650	5,500	22,036	4,600	17,436	1.05	-40	100	17,100	39,196	8,200	30,996	20,000	59,196	12,400	46,796
77	SEKUPANG	11,356	0	1,500	12,856	600	12,256	0.66	-600	600	10,700	23,556	1,200	22,356	12,500	36,056	1,800	34,256
91	AMBON	13,000	-200	1,800	14,600	2,200	12,400	0.75	-200	200	12,200	26,800	4,000	22,800	14,300	41,100	6,200	34,900
92	TERNATE	4,650	-450	1,800	6,000	2,000	4,000	0.27	0	0	4,400	10,400	3,500	6,900	5,100	15,500	5,200	10,300
95	SORONG	4,250	-400	880	4,730	1,080	3,650	0.25	-150	200	4,000	8,780	2,000	6,780	4,700	13,480	3,000	10,480
96	JAYAPURA	12,500	-1,600	4,300	15,200	6,150	9,050	0.72	-100	100	11,800	27,000	10,900	16,100	13,700	40,700	16,500	24,200
97	MERAUKE	1,530	0	100	1,630	130	1,500	0.09	-130	100	1,400	3,000	250	2,750	1,700	4,700	400	4,300
	Total	1,728,869	-44,026	968,080	2,652,923	58,846	2,594,077	100.0	-21,906	22,400	1,627,600	4,281,017	103,826	4,177,191	1,900,000	6,181,017	156,076	6,024,941

(3) PC-level Supply Volume

The distributed SC-level supply volumes are further divided into the subordinate PC areas. Division is made, referring to the total capacity shares by PC area as of the end of PELITA-IV.

PC-level supply volumes in the objective area for the years 1994, 1999 and 2004 are given in ANNEX-7.

(4) Past Trend

1) Past Growth Trend

In Indonesia, the number of main telephone had grown at the annual rate of 10% during 10 years from 1974 (end of PELITA-I) up to 1984 (end of PELITA-III).

Table 2-1-5 Past Growth Trend of Main Telephones

Year	No. of Main Telephone
1974	197,571
1979	315,115
1984	536,102

On the other hand, JICA Long-term Plan assumes 10% annual growth of l.u. within 15 years, 1989-2004; Supply Plan-2 in Long-term Plan could be said realistic.

2) ITU Model

The following equation is formulated from the data of 48 countries/1984; telephone density and GDP per capita are correlated with each other into a regression curve formulated in the following page.

$$\log TD = -3.283502 + 1.2511332 \log GDP$$

$$(R = 0.95)$$

where, TD: No. of main telephone/100 inhab.

GDP: GDP per capita as of 1984 (US$)

R: Correlation coefficient

Figures in the table below show the numbers of main telephone derived from the formula as above, on the assumption that GDP would grow at the annual rate of 5%:

Table 2-1-6 Telephone Density (ITU Model)

Year	Population (x1,000)	Telephone Density	No. of Main Tel.
1994	198,698	1.67	3,289,000
1999	218,556	2.01	4,393,000
2004	243,907	2.38	5,805,000

Figure 2-1-1, indicates the international level of telephone penetration and Indonesian case for the years, 1994, 1999 and 2004 assuming that the supply plan set out in this study be realized.

As shown in the figure, the Indonesian telephone density will reach the target of POSTEL (1.33) in 1994 and could be beyond the international level by 2004.

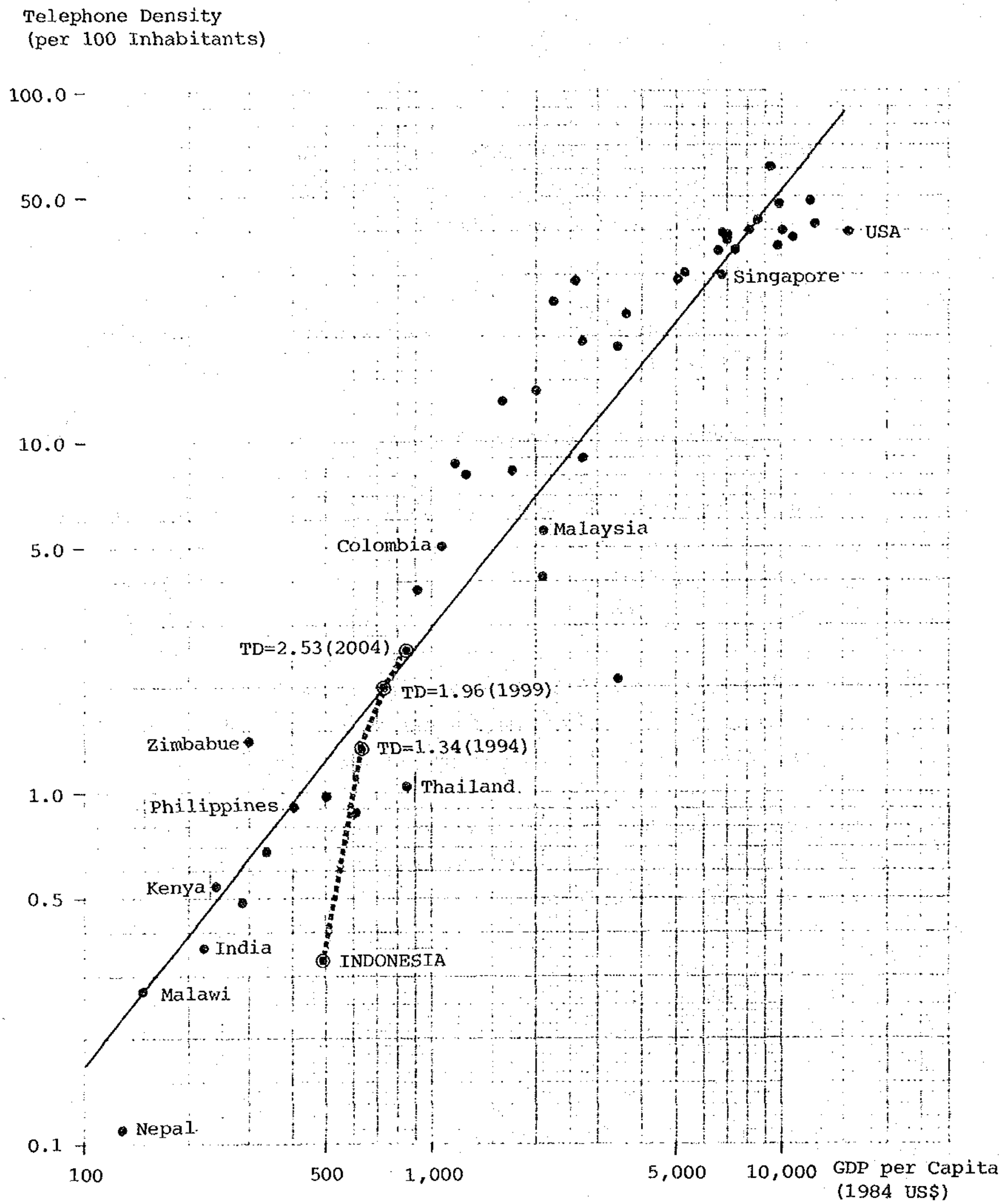


Figure 2-1-1 Telephone Density and GDP per Capita

2-1-3 Forecasted Telephone Demand

JICA Long-term Plan introduced so-called "Demand Function" as a demand forecasting measures for the macroscopic approach; the explanatory variables for this function consist of tariff, income, number of the existing subscribers and population. The nationwide macroscopic telephone demand is to be forecasted by means of the "Demand Function".

The study follows such an approach as in Long-term Plan to forecast telephone demand. The "Demand Function" itself, however, is carefully reviewed and examined in this study by taking into account the latest data for its explanatory variables and actual supply plan set out in 2-1-2.

(1) International Model

The international model in the Long-term Plan originally was quoted from Fundamental Study on Rural Telecom. After the submission of the said report, ITU has published the latest version of "Yearbook of Common Carrier Telecommunication Statistics (13th edition)"; hence available additional data.

In the Long-term Plan, there exists a good deal of discrepancy between the forecasted results by international model and by WITEL model.

Accordingly, the study modifies the international model based on 12-year time-series data in 18 countries.

Obtained regression formula is as follows:

$$\ln\left(\frac{MLA_t + W_t}{MPS_t - ML_{t-1}}\right) = -1.009505 - 0.533327 \ln (SF_t)$$

$$+ 0.1815022 \ln \left(\frac{GDP_t}{N_t}\right)$$

$$+ 0.6072295 \ln \left(\frac{ML_{t-1}}{MPS_{t-1}}\right)$$

$(R = 0.86)$

where, MLA_t : No. of increment in main telephone lines in year t ($\times 10^6$)

W_t : No. of waiting applicants in year t ($\times 10^6$)

$N_{t/t-1}$: No. of population in year t/t-1 ($\times 10^6$)

$MPS_{t/t-1}$: Potential demand population ($= N_{t/t-1} \times 0.7$, $\times 10^6$)

ML_{t-1} : No. of main telephone lines in year t-1 ($\times 10^6$)

SF_t : Per-subscriber telephone revenue in year t (in real-term, 1975 constant price, US$)

GDP_t : Real GDP in year t(1975 constant price, US$ $\times 10^6$)

R : Multi-regression correlation coefficient

In the above formula, $(MLA_t + W_t)$ means the stimulated demands in the year of t. Out of its explanatory variables, per-subscriber revenue is a negative factor against the demand increase; the rise of tariff is to discourage the demand. The remaining factors are positive ones and the telephone supply is a dominant factor for stimulating the demand.

(2) WITEL Model

The Long-term Plan report presumed WITEL model as a demand function for each WITEL from the same viewpoint as employed for the international model.

Through the first and second field surveys of the study, new data as of the years 1985 and 1986 had been collected and the model was examined and modified, taking such data into account. Following formula is the modified one:

$$\ln \left(\frac{D_{it}}{N_{it} - ML_{it-1}}\right) = -6.932086 - 0.408515 \ln (PI_{it}) + 0.2862410 \ln (Y_{it}) + 0.4971982 \ln (TD_{it}) + 0.5416949 (D_0) + 0.5021028 (D_3) + 1.7332294 (D_4) + 0.3553089 (D_9) - 0.231578 (D_{10})$$

($R = 0.93$)

where, D_{it} : Stimulated demand in WITEL i in year t

N_{it} : No. of population in WITEL i in year t

ML_{it-1}: No. of main lines in WITEL i in year t-1

PI_{it} : Installation fee in WITEL i in year t

(in real-term, 1975 constant price Rp. $x10^3$)

Y_{it} : Income in WITEL i in year t

(in real-term, 1975 constant price Rp. $x10^9$)

TD_{it} : Telephone density in WITEL i in year t

D_0-D_{10} : Dummy variables

D_0 : 1 for 1985/1986, 0 for other years

D_3 : 1 for WITEL III, 0 for others

D_4 : 1 for WITEL IV, 0 for others

D_9 : 1 for WITEL IX, 0 for others

D_{10}: 1 for WITEL X, 0 for others

R : Multi-regression correlation coefficient

(3) Nationwide Demand

By means of both models, forecasted is nationwide telephone demand for the years 1994, 1999 and 2004 under the following conditions:

- GDP/GRDP growth rate : 5% per annum
- Population growth rate: 2% per annum approx.
- Tariff system : fixed
- Revenue/Sub. : fixed

Forecasted results by two models are summarized below.

Table 2-1-7 Nationwide Demand Forecast

(x1,000 l.u.)

Year	International Model	WITEL Model
1994	3,378	3,540
1999	5,230	5,472
2004	7,508	7,884

In the study, nationwide macroscopic demand volumes by the international model are distributed among respective WITELs, referring to each WITEL's share obtained by the use of WITEL model.

International model is fit for nationwide forecast reflecting the accumulation of data over years for many countries; WITEL model is well matched with the past records to distribute the macroscopic demand to each WITEL.

Table 2-1-8 shows the past 4-year records on total number of subscribers and waiting applicants per WITEL and forecasted WITEL-based demand.

