THE REPUBLIC OF INDONESIA

FEASIBILITY STUDY REPORT

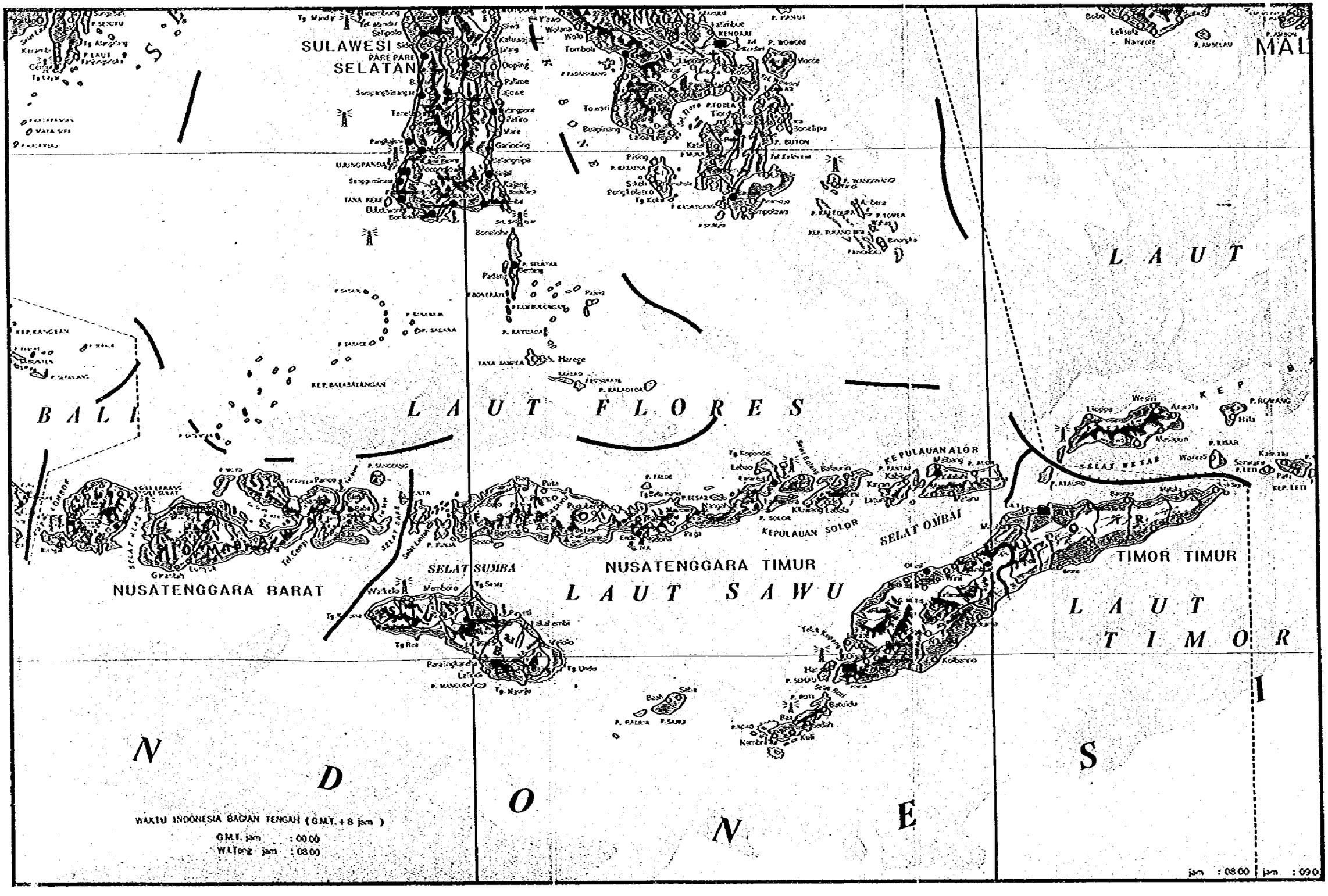
ON

NUSA TENGGARA AREA TERRESTRIAL TRANSMISSION NETWORK PROJECT

FEBRUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

NUSATENGGARA
THE REPUBLIC OF INDONESIA



PREFACE

In response to the request of the Government of the Republic of Indonesia, the Japanese Government decided to conduct a survey on the Nusa Tenggara Area Terrestrial Transmission Network Project and entrusted the survey to the Japan International Cooperation Agency (JICA).

The JICA sent to Indonesia a survey team, headed by Mr. Junichi Ikejima, Project Director, Planning and Coordination, International Cooperation Division, Minister's Secretariate, Ministry of Posts and Telecommunications, for the First Stage and Mr. Akira Aikei, Senior Advisor, International Affairs Division, Telecommunication Policy Bureau of the Ministry, for the Final Stage of the Project from July 26 to September 23, 1983.

The team had discussions with the officials concerned of the Government of Indonesia and Perusahaan Umum Telekomunikasi (PERUMTEL) and conducted a field survey in the Nusa Tenggara area. 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 Project and contribute to the promotion of friendly relations between our two countries.

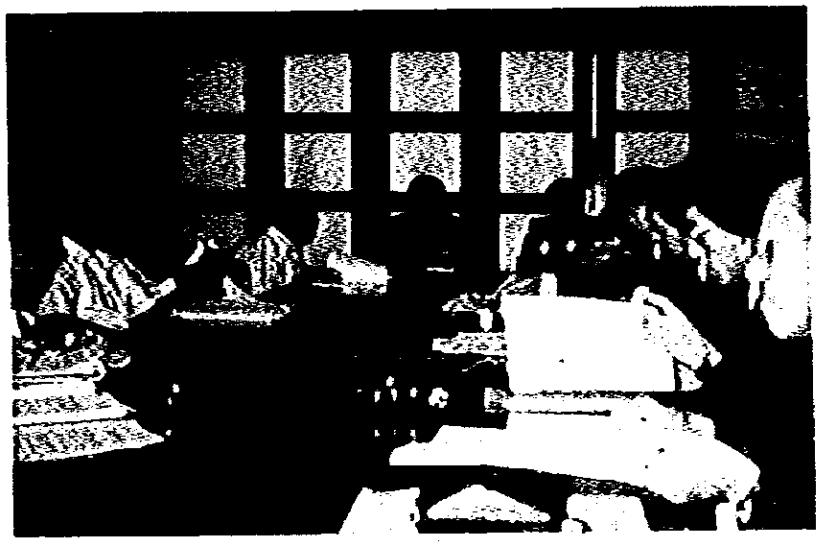
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

February 1984

Keisuke Arita

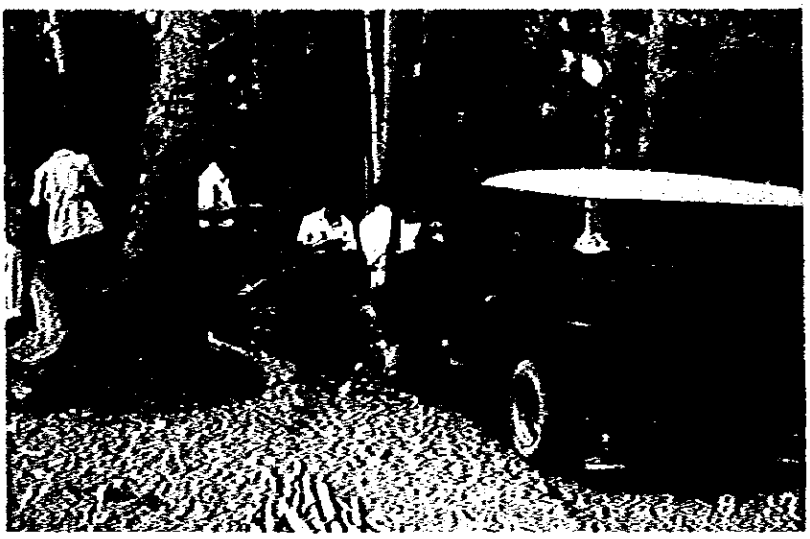
Keisuke Arita
President
Japan International Cooperation Agency

Survey team members explaining the Inception Report
(July 29, 1983, at PERUMTEL, Bandung)



Survey team members reporting and discussing the survey results
(Sept. 21, 1983, at DITJEN POSTEL, Jakarta)

Completing the draft final report
(Jan. 25, 1984, at DITJEN POSTEL, Jakarta)



Survey at a proposed radio repeater site
(Near Maumere Station on Flores Island)

Survey for a proposed microwave route
(Between Bima and Dompu on Sumbawa Island)

Survey at a proposed radio repeater site
(Near Kalabahi Station on Alor Island)

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SUMMARY

SUMMARY

1. Objective and Motivation

The objective of this study is to formulate the Nusa Tenggara Area Terrestrial Transmission Network Construction Plan and evaluate its feasibility.

This study is so motivated that by the implementation of the plan the telecommunication network interconnecting middle and small sized cities in the area can be improved and expanded, and by this means the social and economic activities in the area can be promoted.

2. Basic Philosophy

The basic philosophy of the plan consists of introducing a terrestrial transmission network in Nusa Tenggara area for the purpose of quantitative expansion and qualitative improvement of telephone and non-telephone services.

For the introduction of terrestrial transmission network, attention must be directed toward its co-existence with the domestic satellite communication network already in operation.

3. Coverage Area

The plan covers Nusa Tenggara Barat and Nusa Tenggara Timur.

In Nusa Tenggara Barat, the microwave backbone transmission system already exists and is operating. A small capacity radio transmission system to extend the existing microwave system to the cities of Dompu and Taliwang is contemplated by the plan.

In Nusa Tenggara Timur, the existing microwave system is extended to Sulawesi Island through Poco Ranakah radio repeater station on Flores Island. The plan, this time, is to construct a terrestrial transmission route that extends to further east than Poco Ranakah to cover main cities in Nusa Tenggara Timur. By the implementation of this plan, Kupang and Ende, the Secondary Centers in Nusa Tenggara Timur, can be connected to Maumere and 10 other Primary Centers in the area.

When this plan is implemented, a long distance terrestrial backbone transmission system will be completed, extending from the western end of Sumatra Island to Timor Island by way of Jawa Island. Thus, in Nusa Tenggara area, telecommunication services will be remarkably improved.

4. Demand Forecast

(1) Telephone Demand Forecast

Demand forecast for telephone service consists of macroscopic forecast and microscopic forecast. The former is from the national angle. The latter is specifically for Nusa Tenggara area, with regional specialities including population and local economy trends taken into consideration.

a) For macroscopic forecast, regression analysis is made, utilizing correlation between telephone density and GDP per capita.

b) For microscopic forecast, comparative study is made for the undermentioned three cases. As the result, Case 2 is adopted.

Case 1: To use exchange by exchange subscriber growth rate for Nusa Tenggara area.

Case 2: To review and correct PERUMTEL's microscopic forecast value with up-to-date data.

Case 3: To apply regression analysis, originally for macroscopic forecast, to Nusa Tenggara area.

After the comparison of macroscopic and microscopic forecast results, the latter is adopted. Microscopically forecasted demand values by years follow:

1990	23,600	subscribers
1995	38,000	"
2000	61,200	"
2005	98,600	"
2010	158,800	"

(2) Non-telephone Service Demand Forecast

For macroscopic demand forecast for non-telephone services, PERUMTEL's long term plan, "TELECOMMUNICATIONS IN INDONESIA BY THE YEAR 2000" (This plan is hereafter referred to as the Long Term Plan, for short.) and the Study Report on the Telecommunications Network Development in the Eastern Part of the Republic of Indonesia (The Study Report is hereafter referred to as the Mater Plan.) are used as basic data. Each forecasted value thus obtained is adjusted into final value with the actual diffusion rate in the past.

For microscopic forecast, the macroscopically forecasted value adjusted with local economy trend, etc., is allocated to each exchange. Forecast results are summarized below:

a) Number of outgoing telegram messages per year

1990	571,300 messages
1995	742,800 "
2000	836,000 "
2005	836,000 "
2010	836,000 "

b) Number of telex terminals

1990	86 terminals
1995	130 "
2000	191 "
2005	256 "
2010	341 "

c) Number of leased circuits

1990	10 circuits
1995	16 "
2000	21 "
2005	28 "
2010	36 "

d) Number of subscribers for new services

1990	7 subscribers
1995	17 "
2000	38 "
2005	90 "
2010	224 "

5. Traffic Forecast and Circuit Requirements

(1) Telephone Traffic Forecast

Trunk calling rates in Nusa Tenggara area are calculated with the following points considered:

- Present trunk calling rates
- Trunk calling rates established by PERUMTEL
- Related ITU data

Originating trunk calling rates applied follow:

No. of Subscribers	Originating Trunk Calling Rate (Erl.)
- 300	0.009
301 - 500	0.008
501 - 1,000	0.007
1,001 - 4,000	0.006
4,001 - 7,000	0.005
7,001 -	0.004

(2) Inter-exchange Traffic Distribution

Trunk traffic calculation is made for each Primary Center. Calculation results are then grouped on Secondary Center basis. Finally, trunk traffic groupings are distributed among Secondary Centers in Surabaya Tertiary area. Gravity model is used in this distribution.

For inter-exchange trunk traffic distribution by use of gravity model and for traffic distribution outside of Surabaya Tertiary area, the present state of traffic interflow is taken into consideration.

(3) Traffic Distribution between Terrestrial Transmission System and Domestic Satellite Communication System

Distribution ratios used are the ratios agreed upon by PERUMTEL at the time of this study. They are:

Crow-flight Distance Between Exchanges	Terrestrial Transmission System	Domestic Satellite Communication System
Up to 500 km	80%	20%
Over 500 km	40%	60%

(4) Calculation of Circuits Required

For the number of circuits required for telephone service, calculation results by years follow:

1990	364	circuits
1995	561	"
2000	824	"
2005	1,139	"
2010	1,570	"

6. Terrestrial Transmission System Construction Plan

(1) Alternative Plans

For the construction of terrestrial transmission system referred to in the foregoing, three plans were studied.

Plan A is for the system with capacity to meet circuit requirement as of the year 2005. Plan B is for the system that can satisfy circuit requirement expected in the year 2010. Plan C is for the system with a submarine cable system adopted between Ende and Kupang.

In all three plans, multiplexing equipment required up to five years after the system commissioning will be installed during the initial stage of system construction. Additional installation will follow every subsequent five years. For equipment whose service life is short, replacement will be carried out when the necessity arises.

The transmission route map in all three plans appears in Figures 1 and 2.

(2) Transmission System Type and Capacity

For the transmission system, digital radio system will be adopted. This is from the viewpoint of system compatibility with digital switching equipment to be introduced in the future.

As for transmission capacity, the main system will have capacity of 960 CH (68 Mbit/s) and the spur system 60/120 CH (4/8 Mbit/s). For part of spur systems, 60 or 120 CH analog system will be adopted for the purpose of compatibility with the existing analog system.

(3) Radio Frequency Bands

For the main system, radio frequency band of 6 GHz, upper band, will be assigned (CCIR Rec. 384-3) and for the spur system, 2 GHz band will be allocated (CCIR Rec. 283-4). For the analog system, 800 MHz or 400 MHz band assignment is scheduled.

(4) Power Supply System

Today, the failure rate of telecommunication equipment is extremely low, reflecting the technical advancement of electronic parts used in the equipment. At the same time, the importance of power supply system maintenance is increasing greatly among all kinds of routine maintenance services. Especially in the coverage area of the current plan, where radio stations are to be established on small islands difficult to access, selection of easily maintenable power supply system is of utmost importance.

This time, the solar battery system will be adopted. A system fit for power supply to radio stations, each with load power of 300 W or less, to be established in remote places, the solar battery system is expected to have its price reduced broadly in the near future.

The solar battery system requires considerably high initial cost. It nevertheless holds advantages. First, the access road to each radio station can be of simple build. Second, fuel supply for in-house power generation is not necessary.

To be noted is that for power supply to radio terminal stations, power supply system for switching equipment can be utilized, in principle.

(5) Station Building

In principle, radio terminal station equipment is to be installed in telephone exchanges.

Radio repeater station building is to be the shelter type. This is to reduce the construction period.

7. Construction Cost and Amount of Work

Construction period for this project is divided into two: Stage I and Stage II. This division is in consideration of the period of digitalization of switching equipment in the project area, as well as traffic forecast and domestic satellite communication network construction plan.

Stage I work initiation will be in 1986 and completion in 1989. For Stage II work, initiation will be in 1992 and completion in 1994.