Table 2-1-8 Telephone Supply Records and Demand Forecast

( ):Share

WITEL	1982			1983			1984			1985			Demand Forecast		
	Tel.Sub.	Waiting	T.Demand	Tel.Sub.	Waiting	T.Demand	Tel.Sub.	Waiting	T.Demand	Tel.Sub.	Waiting	T.Demand	1994	1999	2004
I	40,866	10,887	51,753	44,685	14,169	58,854	47,318	16,709	64,027	51,540	22,169	73,709	241,191	393,263	592,287
	(8.6)		(8.4)	(8.9)		(8.1)	(8.8)		(7.6)	(8.6)		(7.5)	(7.14)	(7.51)	(7.88)
II	14,115	3,016	17,131	15,251	4,062	19,313	15,988	6,323	22,311	19,153	8,130	27,283	94,425	150,762	222,993
	(3.0)		(2.8)	(3.0)		(2.7)	(3.0)		(2.6)	(3.2)		(2.8)	(2.80)	(2.88)	(2.97)
III	19,843	8,914	28,757	21,535	11,001	32,536	23,008	16,510	39,518	28,090	39,570	67,660	200,485	316,039	463,852
	(4.2)		(4.7)	(4.3)		(4.5)	(4.3)		(4.7)	(4.7)		(6.9)	(5.94)	(6.04)	(6.17)
IV	171,894	45,683	217,577	176,585	103,018	279,603	194,091	149,915	344,006	216,775	178,273	395,048	1,336,406	1,977,722	2,690,401
	(36.2)		(35.5)	(35.1)		(38.6)	(36.2)		(40.8)	(36.0)		(40.3)	(39.56)	(37.77)	(35.80)
V	47,291	22,603	69,894	53,027	27,972	80,999	53,436	35,426	88,862	64,471	32,275	96,746	353,571	546,780	784,270
	(9.9)		(11.4)	(10.5)		(11.2)	(10.0)		(10.5)	(10.7)		(9.9)	(10.47)	(10.44)	(10.43)
VI	44,418	19,096	63,514	46,463	22,021	68,484	49,413	24,913	74,326	54,646	25,849	80,495	284,103	450,594	664,357
	(9.3)		(10.4)	(9.2)		(9.5)	(9.2)		(8.8)	(9.1)		(8.2)	(8.41)	(8.60)	(8.84)
VII	74,440	16,430	90,870	79,495	22,513	102,008	84,253	32,073	116,326	89,730	36,733	126,463	410,033	656,318	975,165
	(15.7)		(14.8)	(15.8)		(14.1)	(15.7)		(13.8)	(14.9)		(12.9)	(12.14)	(12.53)	(12.97)
VIII	15,929	2,050	17,979	17,153	3,256	20,409	17,440	6,072	23,512	21,048	13,260	34,308	126,434	200,963	295,199
	(3.4)		(2.9)	(3.4)		(2.8)	(3.3)		(2.8)	(3.5)		(3.5)	(3.74)	(3.84)	(3.93)
IX	14,302	4,122	18,424	14,812	5,778	20,590	15,715	10,119	25,834	17,772	11,635	29,407	139,984	227,932	344,549
	(3.0)		(3.0)	(2.9)		(2.8)	(2.9)		(3.1)	(3.0)		(3.0)	(4.14)	(4.35)	(4.58)
X	24,209	4,624	28,833	25,131	6,375	31,506	25,505	7,859	33,364	28,142	8,888	37,030	144,222	238,328	363,779
	(5.1)		(4.7)	(5.0)		(4.3)	(4.8)		(4.0)	(4.7)		(3.8)	(4.27)	(4.55)	(4.84)
XI	3,399	151	3,550	3,984	459	4,443	4,524	678	5,202	5,077	516	5,593	22,516	37,486	57,490
	(0.7)		(0.6)	(0.8)		(0.6)	(0.8)		(0.6)	(0.8)		(0.6)	(0.67)	(0.72)	(0.76)
XII	4,753	377	5,130	5,132	460	5,592	5,411	613	6,024	5,912	947	6,859	24,387	40,410	61,698
	(1.0)		(0.8)	(1.0)		(0.8)	(1.0)		(0.7)	(1.0)		(0.7)	(0.72)	(0.77)	(0.82)
Total	475,459	137,953	613,412	503,253	221,084	724,337	536,102	307,210	843,312	602,356	378,245	980,601	3,377,755	5,236,598	7,516,039
	(100)		(100)	(100)		(100)	(100)		(100)	(100)		(100)	(100)	(100)	(100)

Source: Telephone Subscriber = 'TRAFFIC dalam angka', PERUMTEL
Waiting Applicants = internal data of MATEL

(4) PC Area Demand

International/WITEL model proves that supply volume is the predominant factor to stimulate "demand".

Therefore, PC area telephone demand in the objective area are estimated in proportion to the supply volume in the respective PC area.

The results are listed in ANNEX-7.

2-2 Non-voice Services Demand

For non-voice communication services, the demand forecasts are carried out by using the same regression models as in the Long-term Plan, which were obtained as the result of multi-regression analyses of time-series and cross-section data in several countries.

2-2-1 Data Communication Service

(1) Nationwide Demand

According to the analysis in the Long-term Plan, data communication service demand has a close relation with the telephone density and/or the number of telephone lines. That is, the data communication service requirement tends to be exhanced keeping pace with the growth of telephone penetration rate.

The Long-term Plan derived the following regression formula:

$$\ln(SD) = -8.7778 + (0.7707 + 0.11487 \times \ln(TD)) \times \ln(S) + 3.1724 \times ID$$

$$(R = 0.97)$$

where, SD: Data communication service demand (x1,000)

TD: Telephone density

S : No. of telephone subscribers (x1,000)

ID: Dummy variable for Indonesia

R : Multi-regression correlation coefficient

Following table summarizes the estimate for nationwide data communication service demand:

Table 2-2-1 Nationwide Data Communication Demand

Description	1986	1994	1999	2004
Tel. Sub. (x1,000)	658	2,653	4,281	6,181
Tel. Density	0.39	1.34	1.96	2.53
Data Com. Sub.	300(*)	2,087	4,418	7,791

Note *: Data communication service subscribers of leased circuits and switched circuits (Source: BINPROSENTEL; July 25, 1987).

(2) Objective Area Demand

With regards to the objective area demand, the study distributes the nationwide demand into major cities in Sumatera Island, referring to the distributed share of data communication service demand as of the end of PELITA-IV, which was estimated in PERUMTEL's REPELITA-IV Program. Results follows:

Table 2-2-2 Data Communication Demand/Objective Area

City	1994	1999	2004	REPELITA-IV Pro.	(%)
BNA	6	12	21	2	(0.27)
MDN	106	224	395	38	(5.07)
PD	31	65	115	11	(1.47)
PBR	31	65	115	11	(1.47)
SKN	20	41	73	7	(0.93)
PG	64	136	240	23	(3.07)
TJK	17	36	63	6	(0.80)
JB	9	18	32	3	(0.40)
BN	9	18	32	3	(0.40)
Sumatera Total	293	615	1,086	104	(13.87)
Indonesia Total	2,087	4,418	7,791	750	(100.00)

2-2-2 Telex Service

(1) Nationwide Demand

After the in-depth study, the Long-term Plan proposed the formula mentioned below, for the nationwide telex service demand forecast. This formula had been obtained through regression analysis for selected eight countries including Indonesia, with high correlation.

$$\ln(SX/S)_t = -1.7934 + 0.72074 \times \ln(SX/S)_{t-1}$$
$$-0.0303506 \times \ln(SD/S)_{t-1} + 0.35164 \times ID$$
$$(R = 0.99)$$

where, SX: Telex service demand (x1,000)

S : No. of telephone subscribers (x1,000)

SD: Data communication service demand (x1,000)

ID: Dummy variable for Indonesia

R : Multi-regression correlation coefficient

In this regression model, the number of the existing telex subscribers is a positive parameter to promote the demand. This positive parameter functions more powerfully, when the growth of telex subscribers is higher than that of telephone subscribers.

On the contrary, the growth of data communication service subscribers is a negative parameter. This implies that the data communication service penetration discourages the telex service demand.

Application of the formula above results in:

Table 2-2-3 Nationwide Telex Demand

Description	1986	1994	1999	2004
Tel. Sub. (x1,000)	658(*)	2,653	4,281	6,181
Data Com. Sub.	300	2,087	4,418	7,791
Telex Sub.	11,738(*)	38,281	59,412	83,245

Note *: OPERASI PERUMTEL DALAM ANGKA, 1986

(2) Objective Area Demand

The following table shows the share of telex subscribers in the objective area:

Table 2-2-4 Telex Demand/Objective Area

Year	Indonesia Total	Objective Area Total	Share (%)
1979	3,612	433	(11.99)
1980	4,743	568	(11.98)
1981	6,151	N.A.	N.A.
1982	7,429	983	(13.23)
1983	8,570	1,231	(14.36)
1984	9,487	1,431	(15.08)
1985	10,407	1,643	(15.79)
1986	11,738	1,854	(15.79)

The share in the objective area has been slowly, but steadily, increasing. This means that telex service requirement in the said area is stronger than in the areas other than Sumatera Island. This is notable especially in WITEL II likely because of positive economic activities in Batam Island.

The study estimates the concentration ratio of telex demand in Sumatera Island at 18%, 19% and 20%, for the years 1994, 1999 and 2004, respectively.

For further distribution into each telex exchange area, is referred the number of telex subscribers in 1986, on condition that the existing telex/Gentex network configuration will be maintained upto the year 2004 as it is. Following are the estimated results:

Table 2-2-5 Telex Demand/Telex Exchange Area

Ex. Area	1994	1999	2004	Share in 1986 (%)
BNA	198	324	478	2.87
MDN	3,072	5,032	7,422	44.58
PD	696	1,140	1,681	10.10
PBR	604	990	1,460	8.77
TJP	150	246	363	2.18
SKN	278	456	672	4.04
PG	1,366	2,237	3,300	19.82
TJK	527	864	1,273	7.65
Sumatera Total	6,891	11,289	16,649	100.00
Indonesia Total	38,281	59,412	83,245	

2-2-3 Gentex Service

Gentex service is provided ordinarily in delay-base operation. Therefore, the number of required Gentex terminal equipment is forecasted on the basis of the growth of telegram messages, not of terminal equipment themselves.

(1) Telegram Messages Estimate

The study adopts the same regression model as in the Long-term Plan. That is,

$$TLG = -5.652 + (122.36 + 523.5 \times TD) \times N + (0.33 - 147 \times TD) \times Y - 131.98 \times ID$$

(R = 0.99)

where, TLG: No. of domestic telegram messages (x1,000)

TD : Telephone density

N : Population in million

Y : Real GDP in million US dollars (1980 constant price)

ID : Dummy variable for Indonesia

R : Multi-regression correlation coefficient

The telephone density (TD), one of the explanatory variables, plays a contradictory role either positively or negatively for the estimate of telegram messages; positively, multiplied by population (N) and negatively with the increase of economic index (Y). When per capita GDP reaches some level, the number of telegram messages begins to decrease.

The study applies the above model to Indonesian case in order to estimate the number of telegram messages as follows:

1994 : 13,214 thousands
1999 : 16,332 thousands
2004 : 20,286 thousands

(2) Message Handling at Terminal Equipment

The number of telegram messages handled at one Gentex terminal on annual average basis has been declining as shown below:

Table 2-2-6 Nationwide Gentex Services

Year	Telegram Messages	Terminal Equipment	Per-Terminal Messages
1977	4,403,603	177	24,880
1978	4,905,365	199	24,650
1979	5,503,455	273	20,160
1980	6,455,417	381	16,944
1981	6,923,711	440	15,736
1982	7,141,827	507	14,087
1983	7,858,911	544	14,447
1984	8,418,754	599	14,055
1985	9,086,746	663	13,706
1986	10,377,225	755	13,745

Source: OPERASI PERUMTEL DALAM ANGKA, 1986

The table above shows the gradual downward tendency for the number of per-terminal messages every year.

The study employs the number of messages per terminal and per annum as 14,000, in consideration of maintaining the present service quality.

Then, the estimated telegram messages could be converted into the required number of Gentex terminals, as follows:

1994 : 944 terminals
1999 : 1,167 terminals
2004 : 1,449 terminals

(3) Objective Area Supply

The distribution to each Gentex/telex exchange area is made in proportion to the share of Gentex terminals in 1986, as follows:

Table 2-2-7 Supply of Gentex Terminals/Objective Area

Ex. Area	1994	1999	2004	1986 (*)	
BNA	17	21	27	14	(1.83)
MDN	88	109	135	71	(9.30)
PD	40	49	61	32	(4.19)
PBR	46	55	68	36	(4.72)
TJP	11	14	17	9	(1.18)
SKN	8	10	12	6	(0.79)
PG	47	58	72	38	(4.98)
TJK	15	18	23	12	(1.57)
Sumatera Total	272	334	415	218	(28.57)
Indonesia Total	944	1,167	1,449	763	(100.00)

Source (*): DATA PEMASARAN SAMBUNGAN TELEX (MATEL)

2-3 Traffic Forecast

The toll telephone traffic over the planned backbone terrestrial links is forecasted by the same approach as in the Long-term Plan, in principle as for inter-SC (Secondary Center) traffic and the traffic between each SC and its subordinate PCs (Primary Centers).