The scheduled amount of work follows:

		Stage I	Stage II	Remarks
a)	6 GHz main system	16 sections	-	960 CH system (68 Mbit/s)
b)	2 GHz spur "	6 "	4 sections	60/120 CH system (4/8 Mbit/s)
c)	800 MHz spur "	3 "	-	120 CH system (analog system)
d)	400 MHz spur "	1 "	1 "	60 CH system (analog system)
e)	Entrance cable section	6 "	2 "	

Construction cost is as follows:

	Foreign Currency Portion (¥ million)	Local Currency Portion (Rp. million)
(In the case of Plan A and Plan B)		
Stage I work	4,628 (19,694)	2,878 (2,922)
Stage II work	732 (3,115)	417 (423)
Total	5,360 (22,809)	3,295 (3,345)
(In the case of Plan C)		
Stage I work	8,797 (37,434)	2,878 (2,922)
Stage II work	732 (3,115)	417 (423)
Total	9,529 (40,549)	3,295 (3,345)

Notes:

1. Parenthesized is the U.S. dollar equivalent (in US$ 1,000). The exchange rate used is Rp. 985 = ¥ 235 = US$ 1 (as of the upper part of November 1983).

2. Work cost estimation is at the price level as of the end of 1983.
   Equipment cost estimation is made by referring to export prices obtained from leading manufacturers in Japan.

3. Work contract is on turn-key basis.

4. Work cost quoted above includes contingency.
   Contigency does not include the price increase due to commodity price hike.

In Plan A and Plan B, radio equipment will have transmission capacity to meet circuit requirement as of 2010. Therefore, the amount of initial investment is the same. In Plan C, optical fiber cable will be used for the submarine cable (as is expected from the current trend of cable work technology). In this case, the minimum transmission capacity by far exceeds the required transmission capacity. Hence, the initial investment is bound to increase.

8. Financial and Economic Analyses

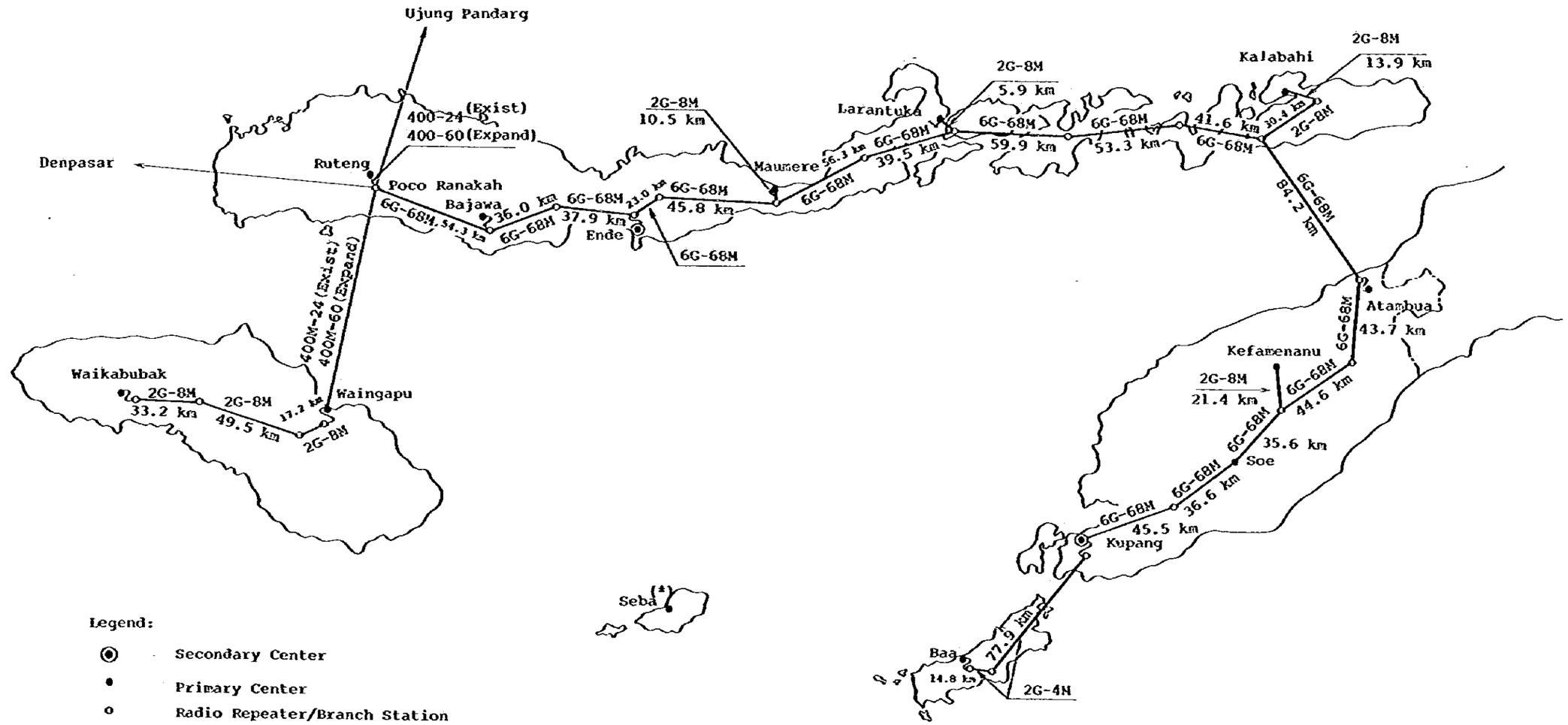
(1) Financial Analysis

For Plan A (project life: 15 years), Plan B (project life: 20 years) and Plan C (submarine cable system plan), calculation is made for profit ratio of total liabilities and net worth (Internal Rate of Return: IRR). Calculation results are 6.9%, 10.0% and 5.7%, respectively. Plan B makes the project feasible provided that the management of system operation is advisable.

Then, on the assumption that project implementation is financed with foreign loan of low interest rate, calculation is made for profit ratio of net worth. Calculation results are 12.5% for Plan A and 17.7% for Plan B. Thus, Plan B wherein the profit ratio of net worth exceeds the interest rate applicable to a loan which PERUMTEL may procure from local financial institution, proves to be financially feasible.

(2) Economic Analysis

Economic IRR of Plan B turns out to be 10.7%. This IRR allows appraisal that this project is feasible economically also, insofar as the minimum requirement is concerned. Furthermore, when the economic effect of this project that includes quantitatively immeasurable benefits of many kinds is taken into account, implementation of this project will make great contributions, to be sure, to the economic development of Nusa Tenggara area.



Legend:

- Secondary Center
- Primary Center
- Radio Repeater/Branch Station
- Planned Radio System
- Planned Entrance Cable System
- Existing Radio System

Note: Stations with (*) mark will be covered by the domestic satellite system (PALAPA System)

6G-68M: 6GHz(U), 68 Mbit/s sytem

2G-8M : 2GHz, 8 Mbit/s system

2G-4M : 2GHz, 4 Mbit/s system

Figure 1 (1/2) Transmission Route Map (Nusa Tenggara Timur: Plan A, Plan B)

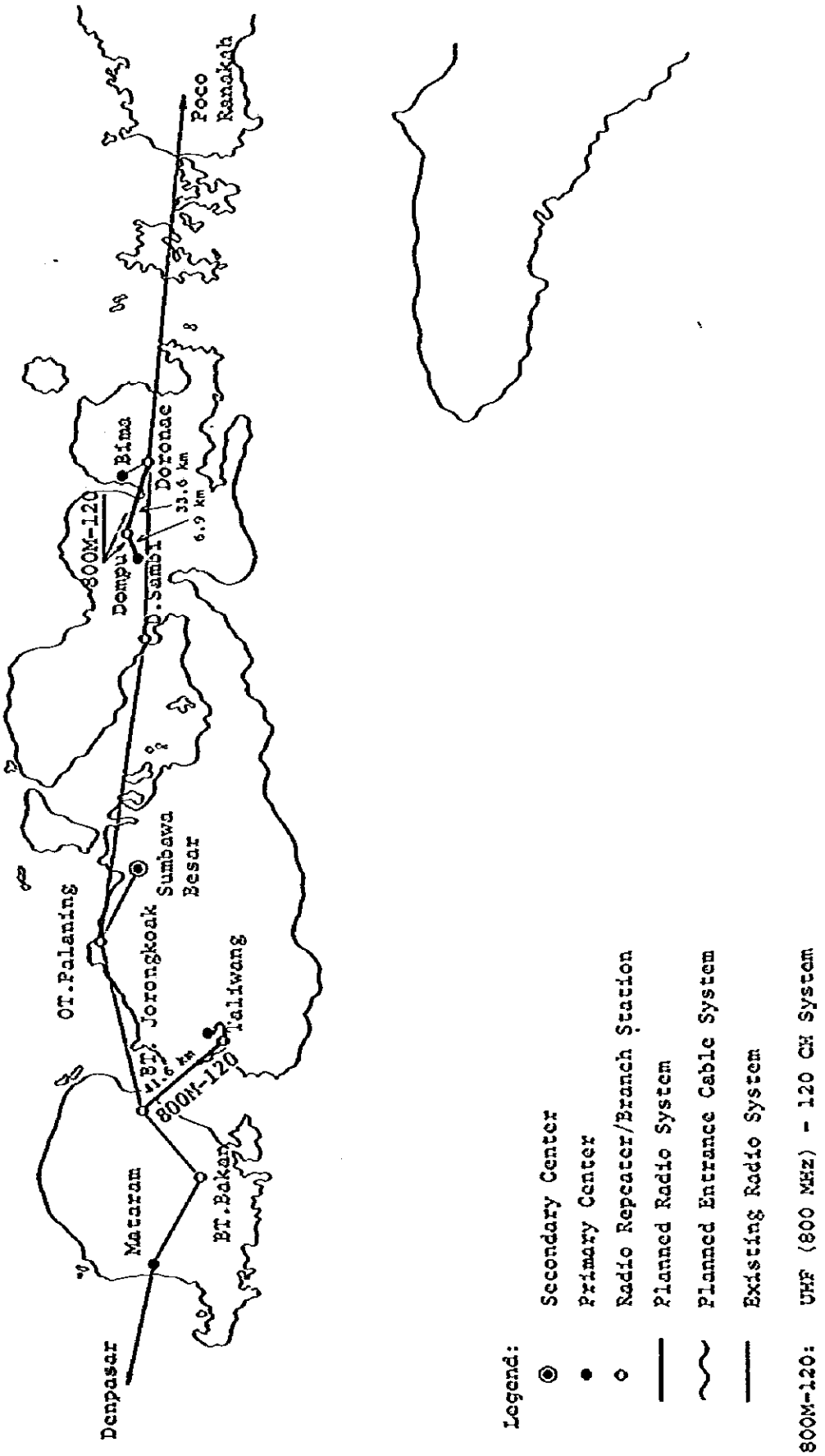
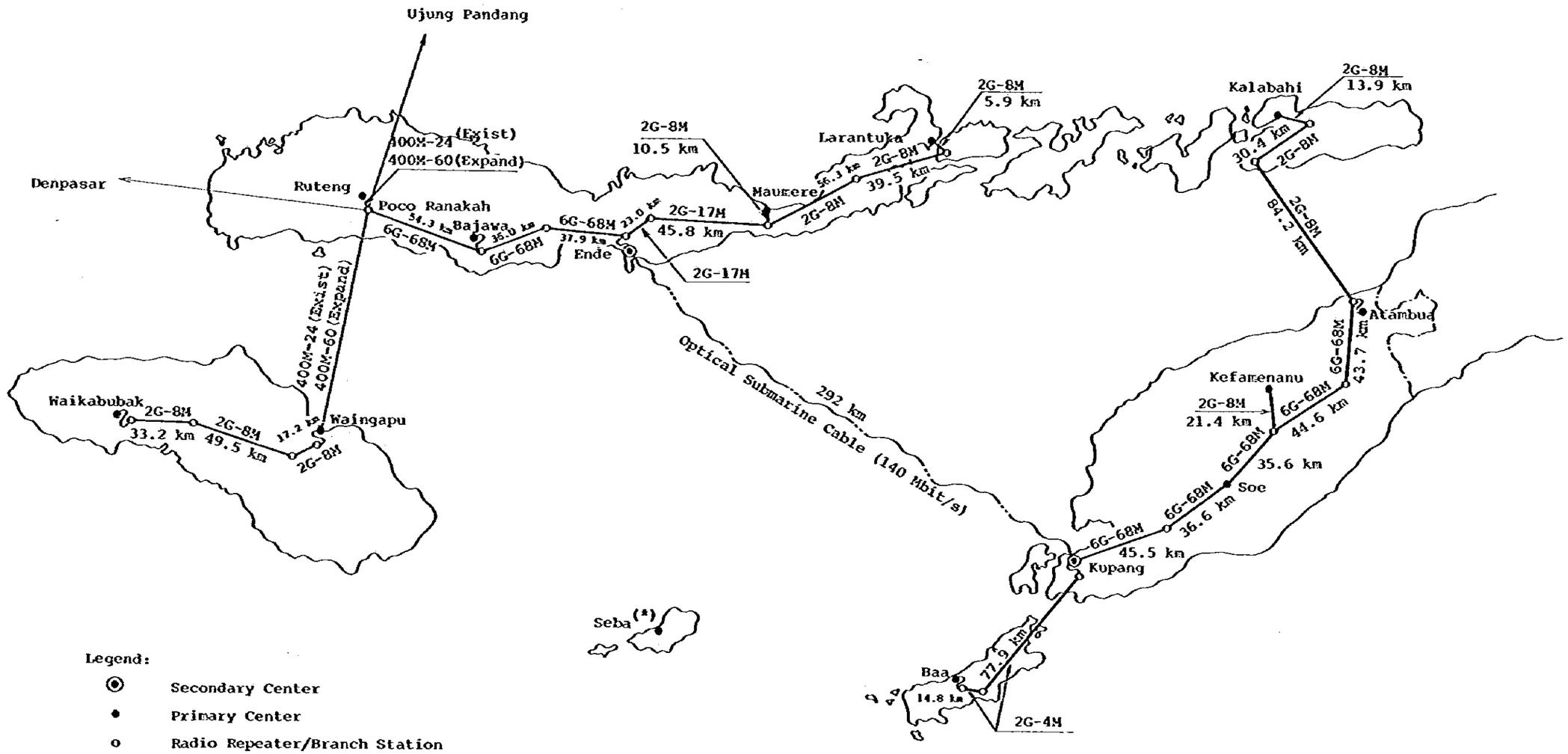


Figure 1 (2/2) Transmission Route Map (Nusa Tenggara Barat)



Legend:

- Secondary Center
- Primary Center
- o Radio Repeater/Branch Station
- Planned Radio Systen
- Planned Submarine Cable System
- Planned Entrance Cable System
- Existing Radio System

Note: Stations with (*) mark will be covered by the domestic satellite system (PALAPA System)

Figure 2 Transmission Route Map (Nusa Tenggara Timur: Plan C)

CONCLUSIONS AND RECOMMENDATIONS

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Nusa Tenggara area is located in the eastern part of Indonesia. It is one of the least developed areas in the nation. Nusa Tenggara Timur, the main area in the study area, is featured in its monocultural structure of economy. It supplies coffee, marine products and livestock to other countries and other parts of Indonesia; it procures agricultural and industrial products from external sources. Its economic development depends a great deal upon the promotion of commercial activities.

In Nusa Tenggara Timur area, telecommunication services are available in a limited number of cities only, and those services are via domestic satellite communication system. In other cities, the extremely restricted operation of HF system is the sole means of telecommunication. Inter-city or inter-island link in the economic aspect is weak, and this fact constitutes one of the major bottlenecks to achieve economic development of the area.

Therefore, it can be the conclusion of this study that, from the implementation of this project, the whole area will gain an important impetus toward dynamic economic development, enabling the population to have their life environment remarkably improved.

However, to implement this project, a large amount of fund is necessary. For fund procurement, it is recommended to take advantage of foreign loan of low interest rate.

Main technical conclusions of project implementation studies, as well as pertinent recommendations, are described below.

1. Terrestrial Transmission System Construction Plan

Study for the formulation of this construction plan covers all three plans mentioned below. From the economic viewpoint, the adoption of Plan B is desirable.

Plan A: To construct transmission system having transmission capacity commensurate with circuit requirement estimate as of the year 2005.

Plan B: To construct transmission system having transmission capacity commensurate with circuit requirement estimate as of the year 2010.

Plan C: To construct transmission system, adopting submarine cable link by optical fiber cable between Ende and Kupang.

Construction cost estimate for each plan is introduced in SUMMARY.

2. Transmission System to be Adopted

Digital transmission system is to be adopted for the terrestrial transmission network to be constructed by this project. For part of spur systems, analog transmission system is to be adopted for the purpose of compatibility with the existing system.

3. Extension of Existing Microwave System

After the completion of terrestrial transmission system projected this time, considerable traffic is expected between Kupang and Ende as Secondary Centers, on one hand, and Surabaya, the Tertiary Center, on the other.

At present, the microwave transmission system with 960 CH capacity is operating in Jakarta - Surabaya - Denpasar - Ujung Pandang section. At the end of 1983, one additional microwave transmission route of 1,260 CH system has been completed between Jakarta and Denpasar.