2-3-1 Traffic Intensity

(1) Traffic Intensity Analysis

The current traffic intensity of the toll outgoing traffic from SC areas is analyzed and the results are shown in Table 2-3-1. The data used in this analysis are the quarterly measured traffic in the year 1985.

The toll outgoing traffic from Jakarta, Medan, Palembang and Surabaya SC areas, combined with TCs, is assumed to constitute 80% of the whole toll outgoing traffic volume, since it is difficult to separate inter-SC traffic from total outgoing traffic for these SC-TC combined areas.

Ende, Sampit and Sekupang are excluded from the analysis due to the lack of their measured traffic data.

(2) Traffic Intensity Trend

As the time-series data of toll traffic flow for the areas under study are not available, the future trend of traffic intensity is estimated by analyzing the past trend of the number of metering pulses per subscriber.

Table 2-3-1 SLDD Traffic Intensity (1985)

SC Area	No.of Sub.	Outgoing SLJJ Traffic (Erl.) I	II	III	IV	Ave.	Taffic Intensity (mErl.) I	II	III	IV	Ave.	m+2(std)
JKT	230,232	725.68	868.72	897.20	916.70	852.08	3.2	3.8	3.9	4.0	3.7	3.5 *
BD	32,393	159.32	153.44	155.42	167.06	158.81	4.9	4.7	4.8	5.2	4.9	5.3
CBN	5,035	15.67	17.39	15.40	13.59	15.51	3.1	3.5	3.1	2.7	3.1	3.7
SM	18,050	82.07	80.35	82.66	76.14	80.31	4.5	4.5	4.6	4.2	4.4	4.8
YK	11,594	58.95	60.98	58.18	54.19	58.08	5.1	5.3	5.0	4.7	5.0	5.5
PWT	10,132	46.30	35.15	35.13	35.08	37.92	4.6	3.5	3.5	3.5	3.7	4.8
SB	49,572	-	-	250.30	245.81	248.06	-	-	5.0	5.0	5.0	4.2 *
JR	8,848	-	-	24.27	24.23	24.25	-	-	2.7	2.7	2.7	2.8
ML	12,664	-	-	43.53	42.24	42.89	-	-	3.4	3.3	3.4	3.4
MN	7,785	40.83	-	43.97	35.18	39.99	5.2	-	5.6	4.5	5.1	6.4
DPR	11,444	34.70	31.93	34.74	33.68	33.76	3.0	2.8	3.0	2.9	3.0	3.1
SBW	785	0.58	0.31	-	3.08	1.32	0.7	0.4	-	3.9	1.7	4.9
END	-	-	-	-	-	-	-	-	-	-	-	4.9 **
KP	1,425	4.70	-	3.20	2.60	3.50	3.3	-	2.2	1.8	2.5	3.8
UP	11,874	-	36.57	31.55	33.60	33.91	-	3.1	2.7	2.8	2.9	3.3
PRE	983	2.99	3.97	3.04	1.09	2.77	3.0	4.0	3.1	1.1	2.8	5.1
MO	3,875	15.61	13.19	19.39	18.35	16.64	4.0	3.4	5.0	4.7	4.3	5.6
PAL	998	4.33	-	-	3.87	4.10	4.3	-	-	3.9	4.1	4.5
KDI	992	3.25	3.53	1.74	2.32	2.71	3.3	3.6	1.8	2.3	2.7	4.2
BJM	5,062	-	-	22.22	22.00	22.11	-	-	4.4	4.3	4.4	4.4
SPT	-	-	-	-	-	-	-	-	-	-	-	6.3 **
SMR	4,715	20.43	16.56	14.86	21.33	18.30	4.3	3.5	3.2	4.5	3.9	5.1
TAR	823	2.62	3.29	1.79	1.75	2.36	3.2	4.0	2.2	2.1	2.9	4.4
PTK	2,122	13.30	13.30	-	-	13.30	6.3	6.3	-	-	6.3	6.3
MDN	36,225	99.49	125.33	118.26	124.14	116.81	2.7	3.5	3.3	3.4	3.2	3.1 *
SBG	985	4.55	3.05	4.20	4.50	4.08	4.6	3.1	4.3	4.6	4.1	5.5
LSM	3,301	14.46	16.12	20.70	21.40	18.17	4.4	4.9	6.3	6.5	5.5	7.4
BNA	3,396	12.23	12.38	12.13	12.36	12.28	3.6	3.6	3.6	3.6	3.6	3.6
PG	9,899	46.92	47.09	52.61	50.56	49.30	4.7	4.8	5.3	5.1	5.0	4.5 *
TJK	6,207	25.05	25.25	26.91	19.30	24.13	4.0	4.1	4.3	3.1	3.9	4.9
LT	1,904	-	-	5.96	6.74	6.35	-	-	3.1	3.5	3.3	3.8
JB	3,269	11.09	11.71	11.13	9.62	10.89	3.4	3.6	3.4	2.9	3.3	3.8
PD	7,746	27.79	34.82	32.68	32.95	32.06	3.6	4.5	4.2	4.3	4.1	4.9
PBR	3,152	10.67	8.03	9.08	9.07	9.21	3.4	2.5	2.9	2.9	2.9	3.6
SKN	-	-	-	-	-	-	-	-	-	-	-	3.6 **
AB	3,316	8.39	7.88	7.76	10.72	8.69	2.5	2.4	2.3	3.2	2.6	3.5
TT	942	2.03	2.57	1.93	2.04	2.14	2.2	2.7	2.0	2.2	2.3	2.9
SON	953	3.02	4.61	3.30	3.96	3.72	3.2	4.8	3.5	4.2	3.9	5.2
JAP #	2,317	11.81	13.90	11.37	-	12.36	5.1	6.0	4.9	-	5.3	6.3
MRK	588	2.04	2.20	1.77	2.07	2.02	3.5	3.7	3.0	3.5	3.4	4.1
TOTAL	515,603											(3.95)

Notes: # Excluding BIAK because of no data
* [m+2(std)]*0.8
** Estimated traffic intensity

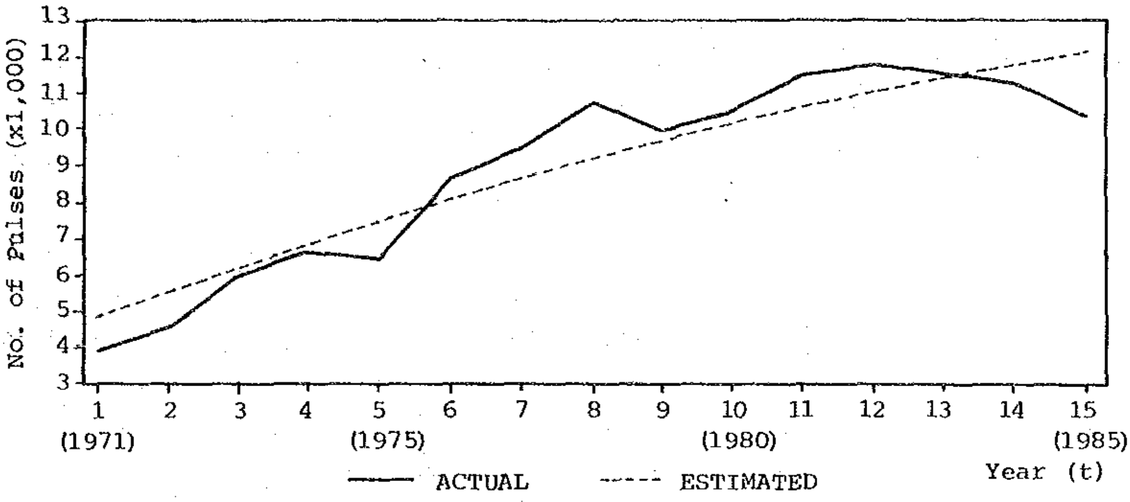
The past trends in the number of automatic subscribers and the number of pulses produced by local and toll calls are as shown in Table 2-3-2. The growth curve for the number of metering pulses per subscriber is illustrated in Figure 2-3-1.

Although the metering pulses per automatic subscriber had increased steadily during 1970, it began to decrease in 1980. The steady increment of per-subscriber pulses was mainly because of the subsequential construction of the backbone terrestrial transmission links connecting major cities in Indonesia. On the other hand, the downward trend observed during 1980 resulted from the following reasons: Construction of backbone links was limited only to MEDAN-BANDA ACEH transmission system in 1982; the tariff rate per pulse was raised frequently; the economic activities were depressed due to oil price turmoil in 1985.

Table 2-3-2 Trend of Total Number of Pulses (Nationwide)

Year	No. of Sub. (Auto)	Total Pulses	Pulses/Sub.
1971	77,437	302,032,002	3,900
1972	95,414	435,580,498	4,565
1973	105,762	631,209,285	5,968
1974	115,298	758,760,178	6,581
1975	130,752	838,032,241	6,409
1976	138,722	1,194,378,067	8,610
1977	156,358	1,476,237,229	9,441
1978	192,857	2,065,941,231	10,712
1979	253,696	2,524,897,380	9,952
1980	319,303	3,353,442,002	10,502
1981	375,424	4,315,919,631	11,496
1982	420,518	4,962,408,846	11,801
1983	444,463	5,147,835,369	11,582
1984	473,736	5,365,553,687	11,326
1985	531,034	5,504,145,342	10,365

Source: Traffic Dalam Angka 1979-1980, 1984-1985



NOTE 1: Transmission System Project

- 1973: JAWA-BALI Route
- 1974: SURABAYA-BANJARMASIN Route
- 1975: Trans-Sumatera Route
- 1976: Satellite (PALAPA-A)
- 1978: Eastern-Micro Route
- 1982: MEDAN-BANDA ACEH Route

NOTE 2: Rise in Calling Charge

- 1979: Rp.20 - Rp.40 (Rp.23.1)
- 1980: Rp.40 - Rp.50 (Rp.25.0)
- 1981: Rp.50 - Rp.60 (Rp.26.6)
- 1985: Rp.60 - Rp.75 (Rp.24.2)

( ): Calling charge in real term (1975 constant price)

Figure 2-3-1 Trend of Pulses per Subscriber

The ceiling pulses per subscriber, 15,000, is obtained by extrapolating those data into Gompertz Curve with the highest correlation coefficient. The derived formula of this Gompertz Curve is as shown below; dummy variable is introduced only for the year 1985.

$$Y = 15{,}000 \times \exp[-\exp(0.341056 - 0.137943 \times T + 0.7322842 \times D)]$$

(R = 0.96)

where, Y: Annual metering pulses per subscriber

T: 1 for the year 1971

D: Dummy variable (1 for T=15, 0 for others)

R: Correlation coefficient

(3) Traffic Intensity Estimate

The toll outgoing traffic intensity from each SC area is forecasted for the years 1994, 1999 and 2004 on the basis of the 1985 data in Table 2-3-1 and the growth curve in Figure 2-3-1.

The traffic values for forecasting the circuit requirement are assumed to be the summation of the mean values and two fold standard deviations in Table 2-3-1. The estimated toll circuits, taking two fold standard deviations into account, can carry about 97% of the offered traffic against traffic fluctuations. This kind of arrangement is to meet the circuit dimensioning level recommended by CCITT (Rec. E500).

The number of pulses per subscriber and its annual increase from 1985 to 1994, 1999 and 2004 are estimated as follows, by the application of the Gompertz Curve shown in Figure 2-3-1:

1985 : 10,365 pulses

1994 : 14,250 pulses (1.37 times as compared with 1985)

1999 : 14,619 pulses (1.41 times)

2004 : 14,808 pulses (1.43 times)

The estimate of the toll traffic intensity are summarized in Table 2-3-3 by using the traffic data and the growth rate of the pulses per subscriber derived above.