Nevertheless, after the completion of terrestrial transmission network in Sulawesi area and Nusa Tenggara area, the existing microwave transmission system covering east of Denpasar will prove its capacity to be deficient. There is need for considering system capacity expansion, based on all-round traffic estimate for Sulawesi and Nusa Tenggara areas.

4. Addition of Trunk Switching Function to Local Switching Equipment

According to Repelita IV (Fourth Five-year Plan to start in 1984) draft, digital switching equipment will be positively introduced in this project area also. In spite of local switching equipment digitalization, manual trunk switching will still be continued in several switching centers. It is preferable that those switching equipment are provided with trunk switching function.
The reasons are:

(1) Local switching centers scheduled to be digitalized can be considered to be trunk switching centers.

(2) Addition of trunk switching function will not require especially large financial investment.

(3) Terrestrial transmission network to be constructed by this project and digital trunk switching equipment are mutually approachable .

5. Promotion of Successful Call Rate Improvement

Field survey result shows that successful calls from this project area to another area are of considerably low rate. This is supposed to be the case with other areas also. Measures to improve the successful call rate should be promoted so that the transmission system can be effectively utilized.

6. Common Use of Telephone Exchange Facilities

Radio terminal equipment required in this project is to be installed in telephone exchanges, in principle.

Power consumption by radio equipment is extremely small, compared with the consumption by switching equipment, so that for power supply to radio equipment, no separate system will be established but the power supply system for switching equipment will be used for radio equipment also. Such shared use of power supply system must be taken into account in the telephone exchange design.

7. Construction Work Plan

Construction work is divided into Stage I and Stage II. This division is made in consideration of the period of telephone exchange innovation with digital switching system, the uptrend of trunk traffic, and the correlation with domestic satellite communication network. For work initiation period, however, there is need for readjustment after Repelita IV finalization.

8. Maintenance System

The project area, this time, consists of island group. This special situation must be duly considered when the maintenance system is established. It is preferable that the Maintenance Centers be established at Kupang and Ende and the Maintenance Sub-centers at Waingapu, Kalabahi and Larantuka, each to take care of maintenance of facilities in the island where it is located and in adjacent islets. Maintenance staff will assume duty at those Maintenance Centers and Maintenance Sub-centers so that for radio terminal stations, unattended maintenance can be administered.

9. Primary Power Supply System

For power supply system at stations where commercial power supply is not available and where load power requirement is 300 W or less, the solar battery system is preferable. The adoption of this system for power supply is preferred because, first, it can be procured at low price these days; second, it does not require fuel supply which is especially difficult at remote places; and third, its maintenance is easy.

10. Access Road

For stations in remote area or in mountain area, access road construction and maintenance cost usually occupies no small percentage out of total construction and maintenance cost.

In this project, it is preferable that access roads to be constructed for stations where the solar battery system will be adopted, be limited to footpaths, to start with, without carriageway construction.

11. Shelter Type Building

For the purpose of reducing the construction work period, all station buildings, except radio terminal stations to be accommodated in telephone exchanges, are to be the shelter type.

12. Radio Frequency Band Selection

In the terrestrial transmission system to be constructed by this project, radio frequency band of 6 GHz, upper band, will be assigned to the main system (960 CH, 68 Mbit/s) and 2 GHz band to the spur system (60/120 CH, 4/8 Mbit/s). For the analog system, assignment of 400 MHz band to 60 CH system and 800 MHz band to 120 CH system is preferred.

13. Synchronizing Signal

In the digital network composed of digital switching equipment and digital transmission system, network synchronization is mainly performed by switching system. Whatever the type of synchronizing system adopted between digital switching systems related to this project, synchronizing signal for transmission system is to be supplied from switching system.

14. Non-telephone Service Facilities

For non-telephone services, transmission facilities only are included in the amount of work, this time. That is to say, for all stations, up to voice channels calculated in the number of circuits required are to be installed in this project.

15. Training of Personnel

Digital transmission system is a new system to be introduced for the first time in this project area. Thus, for system operation as required and for maintaining of eminent tramsission performance, training of personnel to take care of digital system as state-of-the-art technology is indispensable.

This training should preferably be administered in two aspects: factory training by the Contractor and on-the-job training during the construction work period.

16. Employment of Consultant

For purposes of construction work progress as scheduled and facilitation of technology transfer to PERUMTEL personnel, employment of Consultant is preferred.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 Objective of Study

The objective of this study is to examine technical and economic feasibilities of the Nusa Tenggara Area Terrestrial Transmission Network Construction Plan, based on the request from the Government of Indonesia.

1-2 Scope of Study

The coverage area of this project comprises Nusa Tenggara Barat and Nusa Tenggara Timur. Figure 1 and Figure 2 present the route of terrestrial transmission system to be constructed.

Study items are threefold. First is the field survey for the purpose of formulation of the projected terrestrial transmission network plan. Second is the collection of necessary data. Third is the study report making in Japan. Technology transfer to the Counterparts selected and dispatched by PERUMTEL is also in the scope of this study.

Further included in the study is the investigation required in the case of submarine cable link between Ende and Kupang.

1-3 Background of Study

The Government of Indonesia requested the Government of Japan for assistance in the formulation of the Master Plan for terrestrial transmission network construction in the eastern part of the Republic (Sulawesi area, Nusa Tenggara Timur area, Timor Timur area, Maluku area and Irian Jaya area), subservient for Telecommunications Network Improvement and Expansion Plan for that part of the country.

The Government of Japan accepted the request and decided to carry out the study required. Based on this decision, Japan International Cooperation Agency (JICA) dispatched the preliminary study team in December 1981 and the field study team assigned to Master Plan formulation for a period of January through March 1982.

The field study team picked up Sulawesi area as an area requiring urgent feasibility study and Nusa Tenggara area as an area where to continue system improvement.

Thereupon, the Government of Indonesia requested the Government of Japan to carry out the feasibility study of Sulawesi area. The Government of Japan dispatched the feasibility study team for September through November 1982.

The Government of Indonesia then requested the Government of Japan to carry out the feasibility study of Nusa Tenggara area also. The preliminary study team was dispatched in March 1983, followed by the dispatch of the main study team in July, 1983.

1-4 Study Team Organization, Duty Lineup of Members

The study team was composed of 10 members. Names of members and their duty lineup appear in Table 1-1.

1-5 Study Itinerary

The field study was carried out from July 26 until September 23, 1983. Study itinerary and study sub-team organizations are shown in ANNEX-1. Data collected in the field study are listed in ANNEX-2.

1-6 Competent Indonesian Authorities and Personnel

Competent Indonesian authorities for implementation of this project are DITJEN POSTEL and PERUMTEL. DITJEN POSTEL belongs to the Department of Communications and Tourism of the Government of Indonesia. Personnel of these two organizations and of Japanese authorities in Indonesia, who participated in the field study, are as follows:

(1) Indonesia Side

1) DITJEN POSTEL

Mr. R.I. Soemardi Bc.T.T.	Director of Planning
Ir. Agus Darman	Chief of Sub-directorate for Telecommunication Technical Development
Mr. H.V.R. Saragih Bc.T.T.	Staff of Planning Division
Mr. Sutarto	"
Mr. Moher Malano	"

2) DEPARPOSTEL

Mr. Rai Sardjana Bc.T.T.	Staff
Drs. Soetomo	Staff of Bureau I

3) PERUMTEL

Mr. Roesmijanto Bc.T.T.	Chief of Terrestrial Transmission Planning Division C
Ir. Tjahjono D.H.	Chief of Terrestrial Transmission Planning Division B
Mr. Azwar Mohamad Bc.A.T.	Chief of Terrestrial Transmission Planning Division E
Drs. Sutjito Bc.T.T.	Chief of Capital Management Division
Ir. Budiwasisto	Staff of Coordination Planning Division
Mr. Yasin Rivai Bc.T.T.	Staff of Terrestrial Transmission Planning Division
Ir. Mulia Tambunan	Staff of Terrestrial Transmission Planning Division
Ir. Adi Prasetya	"
Mr. Jajat Suprijatna Bc.T.T.	"
Ir. Andreas Peranginangin	Staff of Satellite Transmission Planning Division
Ir. Iwan Krisnadi	"
Ir. Suradji	"
Ir. Mas'ud Bc.T.T.	Staff of Production Planning Division
Mr. Loeshir Arif JEC	Staff of Toll Exchange Planning Division
Ir. Dewi Arumi	Staff of Switching Planning Division
Ir. Gadang R.	Staff of Cable Planning Division

Mr. Soewito Bc.T.T.	Staff of Cable Planning Division
Drs. I. Nangah Seroma	Staff of Capital Management Division
Drs. Endang Rachmat	Staff of Financial Division

4) WITEL VIII

Ir. P. Soedarmadi Bc.T.T.	Regional Director of WITEL VIII
Mr.Soemartono	Chief of Transmission Technic Division
Mr. Sarbini Bc.T.T.	Chief of Telephone Technic Division
Mr. Ending Djukardi Bc.T.T.	Chief of Telegraph Technic Division
Mr. Ranief Bc.T.T.	Chief of Operation/Traffic Division

5) WITEL V

Ir. Abdul Muhaimin	Regional Director of WITEL V

(2) Japan Side

Mr. Yasuo SUZUKI	First Secretary, Embassy of Japan, Jakarta
Mr. Tatsuichi HIDAKA	Resident Representative, Jakarta Office, Nippon Telegraph & Telephone Public Corporation (NTT)
Mr. Takao IWASHIMIZU	Leader, Japan Telecommunications Mission (JTM)
Mr. Ken INOMATA	Assistant Resindent Representative, Jakarta Office, JICA

Table 1-1 Number of Feasibility Study Team

Name	In charge of	Affiliated to
Junichi IKEJIMA	Leader (First Stage)	Project Director, Planning and Coordination, International Cooperation Division, Ministers Secretariate, Ministry of Posts and Telecommunications
Akira AIKEI	Leader (Middle and Last Stages)	Senior Advisor, International Affairs Division, Telecommunication Policy Bureau, Ministry of Posts and Telecommunications
Kazutomo OSAWA	Sub-leader (Network Engineering)	Senior Staff Engineer, International Affairs Bureau, Nippon Telegraph & Telephone Public Corporation (NTT)
Takashi SUZUKI	Survey Leader (Radio Engineering)	Deputy General Manager, International Operation Division, The Nippon Telecommunications Consulting Co., Ltd. (NTC)
Kazuo HORITA	Radio Engineering	Assistant to General Manager, International Operation Division, NTC
Kinya SUZUKI	Submarine Cable Engineering	Assistant to General Manager, International Operation Division, NTC
Satoru KUSHIDA	Transmission Engineering	Assistant Manager, Engineering Section, International Operation Division, NTC
Junichi KOMADA	Traffic and Switching Engineering	Staff, Engineering Section, International Operation Division, NTC
Yoshihide HIRATA	Outside Plant Engineering	Staff, First Division Department, Communication Engineering Division, NTC
Nikio DANON	Economic Analysis	Economist, Marketing Department, International Operation Division, NTC

Name	In charge of	Affiliated to
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CHAPTER 2

TELECOMMUNICATIONS IN NUSA TENGGARA AREA

CHAPTER 2 TELECOMMUNICATIONS IN NUSA TENGGARA AREA

2-1 Overview of Nusa Tenggara Area

Nusa Tenggara area, the objective area of this study, is located in an island chain extending from Lombok Island to Timor Island in the eastern part of Indonesia.

Nusa Tenggara area is divided into two provinces by the administrative boundary: Nusa Tenggara Barat Province and Nusa Tenggara Timur Province. The former comprises six prefectures (Kabupatens) including Lombok Island and Sumbawa Island. The latter comprises 12 prefectures including Flores Island, Sumba Island and Timor Island.

The capital city of Nusa Tenggara Barat Province is Mataram on Lombok Island. Kupang on Timor Island is the capital city of Nusa Tenggara Timur Province.

(1) Nusa Tenggara Barat Province

Nusa Tenggara Barat Province embraces 20,177 km^2 in total land area. This corresponds to about 1% of the whole of Indonesia. The population numbers about 2,700,000 as of 1980. This occupies a share of about 1.8% out of the whole population of Indonesia. The population density stands at 135 persons/km^2 or greater than the national average of 77 persons/km^2. In three prefectures on Lombok Island, the population density even exceeds 200 persons/km^2.

The annual population growth rate during 1961-1971 is 2.02% on average. This growth rate is lower than the corresponding rate for the whole of Indonesia.

However, for the next decade of 1971-1980, the average annual growth rate marks 2.36%. This rate is higher, though slightly, than the corresponding rate of 2.32% for the whole of Indonesia. In Lombok Barat and Dompu Prefectures, in particular, the growth rate is higher than in other prefectures.

Main industries are rice growing, forestry and coffee plantation. Timber export accounts for about 40% and coffee export about 30% out of their respective gross exports of the Province. Rice, soybeans and tobacco are supplied to other areas of the country.

Component ratios of gainfully occupied population by industrial sectors consist of 54% in agriculture, 12% in manufacturing, and 26% in trade and services.

GRDP (Gross Regional Domestic Product) growth rate in five years period of 1975-1979 is by 7% on annual average. As of 1980, it amounts to Rp. 14,395 million. The annual growth rate of 7% falls short of the corresponding growth rate of 7.8% for the whole of Indonesia. GRDP per capita amounting to Rp. 49,154 as of 1979 is also smaller than the national average.

GRDP component ratios by sectors as of 1975 comprise 60.4% in agriculture, 3.6% in mining/manufacturing, and 36% in trade/services. As of 1980, these are 52.3%, 11% and 36.7%, respectively. Growth in mining/manufacturing is conspicuous.

Infrastructures mainly consist of roads and harbors. Especially on Lombok Island, both these facilities are well maintained. So is the national highway on Sumbawa Island also.

The Fourth Five-year Plan of the Province (Repelita IV) itself places emphasis on improvement of secondary and feeder roads, as well as improvement and expansion of harbor facilities. This is for the purpose of provincial export promotion and tourism development.

Also planned in Repelita IV is to transmigrate inhabitants from overpopulated Lombok Island to underdeveloped Sumbawa Island. Planned development areas on Sumbawa Island center upon the cities of Bima, Dompu, Bades and Sumbawa Besar.

(2) Nusa Tenggara Timur Province

Nusa Tenggara Timur Province embraces 47,876 km^2 in total land area. This corresponds to about 2.5% of the whole territories of Indonesia. The population numbers about 2,700,000 as of 1980 or practically the same as in Nusa Tenggara Barat Province.

The population density registers 57 persons/km^2 or smaller than the national average of 77 persons/km^2. Sikka is the sole prefecture where the population density exceeds 100 persons/km^2.

The population growth rate during 1961-1971 is 1.57% in annual average. For 1971-1980, the corresponding growth rate is 1.95%. Both are considerably below the national average of 2.32%. Prefectures where the growth rate exceeds the national averages are only three, i.e., Kupang, Sumba Barat and Manggarai.

The major part of population by religion are Christians. Catholics account for 53% and Protestants, 29%. The percentage of Christians is higher than in other areas. The Muslim population makes only 1% minority. Catholics are concentrated on Flores Island and Protestants on Sumba Island and Timor Island.

In this Province, main industries are coffee plantation, livestock farming, fishery and copra cultivation. Coffee is mainly for export. Export record as of 1980 occupies 92% majority out of total export of the Province. Domestic supply consists of livestock (oxen and horses) and copra.

Component ratios of gainfully occupied employment population by industrial sectors break down to 77% in agriculture, 9% in manufacturing and 9% in services.

GRDP as of 1980 amounts to Rp. 144,730 million. Growth rate in five years period of 1975-1979 is 8.2% in annual average. This growth rate is somewhat higher than the corresponding growth rate for the whole of Indonesia. Compared with Nusa Tenggara Barat Province, the growth rate is lower in 1975 but in 1980 the absolute value is greater. Thus, GRDP per capita also is at a high level of Rp. 52,876.

GRDP component ratios by industrial sectors as of 1975 comprise 69.07% in agriculture, 4.84% in mining/manufacturing, and 26.09% in trade/services. As of 1980, these are 57.08%, 6.42% and 36.86%, respectively. Growth in trade/services stands out. Especially noteworthy is the growth in public administration sector and transportation/communication sector.

Above may presumably be attributed to the monocultural structure of economy to import in agricultural products, such as rice, and industrial products, such as cement and iron, by exporting coffee and livestock.

In this Province also, infrastructures mainly consist of roads and harbors. On Flores Island and Sumba Island, highways exist but, except for limited sections, are incomplete. Maintenance is especially defective.

Harbor facilities are established mainly at Tenau near Kupang and in Maumere, Waingapu, Atapupu, Reo and Ende also. By the Fourth Five-year Plan of the Province (Repelita IV), this Province emphasizes on agricultual development and intra-area transportation improvement. More precisely, road from Maumere to Reo and road from Tenau to Kupang are planned to be improved, and harbor, as well as commercial, facilities are also to be improved for the purpose of Surabaya-Lembar-Tenau-Atapupu and Surabaya-Lembar-Reo-Maumere sea route expansion.