Table 2-3-3 Estimated Traffic Intensity (Excluding D.A. Traffic)

	End of REPELITA-V (1994)			End of REPELITA-VI (1999)			End of REPELITA-VII (2004)		
Area	Total sub.	CR (mErl)	T.TRF(Erl)	Total sub.	CR (mErl)	T.TRF(Erl)	Total sub.	CR (mErl)	T.TRF(Erl)
JKT(21)	1,140,000	4.80	5,472.00	1,655,700	4.94	8,179.16	2,257,700	5.01	11,311.08
BD (22)	205,040	7.26	1,488.59	328,500	7.47	2,453.90	472,800	7.58	3,583.82
CBN(23)	22,260	5.07	112.86	39,800	5.22	207.76	60,300	5.29	318.99
SM (24)	94,090	6.58	619.11	164,500	6.77	1,113.67	246,600	6.86	1,691.68
YK (27)	67,100	7.54	505.93	120,500	7.76	935.08	182,800	7.87	1,438.64
PWT(28)	45,550	6.58	299.72	76,200	6.77	515.87	112,000	6.86	768.32
SB (31)	196,650	5.75	1,130.74	354,500	5.92	2,098.64	538,700	6.01	3,237.59
JR (33)	35,250	3.84	135.36	62,100	3.95	245.30	93,400	4.00	373.60
ML (34)	44,630	4.66	207.98	75,000	4.79	359.25	110,500	4.86	537.03
MN (35)	37,480	8.77	328.70	61,600	9.02	555.63	89,500	9.15	818.93
DPR(36)	60,910	4.25	258.87	101,000	4.37	441.37	147,900	4.43	655.20
SBW(37)	7,316	6.71	49.09	12,826	6.91	88.63	19,226	7.01	134.77
END(38)	8,150	6.71	54.69	11,700	6.91	80.85	15,700	7.01	110.06
KP (39)	25,160	5.21	131.08	46,450	5.36	248.97	71,350	5.43	387.43
UP (41)	49,700	4.52	224.64	91,300	4.65	424.55	139,700	4.72	659.38
PRE(42)	11,200	6.99	78.29	19,000	7.19	136.61	28,100	7.29	204.85
MO (43)	26,790	7.67	205.48	50,600	7.90	399.74	78,400	8.01	627.98
PAL(45)	14,700	6.17	90.70	26,000	6.35	165.10	39,300	6.44	253.09
KDI(40)	8,600	5.75	49.45	15,800	5.92	93.54	24,200	6.01	145.44
BJM(51)	35,000	6.03	211.05	61,200	6.20	379.44	91,600	6.29	576.16
SPT(53)	5,060	8.63	43.67	9,600	8.88	85.25	15,000	9.01	135.15
SMR(54)	34,000	6.99	237.66	64,600	7.19	464.47	100,300	7.29	731.19
TAR(55)	2,000	6.03	12.06	3,100	6.20	19.22	4,300	6.29	27.05
PTK(56)	14,900	8.63	128.59	26,300	8.88	233.54	39,800	9.01	358.60
MDN(61)	153,876	4.25	653.97	278,150	4.37	1,215.52	423,350	4.43	1,875.44
SBG(63)	4,880	7.54	36.80	8,800	7.76	68.29	13,400	7.87	105.46
LSM(64)	15,350	10.14	155.65	22,900	10.43	238.85	31,700	10.58	335.39
BNA(65)	13,920	4.93	68.63	25,570	5.08	129.90	39,220	5.15	201.98
PG (71)	51,520	6.17	317.88	84,400	6.35	535.94	122,600	6.44	789.54
TJK(72)	40,250	6.71	270.08	62,350	6.91	430.84	88,100	7.01	617.58
LT (73)	19,413	5.21	101.14	34,813	5.36	186.60	52,813	5.43	286.77
JB (74)	12,000	5.21	62.52	21,600	5.36	115.78	32,800	5.43	178.10
PD (75)	31,040	6.71	208.28	52,050	6.91	359.67	76,550	7.01	536.62
PBR(76)	17,436	4.93	85.96	30,996	5.08	157.46	46,796	5.15	241.00
SKN(77)	12,256	4.93	60.42	22,356	5.08	113.57	34,256	5.15	176.42
AB (91)	12,400	4.80	59.52	22,800	4.94	112.63	34,900	5.01	174.85
TT (92)	4,000	3.97	15.88	6,900	4.09	28.22	10,300	4.15	42.75
SON(95)	3,650	7.12	25.99	6,780	7.33	49.70	10,480	7.44	77.97
JAP(96)	9,050	8.63	78.10	16,100	8.88	142.97	24,200	9.01	218.04
MRK(97)	1,500	5.62	8.43	2,750	5.78	15.90	4,300	5.86	25.20
TOTAL	2,594,077	5.51	14,285.56	4,177,191	5.70	23,827.38	6,024,941	5.80	34,969.14

2-3-2 Inter-SC Traffic

In this study, inter-SC traffic is forecasted by the following two steps:

STEP-1: Calculation by a regression model as in JICA Long-term Plan

STEP-2: Adjustment by "Kruithof Algorithm" stipulated in GAS 3 Manual, ITU

STEP-1 is to forecast the theoretical inter-SC traffic volume through the use of a regression model. This theoretical derivation, however, does not always reflect the actual traffic flow, in other words, the actual traffic intensity per subscriber.

Then, STEP-2 adjusts such discrepancies by employing "Kruithof Algorithm".

(1) Regression Model Modification

The regression model introduced in the Long-term Plan indicates that the smaller the number of subscribers in a SC area is, the higher its traffic intensity goes up. This result is quite consistent with the general traffic tendency that the toll traffic intensity per subscriber decreases as the network expands in accordance with the increase of subscribers.

On the other hand, there are many cases where the values thus forecasted are quite inconsistent with actual ones when examined in detail.

Careful examination of the forecasted value derived from the model reveals: traffic intensities of respective SCs differ so much from each other that overestimate of traffic for small SC areas could arise.

Therefore, the study modified the model from the following viewpoints:

1) The data to be used for the study are those for 112 sections as in the Long-term Plan. The study, however, uses the median of quarterly measured data in 1985 to relieve the seasonal fluctuations, though the Long-term Plan uses one of the quarterly data in 1984.

2) The number of subscribers used here includes the whole automatic exchanges' subscribers in SC area including its subordinate PCs and local exchanges.

3) The explanatory variable, Pij, the number of charged pulses for one-minute call is replaced with the crow flight distance (Dij) between the i-th SC and the j-th SC.

4) The correlation coefficient of the multiple regression is raised by increasing the number of dummy variables used as explanatory variables.

The modified formula is as shown below:

$$\ln Xij = -3.764853 + 0.5006986 \ln Si + 0.4487037 \ln Sj + (-0.681247 + 0.1563939 \times D1) \times \ln Dij + 0.4646919 \times D2 - 0.766746 \times D3 - 1.266141 \times D4$$

(R = 0.9)

where, Xij : The traffic flow from the i-th SC area to the j-th SC area (Erl.)

Si/Sj: The number of automatic subscribers in the i-th/j-th SC area

Dij : Crow flight distance between the i-th SC and the j-th SC (km)

D1 : Dummy variable (1 for incoming and outgoing from/to JAKARTA, 0 for others)

D2 : Dummy variable (1 for incoming and outgoing from/to MEDAN, 0 for others)

D3 : Dummy variable (1 for incoming and outgoing from/to CIREBON, 0 for others)

D4 : Dummy variable (1 for incoming and outgoing from/to SUMBAWA BESAR, 0 for others)

R : Multi-regression correlation coefficient

(2) Traffic Volume Adjustment

There still remains a discrepancy, as a matter of course, to some extent between the theoretical value and the estimated value by SC; the study employs "Kruithof Algorithm" (refer to GAS 3 Manual, ITU) to reduce the discrepancy.

The theoretically derived value from the regression model is used only to obtain the portion of traffic to be distributed for each SC and the total traffic volume to terminate/originate in each SC is adjusted based upon the estimated data shown in Table 2-3-3, through the use of "Kruithof Algorithm."

2-3-3 PC-SC Traffic

The results of toll traffic flow analysis shows that, at almost all SC areas, 70-80% of the toll traffic originated from PCs and local exchanges be transit traffic which flows out to the other SC areas via self-SC. Traffic flow diagrams for sampled SCs are attached as ANNEX-1.

Accordingly, in this study, toll traffic intensity from PCs and local exchanges is set at 1.3 times equivalent to the estimated traffic intensity from each SC area, which is listed in Table 2-3-3.

The estimated PC-SC toll traffic intensity and toll traffic volume are summarized in ANNEX-8, for each PC area in the objective area of the study.

2-4 Circuit Dimensioning

The study adopts the network dimensioning procedure by "Alternate Routing" described in GAS 3 Manual, ITU.

As for the use of satellite transmission link, the study employs the same distribution curve for inter-SC toll traffic as in the Long-term Plan.

2-4-1 Assumptions

(1) Circuit Calculation

The conditions for the Alternate Routing Method are as follows:

1) Routing Conditions
In principle, the study adopts the same routing conditions as those in the Long-term Plan which follows the suit of REPELITA-IV Program by PERUMTEL. For some final routes for toll traffic from/to outside Sumatera Island, however, the routing condition of SC-TC-TC-SC is adopted, to reduce the establishment of small final circuit groups.

2) Cost Comparison
The costs of the high-usage route and the final route are assumed to be proportional to their transmission distances. The transmission distances in the Long-term Plan are applied as the cost parameter for calculation.

3) Grade of Services (G.O.S.)
The G.O.S. of the final route circuits is assumed to be equivalent to that of REPELITA-IV program and thus, the loss probability is fixed at the level of 0.01.

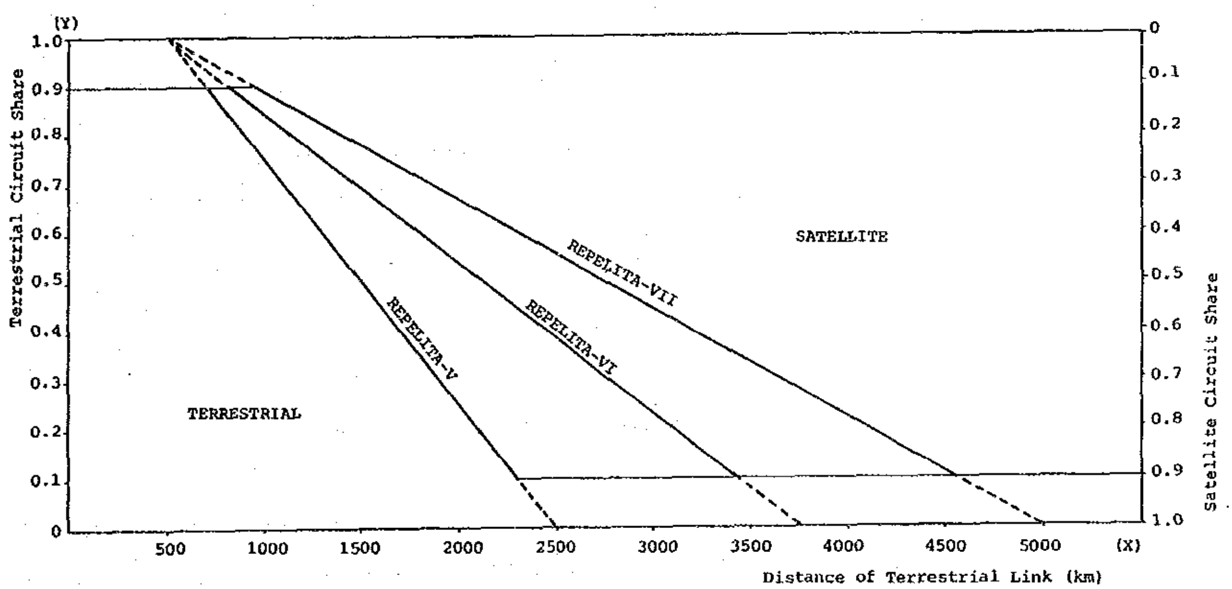
4) High-Usage Route Establishment

As the criterion of high-usage route establishment, PERUMTEL proposes the range of 15-20 circuits or 13-Erlang equivalent. The study assumes the criterion for establishing high-usage route at 15 circuits, taking effective use of the digital transmission system into consideration.

(2) Circuit Allocation to Terrestrial/Satellite Transmission System

The distribution curve shown in Figure 2-4-1 is proposed in the Long-term Plan.

The study employs this distribution curve for allocating the required circuit to terrestrial or satellite transmission system.