For industrial development, Maumere and Kupang are planned as a growth pole, the former to promote cotton industry and the latter to strengthen chemical industry.

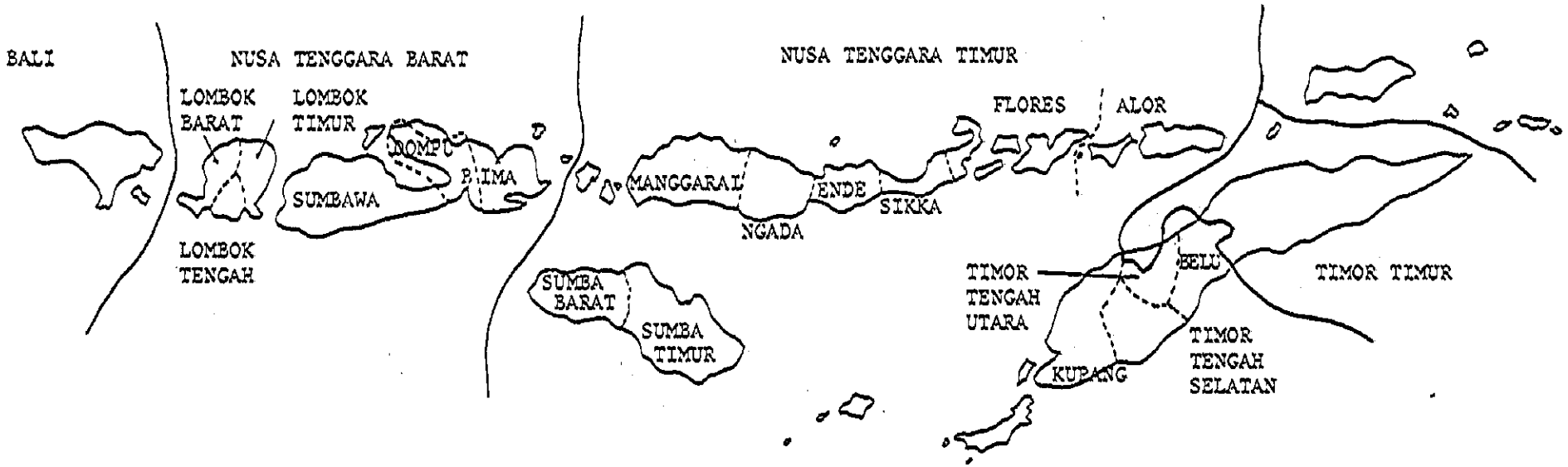


Figure 2-1 Administrative Map of Nusa Tenggara Area

Table 2-1 Economic Indicator of Nusa Tenggara Area

	Total Land Area (km^2)	Year	Population	Population Density ($/km^2$)	Annual Increase of Population (%)	Year	GRDP at Constant 1975 (Million Rp)	Annual Increase of GRDP (%)	GRDP per Capita (Rp)
Nusa Tenggara Timur	47,876	1961	1,967,297	41	-	1975	93,487.21	-	38,713
		1971	2,295,287	48	1.57	1979	128,138.36	8.2%	48,784
		1980	2,737,166	57	1.95	1980	144,729.7	-	52,876
Nusa Tenggara Barat	20,177	1961	1,807,830	90	-	1975	100,634.5	-	41,405
		1971	2,203,465	109	2.02	1979	131,762.6	7%	49,154
		1980	2,724,664	135	2.36	1980	143,905.4	-	52,816
Indonesia	1,919,443	1961	97,085,348	51	-	1975	12,696,847.2	-	-
		1971	119,208,229	62	2.1	1979	17,146,609.19	7.8%	-
		1980	147,490,298	77	2.32	-	-	-	-

Source: DALAM ANGKA NTB 1980, NTT 1980
STATISTICAL YEAR BOOK OF INDONESIA 1982

2-2 Actual Situation of Telecommunications

2-2-1 Telephone Service

For switching centers taken up for study in this project, the distribution map appears in Figure 2-2. The list of those switching centers is in Table 2-2. Local exchanges in Nusa Tenggara area are also included in the distribution map and list.

As seen in the table, telephone service in this project area is manual service to a great extent. Service capacity of manual exchange is of relatively small scale for the most part.

Many exchanges in the local switching network are without subscriber lines commensurate with switching equipment capacity. This fact probably constitutes the primary impediment to telephone service diffusion in the area. Especially in Larantuka and Waikabubak Exchanges, though the trunk manual board is installed, no subscriber line installation exists at all.

In Waingapu Exchange, subscriber lines are installed, however, the operation is under the resposibility of the local autonomy. Trunk manual board only is under the control of PERUMTEL.

(1) Telephone Density

Nusa Tenggara is one of the areas in Indonesia where telecommunications service is least developed. According to Bureau of Statistics data, the telephone density in the area as indicated by the number of telephones installed per 100 inhabitants is 0.109 as of 1980 against the national average of 0.348.

However, the growth rate of telephone installations in the area during four years from 1977 through 1981 is about 15% in the annual average. This growth rate exceeds, though slightly, the corresponding national average growth rate of 14%. This can be considered to reflect the qualitative improvement of telephone service by reason of service-in of satellite system earth stations constructed in various places during the past several years.

Latest data collected in the field survey, this time, also indicate the continued growth of telephone density in the area. That is to say, according to these data, the telephone density as of July 1983 is 0.140.

(2) Telephone Automatization Ratio

Out of 19 Secondary and Primary Centers located in this project area, only three have the automatic switching equipment introduced up to the present. Therefore, subscriber's long distance dialling service is available to subscribers of these three exchanges only. All automatic switching equipment so far installed is of crossbar type. The three exchanges are:

Secondary Centers:	Sumbawa Besar, Kupang
Primary Center:	Mataram

When the number of subscribers is taken into account, the local automatization ratio at the present stage is 57%.

According to PERUMTEL's Repelita IV draft, all the three exchanges are to be provided with digital switching equipment also by the year 1989. In several other exchanges, manual board replacement with digital switching equipment is scheduled.

When Repelita IV comes to a successful conclusion, the automatization ratio of all local switching equipment in the country will attain to 97.5%, and this almost completely realizes automatic switching service in the national network. In this project area, however, the automatization ratio will still be not higher than 86.9%.

2-2-2 Non-telephone Services

Non-telephone services being offered in Nusa Tenggara area comprise telegram service, telex service and leased circuit service. Table 2-3 presents the number of terminal equipment installed for non-telephone services in the area. The number of equipment is part of data obtained in the field survey, this time.

(1) Telegram Service

Telegram offices located in main cities of the country are connected to the gentex network through gentex exchanges. In Nusa Tenggara area, no gentex exchange exists so that all gentex terminals are accommodated in the gentex switching equipment installed in Denpasar. Meanwhile, at telegram offices without gentex terminals, service utilizing HF system is provided.

The number of telegram messages handled per 1,000 inhabitants is 47 in the annual national average as of 1981. The corresponding number in Nusa Tenggara area stands at 64, broadly exceeding the national average. This fact is considered to indicate that in spite of the low telephone density, the potential demand for telecommunications service itself is large.