REPELITA-V : Y = 1.25 - 0.0005X
REPELITA-VI : Y = 1.125 - 0.0003X
REPELITA-VII : Y = 1.1 - 0.00022X

(Source: JICA Long-term Plan)

Figure 2-4-1 Share of Terrestrial and Satellite Circuits

(3) Terrestrial Transmission System Expansion

The Long-term Plan proposed the several construction plans for the terrestrial backbone transmission system. Out of these plans, the study takes into consideration the following projects in the non-objective areas, for the purpose of circuit requirement calculation:

REPELITA-V : Trans-Sulawesi Digital M/W System
BJM-UP Optical Fiber Submarine Cable
Trans-Kalimantan Digital M/W System
East Indonesia Digital M/W System
BPP-SMR Digital M/W System
UP-AB Optical Fiber Submarine Cable

REPELITA-VI : AB-JAP Optical Fiber Submarine Cable

REPELITA-VII: JAP-MRK Digital M/W System

(4) Satellite Transmission System Expansion

PERUMTEL has formulated the following expansion/reallocation programs for the satellite transmission links throughout Indoneisa within the period of PELITA-IV:

- For FDMA : PROGRAM 1212/REALOKASI (2,508 cct.)
- For TDMA : DIGITAL TDMA PHASE-I (450 cct.)
DIGITAL TDMA PHASE-II (5,454 cct.)

According to the above programs, following satellite transmission links are taken into consideration in the study:

Tabel 2-4-1 Satellite Transmission Links
(Objective Area)

Section	FDMA	TDMA(cct.) (PH-I)	(PH-II)	Total
JKT-MDN	60	(30)	(130)	160
JKT-BNA	48			0
JKT-PG	36		(120)	120
JKT-PD	0		(60)	60
JKT-PBR	36		(52)	52
JKT-SKN	108			0
BD-MDN	0		(32)	32
SB-MDN	0	(30)	(20)	50
SB-PG	36	(30)		30
MDN-PG	0		(24)	24
MDN-PD	0		(38)	38
MDN-PBR	0		(24)	24
MDN-SKN	48			0
PG-PD	0		(26)	26
PD-PBR	24		(24)	24
PBR-SKN	24			0
SKN-SB	60			0
Total	480 cct.			640 cct.

Data Source: BINPROSATTEL (Aug. 8, 1987)

2-4-2 Inter-SC Circuit Requirement

(1) Total Circuit Requirement

Under the above assumptions and inter-SC traffic matrices (ANNEX-3), circuit requirements for telephone service among all SCs are calculated according to the network optimization procedure of "Alternate Routing" method.

Figure 2-4-2 shows the general circuit calculation steps in "Alternate Routing" method.

ANNEX-5 represents the calculation results for the objective SCs in Sumatera Island concerned, for the years 1994, 1999 and 2004.

As for total circuit requirements, 10% increase of the required telephone circuits are considered for non-voice communication services in the study.

(2) Terrestrial Circuit Requirement

Terrestrial circuit requirements for Trans-Sumatera Digital Microwave System is to be obtained in the undermentioned manner, out of the above total circuit requirements.

1) Tentative Terrestrial/Satellite Circuit Distribution

The total circuit requirements including 10% margin to be assigned for leased circuits are tentatively divided into terrestrial and satellite links by means of the distribution curve shown in Figure 2-4-1.

However, in the case of small total circuit requirements, more precisely, not larger than 30 circuits, all circuits are intentionally allocated to the terrestrial link only, because of the effective use of the transmission system.

2) Satellite Circuits Arrangement

As mentioned in the preceding paragraph, so many satellite links will be expanded/provided by the end of PELITA-IV. These systems are assumed to continue their operations for the time being.

Then, the study makes the following modifications to the tentatively calculated satellite circuit requirements, so that the said system will be effectively used in the future:

CASE-1: When the number of tentatively calculated satellite circuits is below the existing satellite system capacity, existing satellite circuits are increased upto 80% of its capacity. That is, the number of tentatively calculated terrestrial circuits is to be decreased by the amount of equivalent satellite circuits.

CASE-2: When the number of tentatively calculated satellite circuits is beyond the existing satellite system capacity, the satellite system is expanded upto the tentatively calculated satellite circuits level by TDMA, whereas the existing FDMA is not expanded.

However, in the case of TDMA-expansion of below 30 circuits, TDMA is not expanded. It means that the number of tentatively calculated terrestrial circuits is to be increased by its equivalents.

Figure 2-4-3 represents the satellite circuits dimensioning diagram.

ANNEX-6 summarizes the terrestrial/satellite circuit requirements in the years 1994, 1999 and 2004.

2-4-3 PC-SC Circuit Requirement

Based on the estimated PC-SC traffic in the objective area (ANNEX-8), PC-SC circuit requirements in the year 1994, 1999 and 2004 are calculated under the following conditions:

- Intra-SC network configuration: Star-network
- Grade of services : B=0.01

Calculation results are included in ANNEX-8.

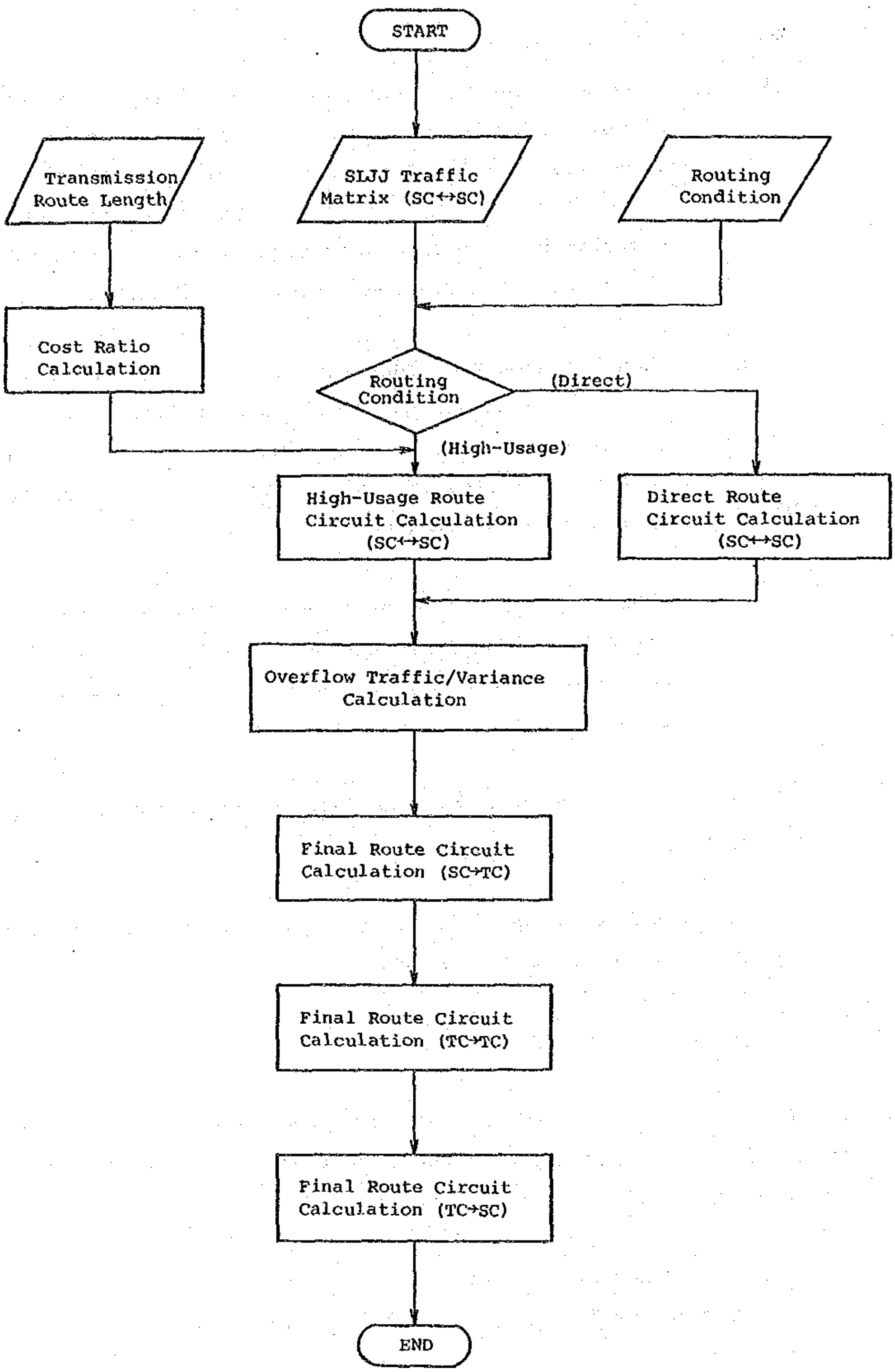


Figure 2-4-2 Toll Circuit Calculation Flow

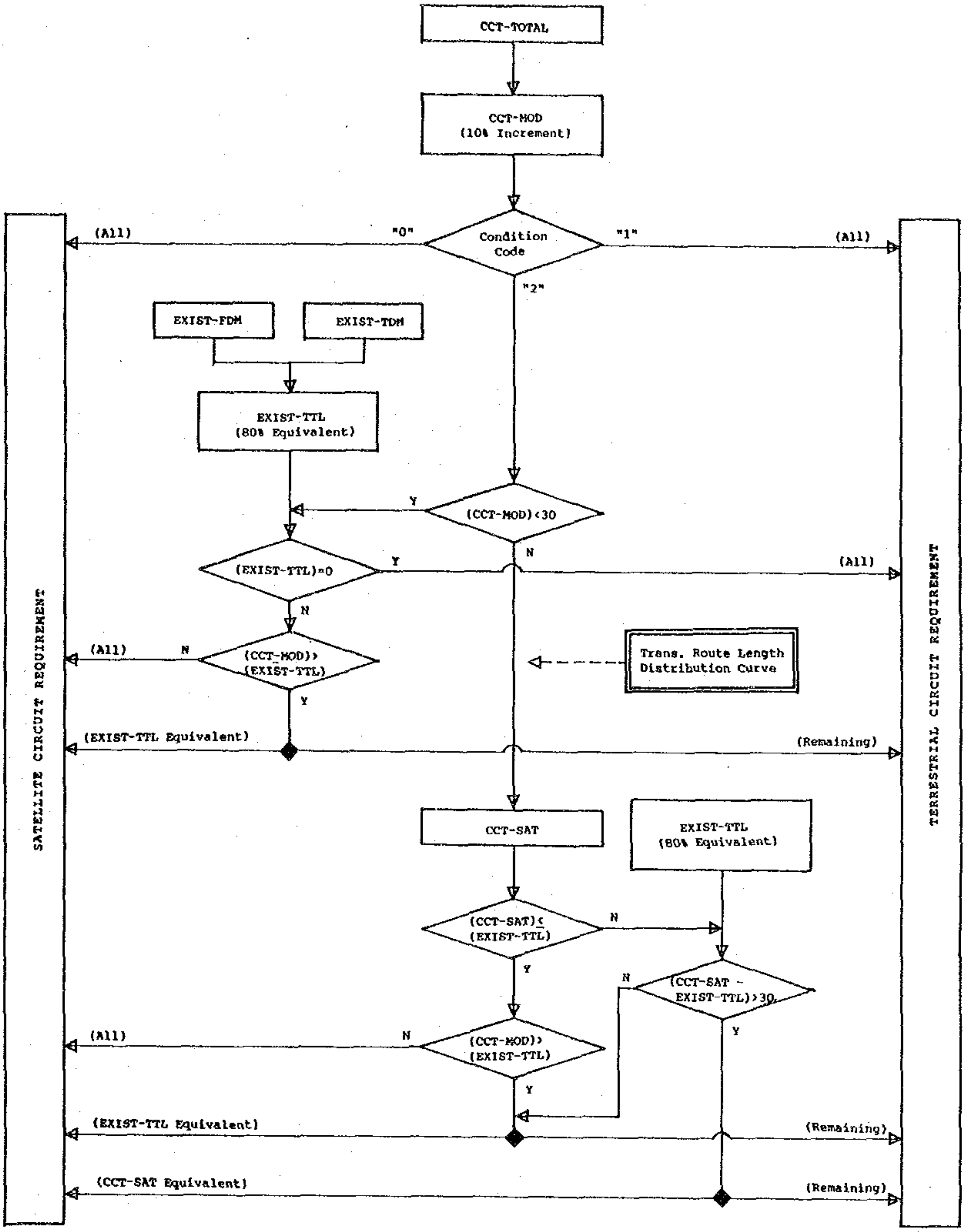


Figure 2-4-3 Satellite Links Dimensioning Diagram

3. OPTIMUM DIGITAL TRANSMISSION SYSTEM

3. OPTIMUM DIGITAL TRANSMISSION SYSTEM

3-1 Performance Objectives

According to the latest CCIR Recommendation 634 (Geneva, 1986) on real digital radio links to form a part of a high grade circuit within an ISDN, the following error performance criteria should be respected for a link with length L of between 280 km and 2500 km;

(1) BER $\geq 1 \times 10^{-3}$ for no more than 0.054 x L/2500% of any month. Integration time 1 sec;

(2) BER $\geq 1 \times 10^{-6}$ for no more than 0.4 x L/2500% of any month. Integration time 1 minute;

(3) Total error seconds for no more than 0.32 x L/2500% of any month;

(4) Residual bit error ratio $\leq (L \times 5 \times 10^{-9})/2500$

For planning purpose, the first objective is considered most stringent, and it is assumed that meeting this objective automatically satisfies the remaining terms.

3-2 Route Selection

Three different plans, i.e., the existing route plan and the western route plan according to the Scope of Work, and in addition the eastern route plan have been prepared, compared and studied (see Figure 3-2-1); required transmission capacity of each routing plan for rough estimate of initial investment cost appears in Figure 3-2-2.

3-2-1 Existing route plan

The existing Trans-Sumatera analog backbone microwave system (1260 ch on 4 GHz band) links Jakarta with Padang, Medan, Jambi, Palembang, Lahat and Tanjung Karang and has been operated satisfactorily for about 12 years since 1975.

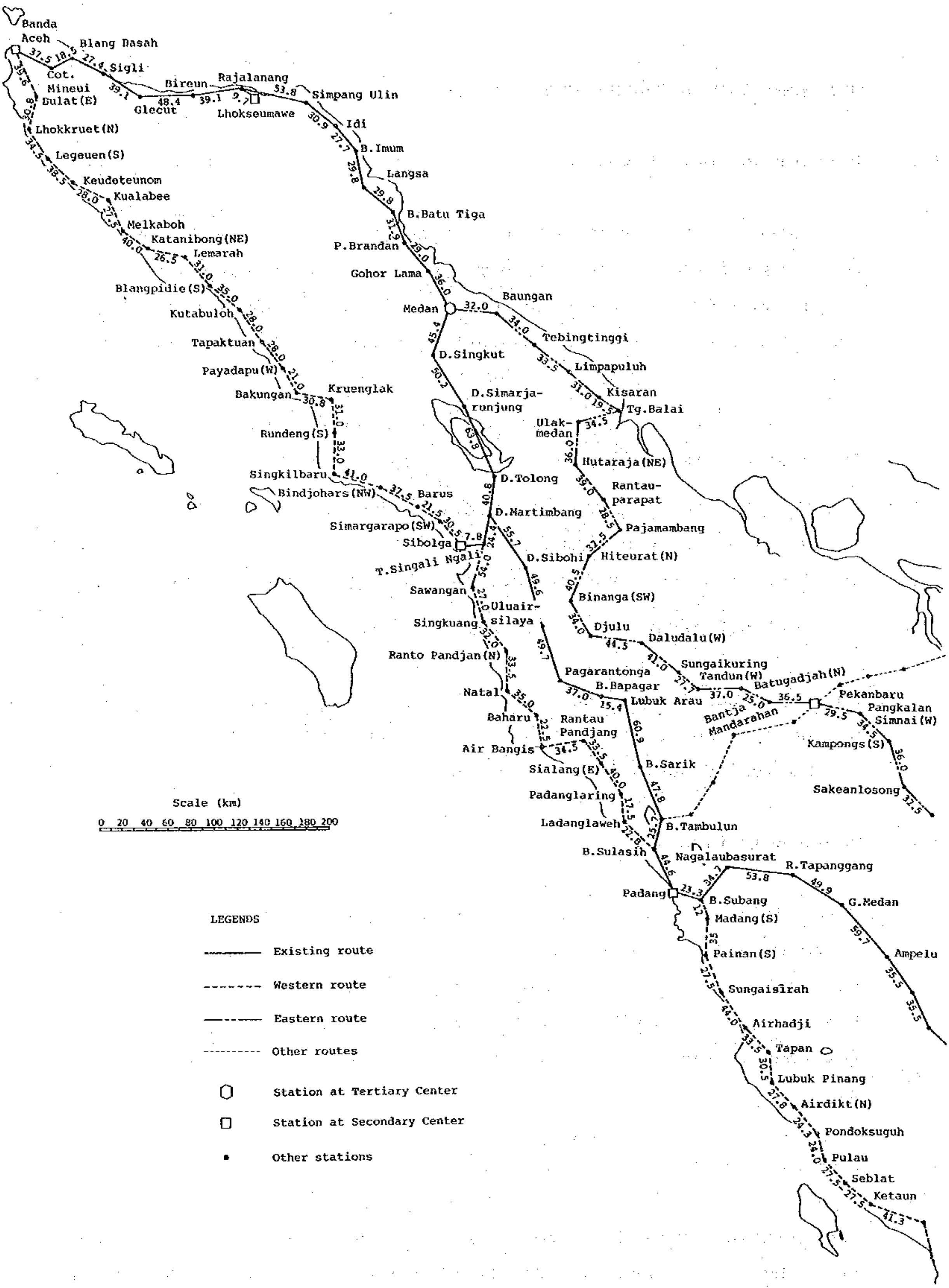
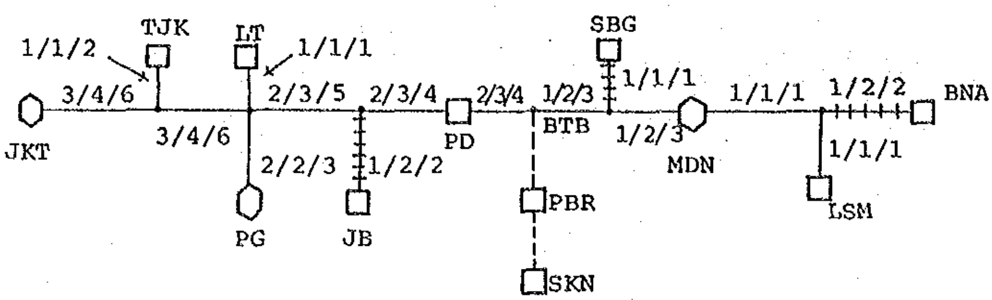
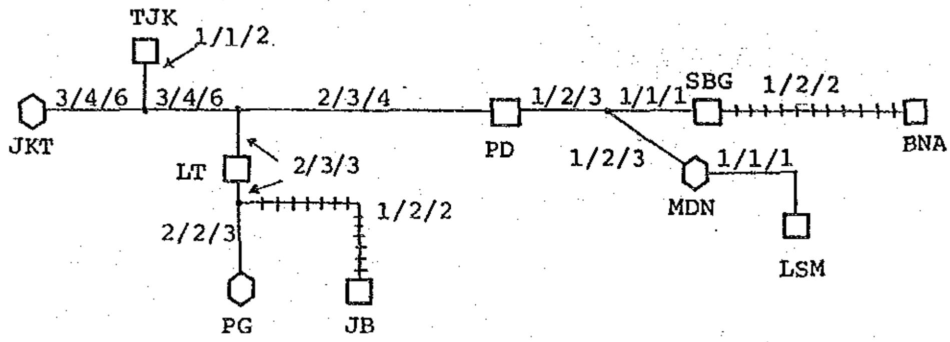


Figure 3-2-1 Route Plans for Trans-Sumatera Digital Microwave System (1/2)

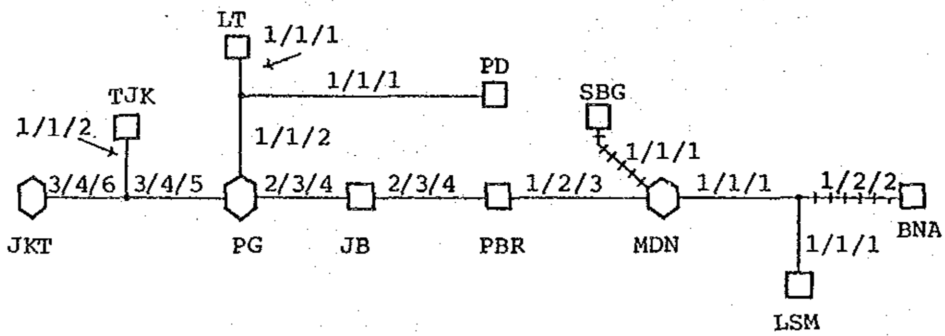
Figure 3-2-1 Route Plans for Trans-Sumatera Digital Microwave System (2/2)



a. Existing route plan



b. Western route plan



c. Eastern route plan

Note:
- ———— 140 Mbit system
- ++++++++ 34 Mbit system
- \- - - - - - System by other project
- x/y/z No. of working RF channels for 1994/1999/2004

Figure 3-2-2 Required Transmission Capacity

Also an analog microwave system (1260 ch) using upper 6 GHz band has been in operation satisfactorily between Medan, Lhokseumawe, and Banda Aceh since 1982.

From these backbone links small or medium capacity radio links are branched to Metro, Baturaja, Bukittinggi, Pematangsiantar, Kabanjahe, Belawan, Binjai, Lhoksukon, Kuala Simpang and Sabang.

The existing route plan intends to utilize as many existing buildings, towers and access roads as possible to install facilities for new digital microwave system under the study.

However, the plan may need a minor modification on the radio path passing over the Sunda strait to improve the adverse effect caused by reflected ray. According to study results on 1/50,000 map, considerable amount of suppression, (about 30 dB or more) may be gained by ridges located 8 to 12 km from the Rajabasa when new site near Mancak is used. Existence of the ridges was found only on map study, then it should actually be confirmed through a detailed survey in the implementation stage. The new site and the radio path are assumed as shown in Figure 3-2-3.

Table 3-2-1 shows the number and length of repeating hops for the existing route plan;
Figure 3-2-4 is a schematic drawing of the existing route plan.

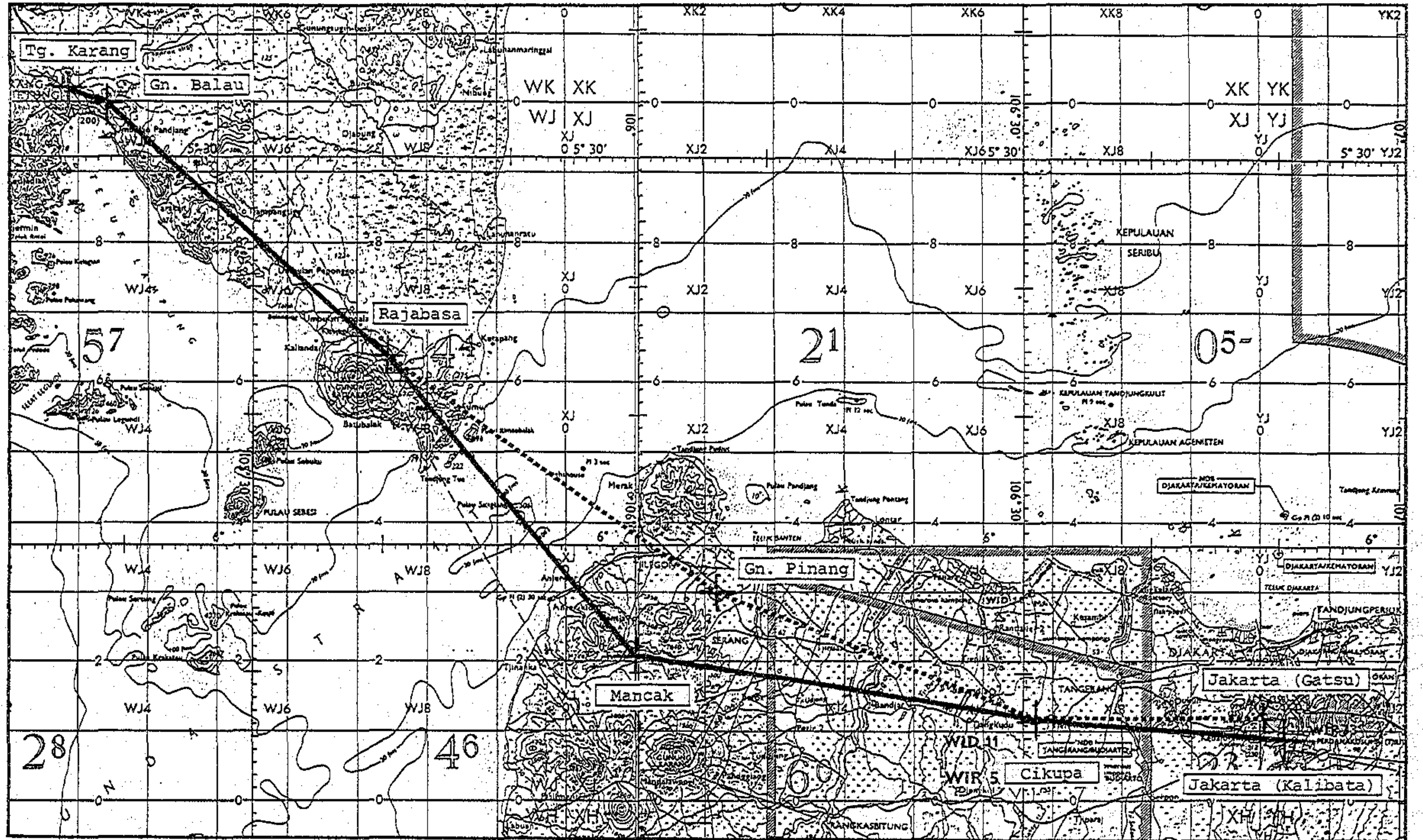


Figure 3-2-3 Radio Path over Sunda Strait

Note: New route
Existing route

Table 3-2-1 No. and Length of Repeating Hops (Existing Route Plan)

Section	Length (km)	No. of Hops			Hop Length (km)		
		≥30 km	<30 km	Total	Max.	Average	Min.
Jakarta - Gn. Balau	202.0	4	0	4	57.1	50.5	36.0
Gn. Balau - Bkt. Asam	267.6	5	1	6	57.8	44.6	25.1
Bkt. Asam - Bkt. Pedukuh	243.0	5	1	6	52.7	41.0	28.3
Bkt. Pedukuh - Padang	337.3	7	1	8	59.7	42.2	23.3
Padang - Dk. Martimbang	386.4	8	1	9	60.9	42.9	15.4
Dk. Martimbang - Medan	200.2	4	0	4	63.8	50.1	40.8
Medan - Rajalanang	270.1	4	4	8	54.7	33.8	28.3
Rajalanang - Banda Aceh	211.1	2	4	6	47.9	35.2	18.5
Gn. Balau - Tg. Karang	6.4	0	1	1	6.4	6.4	6.4
Bkt. Asam - Palembang	140.2	3	0	3	61.5	46.7	30.2
Bkt. Asam - Lahat	28.3	0	1	1	28.3	28.3	28.3
Bkt. Pedukuh - Jambi	161.1	3	2	5	39.7	32.2	29.0
Rajalanang - Lhokseumawe	9.7	0	1	1	9.7	9.7	9.7
Dk. Martimbang - Sibolga	32.2	0	2	2	24.4	16.1	7.8
Total	2,495.6	45	19	64	63.8	39.0	6.4

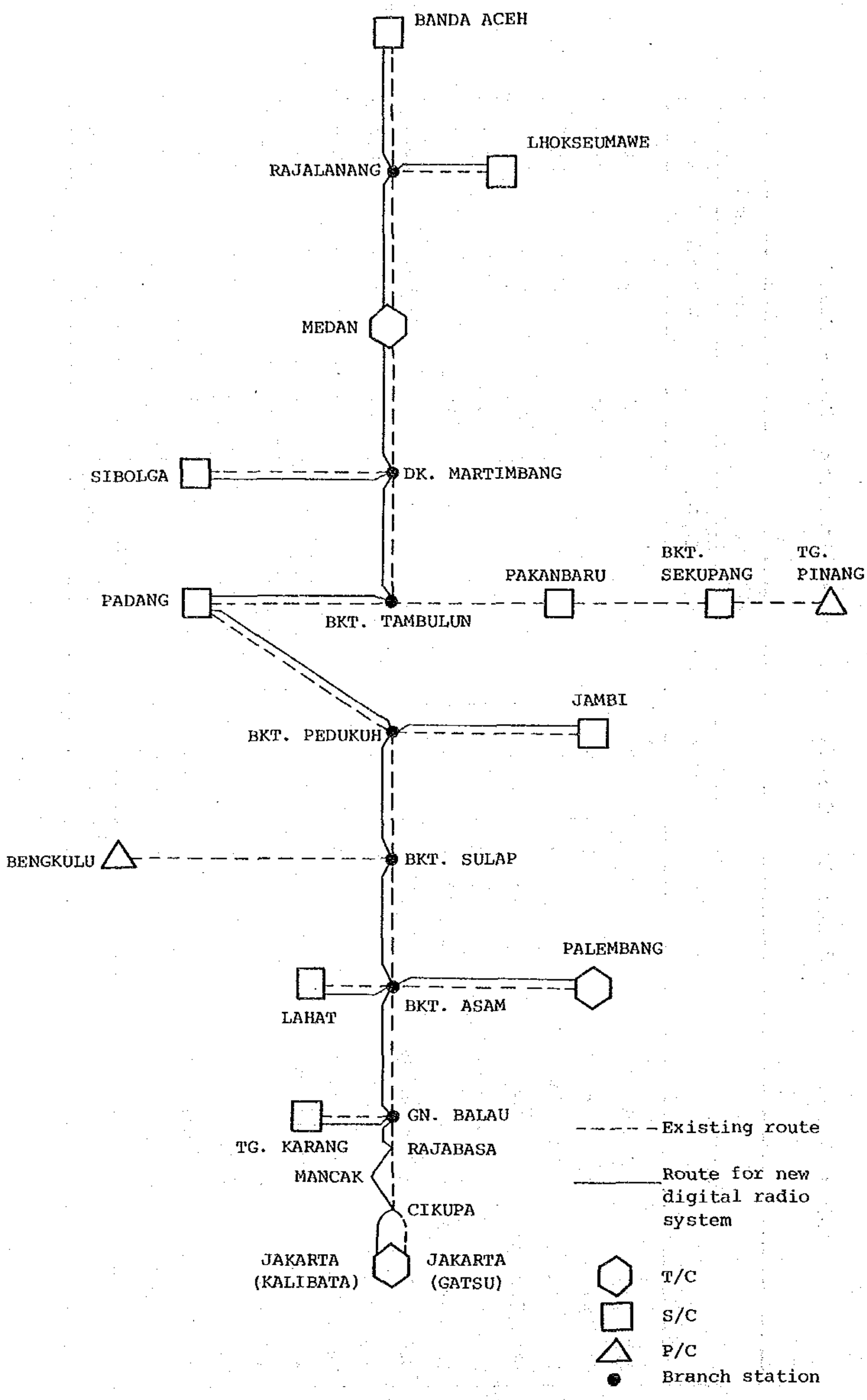


Figure 3-2-4 Existing Route Plan

The existing route plan is summarized as follows (refer also to Table 3-2-1):

(1) RF band and transmission capacity

Refer to Figure 3-3-2.

(2)	Total route length	2,495.6 km
(3)	Total no. of hops	64
(4)	Total no. of hops (≥ 30 km)	45
(5)	Total no. of hops (< 30 km)	19
(6)	No. of terminal/branch stations	10/5

(7) Towers

No. of existing towers available	60
No. of new towers	5

(8) Supervisory & control system

Route control center:	1 station	Jakarta
Regional control & repair center:	4 stations	Jakarta Palembang Padang Medan
Service depot:	7 stations	Tg. Karang (Gn. Balau) Bkt. Asam Bkt. Pedukuh Sungaidareh (Gn. Medan) Dk. Martimbang Lhokseumawe Banda Aceh
Centralized supervisory and control center (To be planned):		Jakarta

3-2-2 Western route plan

The western route generally goes through the western coast area running over Barisan range and it is considered as a very difficult plan in view of both microwave propagation and operation & maintenance.

- This route takes the same route as the existing route from Jakarta to Gn. Balau, then it is branched off to the west, runs through the valley in Barisan range to the north and reaches Bengkulu as shown in Figures 3-2-1 and 3-2-5.

- From Bengkulu the route runs mostly in the coastal area to reach Banda Aceh via Padang and Sibolga.

- To Medan and Lhokseumawe, the route has to run along the existing route connecting at Dk. Martimbang.

- The western route is also branched to Palembang and Jambi from Padang Bindu.

- Extension to Tg. Karang is made from Gn. Balau as in the existing route plan.

- The western route plan is summarized as follows (Refer also to Table 3-2-2):

(1) RF band and transmission capacity
Refer to Figure 3-2-2.

(2) Total route length 3,215.8 km

(3) Total no. of hops 96

(4) Total no. of hops ($\geq$ 30 km) 60

(5) Total no. of hops (< 30 km) 36

(6) No. of terminal/branch stations 11/4

(7) Towers

No. of existing towers available 36

No. of new towers 61

(8) Supervisory & control system

Route control center:	1 station	Jakarta
Regional control & repair centre:	4 stations	Jakarta
		Palembang
		Padang
		Medan
Service depot:	14 stations	Tg. Karang (Gn. Balau)
		Bkt. Asam
		Jambi
		Sibolga
		Lhokseumawe
		Banda Aceh
		Bkt. Pedukuh
		Benkulu
		Mukomuko
		Natal
		Dk. Martimbang
		Tapaktuan
		Meulaboh
Centralized supervisory and control center (To be planned):		Jakarta

Table 3-2-2 No. and Length of Repeating Hops (Western Route Plan)

Note: Bracketed figures show the number of hops on the exist. route.

Section		Length (km)	No. of Hops			Hop Length (km)		
			≧30 km	<30 km	Total	Max.	Average	Min.
Jakarta	- Gn. Balau	202.0	4	0	4 (1)	57.1	50.5	36.0
Gn. Balau	- Benkulu	452.3	8	6	14	50.0	32.3	14.6
Benkulu	- Padang	417.7	8	6	14 (1)	44.0	29.8	12.0
Padang	- Sibolga	377.8	8	5	13	54.0	31.0	7.8
Sibolga	- Banda Aceh	633.9	13	7	20	41.0	31.7	21.5
Gn. Balau	- Tg. Karang	6.4	0	1	1 (1)	6.4	6.4	6.4
Padang Bindu	- Lahat	24.0	0	1	1	24.0	24.0	24.0
Bkt. Asam	- Jambi	404.1	8	3	11 (11)	52.7	36.7	28.3
Bkt. Asam	- Palembang	140.2	3	0	3 (3)	61.5	46.7	30.2
T.Singali Ngali	- Dk. Martimbang	24.4	0	1	1 (1)	24.4	24.4	24.4
Dk. Martimbang	- Medan	200.2	4	0	4 (4)	63.8	50.1	40.8
Medan	- Lhokseumawe	279.8	4	5	9 (9)	54.7	31.1	9.7
Bkt. Asam	- Lahat	28.3	0	1	1 (1)	28.3	28.3	28.3
Total		3,215.8	60	36	96 (32)	63.8	33.5	6.4

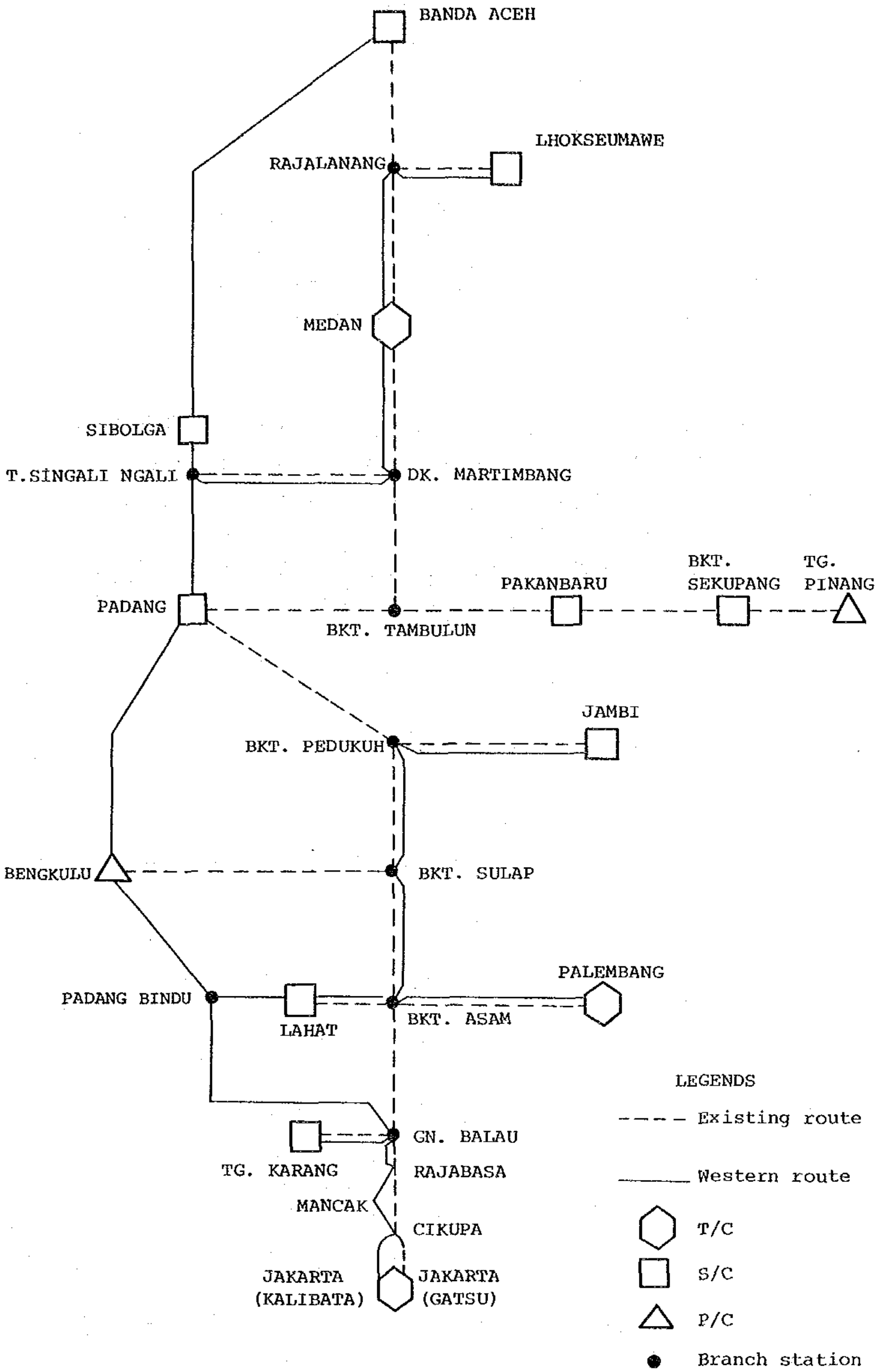


Figure 3-2-5 Western Route Plan

3-2-3 Eastern route plan

The eastern route passes the central or eastern area of Sumatera island as shown in Figures 3-2-1 and 3-2-6. The southern and middle portion of the land along the route is considered to be swampy or covered with tropical forest; tree height in a certain area around Pakanbaru exceeds 50 m.

In general, the eastern route area lacks mountainous or hilly ground that is favorable for microwave propagation to reduce fading probability and number of necessary repeater stations, however, it may be more favorable to have many key stations such as Palembang, Jambi, Pakanbaru come on the main eastern route from the viewpoint of network configuration, i.e., exchange accessibility.

No alternative route is considered between Medan and Banda Aceh.

Route portion between Jakarta and Gn. Balau is the same as in the other plans.

Eastern route plan is summarized as follows (refer to Table 3-2-3):

(1) RF band and transmission capacity
Refer to Figure 3-2-2.

(2)	Total route length	3,196.0 km
(3)	Total no. of hops	89
(4)	Total no. of hops (≥ 30 km)	66
(5)	Total no. of hops (≥ 30 km)	23
(6)	No. of terminal/branch stations	11/3

(7) Towers

No. of existing towers available	43
No. of new towers	47

(8) Supervisory & control system

Route control center:	1 station	Jakarta
Regional control & repair centre:	4 stations	Jakarta Palembang Padang Medan
Service depot:	14 stations	Tg. Karang (Gn. Balau) Bkt. Asam Jambi Pakanbaru Sibolga Lhokseumawe Banda Aceh Memgalla Bkt. Pedukuh Sungaidareh (G. Medan) Rengat Binaga South Rantau Prapat Dk. Martimbang
Centralized supervisory and control center (To be planned):		Jakarta

Table 3-2-3 No. and Length of Repeating Hops (Eastern Route Plan)

Section		Length (km)	No. of Hops			Hop Length (km)		
			≧30 km	<30 km	Total	Max.	Average	Min.
Jakarta	- Gn. Balau	202.0	4	0	4 (1)	57.1	50.5	36.0
Gn. Balau	- Palembang	354.3	8	1	9	48.0	39.4	27.5
Palembang	- Jambi	224.5	6	0	6	41.5	37.4	31.0
Jambi	- Pakan Baru	332.3	7	5	12	39.5	27.7	20.0
Pakan Baru	- Medan	606.7	14	4	18	44.5	33.7	25.0
Medan	- Rajalanang	268.9	4	4	8 (8)	53.8	33.6	27.7
Rajalanang	- Banda Aceh	210.0	4	2	6 (6)	48.4	35.0	18.5
Padang	- Bkt. Asam	580.3	12	2	14 (14)	59.7	42.2	23.3
Rajalanang	- Lhokseumawe	9.7	0	1	1 (1)	9.7	9.7	9.7
Medan	- Dk. Martimbang	200.2	4	0	4 (4)	63.8	50.1	40.8
Dk. Martimbang	- Sibolga	32.2	0	2	2 (2)	24.4	16.1	7.8
Palembang	- Bkt. Asam	140.2	3	0	3 (3)	61.5	46.7	30.2
Bkt. Asam	- Lahat	28.3	0	1	1 (1)	28.3	28.3	28.3
Gn. Balau	- Tg. Karang	6.4	0	1	1 (1)	6.4	6.4	6.4
Total		3,196.0	66	23	89 (41)	63.8	35.9	6.4

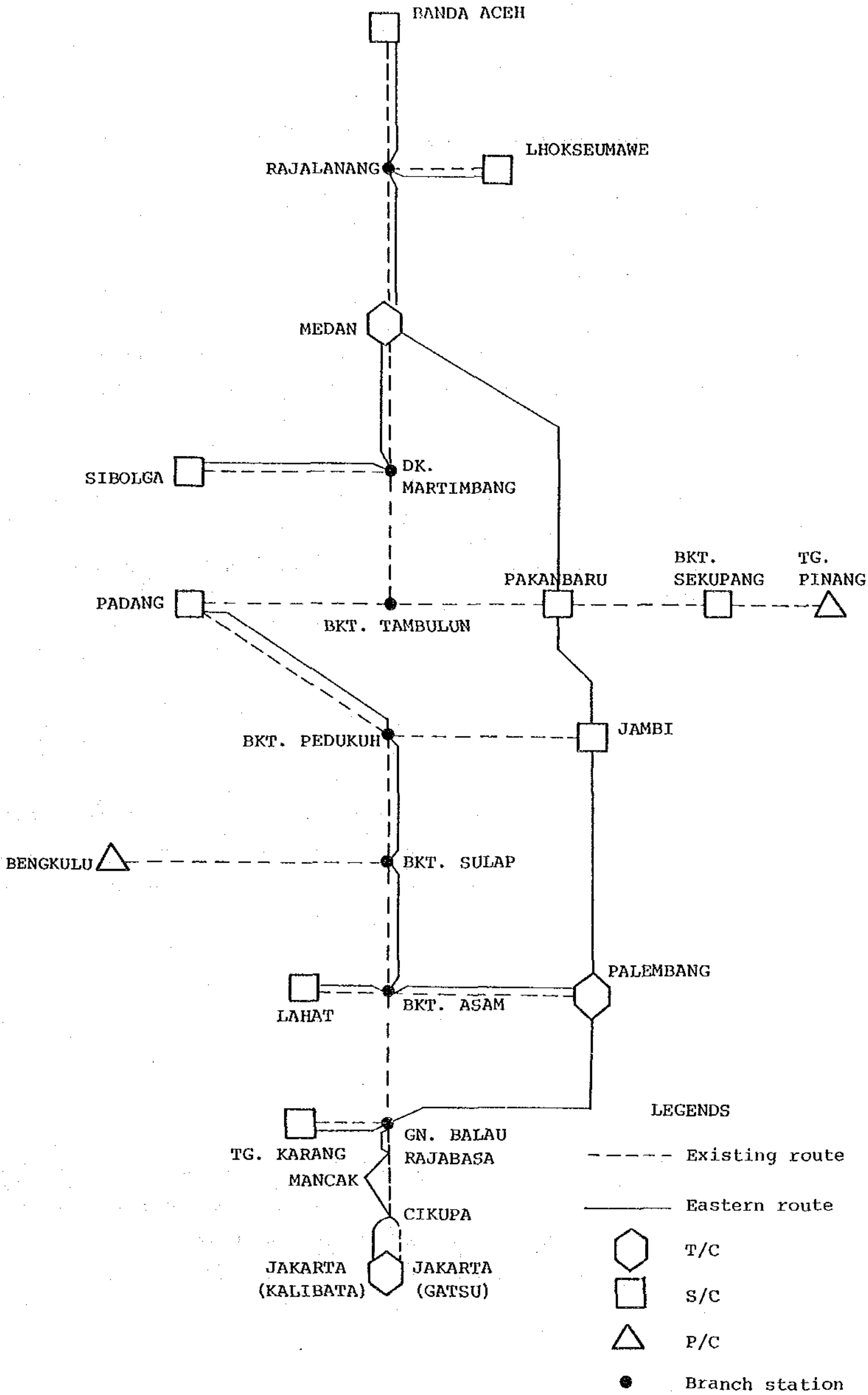


Figure 3-2-6 Eastern Route Plan

3-3 Transition from Analog to Digital Network

3-3-1 Transition in Sumatera Island

(1) Network digitalization

It is practical to proceed network digitalization in line with replacement of existing transmission facilities and installation of digital exchanges.

In transition period from analog to digital network, the network configuration should be simplified as much as possible so that the network itself can be flexible to absorb an abrupt (sudden) change of surroundings.

(2) Aspect to Be Considered

1) Route Diversity

Duplication of the backbone microwave system will enhance the reliability of the system and in addition, present possibility to provide a means to cover small subscriber zones which are linked only by satellite communication systems.

2) Synchronization

Complete synchronization of the network is a prerequisite for digitalization.

In Indonesia, PAMS (Preselected Alternate Master Slave) method is to be adopted according to FTP. In addition, when two ISC's (International Switching Center) are established in future, two master clocks, i.e., one for each ISC, function to backup each other.

3) Coexistence with Analog Network

Terrestrial microwave systems for the sections as follows are under operation:

Jakarta-Medan since 1975
Medan-Banda Ache since 1982

Although the Trans-Sumatera analog terrestrial microwave system will be used even after provision of the new digital system, the coexisting period depends upon availability of spares.

3-3-2 Radio subsystem

(1) Co-existing period

Although the existing analog Trans-Sumatera microwave system will be used even after **Trans-Sumatera Terrestrial Digital Transmission System** starts its operation, the period of co-existence may be limited by availability of spares necessary for operation of the existing system.

(2) Operation and maintenance

According to the existing route plan, new radio stations to TSDMS are Kalibata, P. Brayan, Mancak, Sibolga and T. Singali Ngali; the existing manpower can cover the O&M of new TSDMS in the co-existing period if appropriate measures are taken.

(3) TV signal transmission

The TSDMS should provide a means capable of transmitting TV signal to backup the PALAPA system. After completion of the TSDMS, the backup function can be transferred to this system from the existing analog system.

3-3-3 Muldex Subsystem

Interworking between transmission systems and exchanges for the transition period of digitalization must be carefully examined.

Full-digitalization of exchanges is expected to take place by the year 1999 in Indonesia; some parts of transmission links could be digitalized even at the initial stage of digitalization toward establishment of ISDN depending upon their viabilities.

Even though the section between Jakarta and Medan is to be digitalized by the year 1994, some of the existing trunk exchanges over that section will remain analog; connection between analog exchanges and digital transmission links requires A/D converters, i.e., channel units of muldex subsystem, to be provided during the transition period.