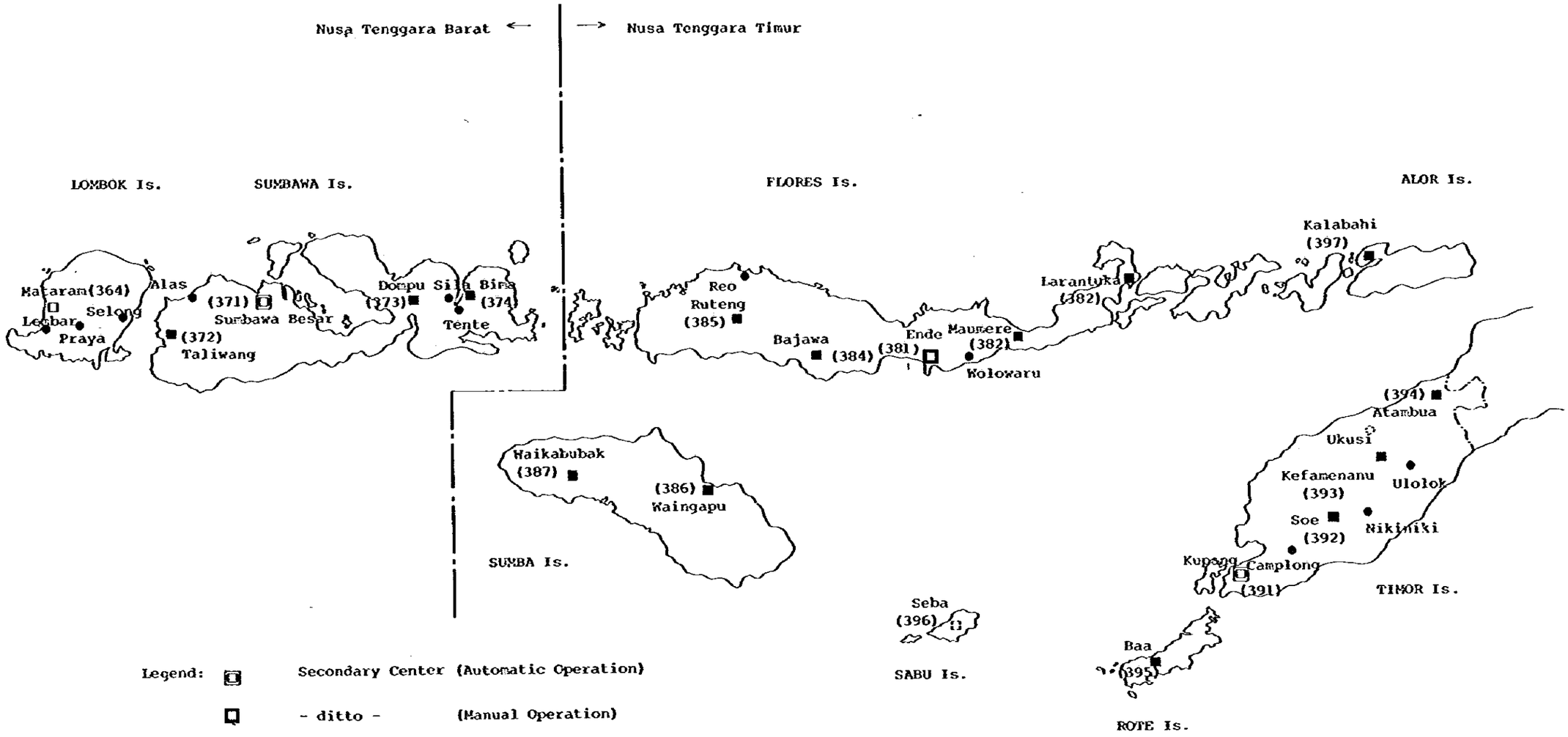
(2) Telex Service

Telex terminals also, like gentex terminals, are accommodated in gentex exchanges and organize the nationwide network. Naturally, telex terminals in Nusa Tenggara area are accommodated in gentex switching equipment installed in Denpasar.

As seen in Table 2-3, the number of telex terminals in Nusa Tenggara area is not very large. They are mainly located in Mataram and Kupang, the capital cities of Nusa Tenggara Barat and Nusa Tenggara Timur, respectively.

(3) Leased Circuit Service

Leased circuit service offered in Nusa Tenggara area is of the lease of transmission circuits only. Circuits thus offered are utilized as point-to-point telegraphic circuits.



Legend:

▣	Secondary Center	(Automatic Operation)
▣	- ditto -	(Manual Operation)
□	Primary Center	(Automatic Operation)
■	- ditto -	(Manual Operation)
▯	- ditto -	(Not Installed)
●	Local Exchange	(Manual Operation)
○	- ditto -	(Not Installed)

Note: Parenthesized figures show Area Codes.

Figure 2-2 Location of Trunk/Local Exchanges

Table 2-2 (1/4) Exchange List

(As of 1983, Mataram Primary Area)

Area Code	Exchange Name	Switching System		Sub. Cable Capacity	Transmission System	Number of Subscribers	Waiting Applicants	Remarks
		Type	Capacity					
364	Mataram	PCM1000C	3,000	3,860	MW/SBS	2,727	805	Digital ESS: Under Planning within Repelita IV
	Lembar	ABK	40	60		26	13	
	Selong	ABK	400	300		230	33	Digital ESS and SBK: Under Planning within Repelita IV
	Praya	ABK	400	300		202	103	SBK: Under Planning within Repelita IV

Table 2-2 (2/4) Exchange List

(As of 1983, Sumbawa Besar Secondary Area)

Area Code	Exchange Name	Switching System		Sub. Cable Capacity	Transmission System	Number of Subscribers	Waiting Applicants	Remarks
		Type	Capacity					
371	Sumbawa Besar	PC1000C	1,000	639	MW	599	57	Digital ESS: Under Planning within Repelita IV
	Alas	ABK	200	154		154	8	SBK: Under Planning within Repelita IV
372	Taliwang	ABK	140	90		87	0	
373	Dompu	ADK	300			223	100	SBK: Under Planning within Repelita IV
374	Bima	ADK + ABK	800		MW	739	111	Digital ESS: Under Planning within Repelita IV
	Tente	ABH	50			47		
	Sila		40			24		

Table 2-2 (3/4) Exchange List

(As of 1983, Ende Secondary Area)

Area Code	Exchange Name	Switching System		Sub. Cable Capacity	Transmission System	Number of Subscribers	Waiting Applicants	Remarks
		Type	Capacity					
381	Ende	ABK + ABJ	600	540	SBK	367	115	Digital ESS: Under Planning within Repelita IV
	Wolowaru	ABK	50	20		10	0	
382	Maumere	ABK	300	310	SBK	293	170	C.B. Manual Board with 550 L.U.: Under Installation
383	Larantuka	ABJ	100	0	SBK	0	80	No Local Network
384	Bajawa	ABK	200			0	199	Under Final Test
385	Ruteng	ABK	350	300		296	87	CB Manual Board with 480 L.U. or Digital ESS: Under Planning within Repelita IV
	Reo	ABK	100	90		69	12	
386	Waingapu	ABK	300		SBS	245	140	Local Network: Under Government Control
387	Waikabubak	ABJ	100	0	SBK	0		No Local Network

Table 2-2 (4/4) Exchange List

(As of 1983, Kupang Secondary Area)

Area Code	Exchange Name	Switching System		Sub. Cable Capacity	Transmission System	Number of Subscribers	Waiting Applicants	Remarks
		Type	Capacity					
391	Kupang	PCL000C	1,426	3,000	SBS	1,367	252	Digital ESS: Under Planning within Repelita IV
	Camplong	CTD	20	20		10	0	
392	Soe	ABK	100	180		95	66	SBK: Under Planning within Repelita IV
	Nikiniki	ABH	50	20		14	7	
393	Kefamenanu	ADK	100	120		94	61	Digital ESS and SBK: Under Planning within Repelita IV
	Ulolok	CTD	20	10		4	4	
	Ukusi	-	-	-		-	-	Digital ESS: Under Planning
394	Atambua	ABK + ABJ	200	260	SBK	188	40	
395	Baa	ABH	100	125		24	10	
396	Seba	-	-	-		-	-	SBK: Under Planning within Repelita IV
397	Kalabahi	ABK + ABJ	100	100	SBK	98	68	Handed over from Government in 1966

Table 2-3 Status Quo of Non-telephone Services

(As of 1983)

Service / Area	Gentex Terminals	Telex Lines	Leased Circuits
Mataram	5	17 (12)	2
Sumbawa Besar	3	2 (1)	(1)
Bima	3	2	-
Ende	2	-	-
Ruteng	-	(3)	-
Waingapu	2	1	-
Kupang	5	19 (11)	3
TOTAL	20	41 (27)	5 (1)

Note: Parenthesized figures show waiting applicants.

2-2-3 Status Quo of Trunk Transmission Network

The terrestrial transmission network in Nusa Tenggara area consists of main route and two spur routes. Main route is composed of Eastern Microwave System that extends from Denpasar, Bali Island, to Ujung Pandang, Sulawesi Island, traversing Nusa Tenggara Barat and proceeding by way of Poco Ranakah, Flores Island, repeater station. Two spur routes, one to Ruteng and the other to Waingapu, branch from the main route at Poco Ranakah repeater station.

Out of all objective exchanges of this project, exchanges covered by the existing terrestrial transmission network are the following five:

(1) Nusa Tenggara Barat Area

- Mataram (on main route)
- Sumbawa Besar (on main route)
- Bima (on main route)

(2) Nusa Tenggara Timur Area

- Ruteng (on spur route)
- Waingapu (on spur route)

In Nusa Tenggara area, in addition to the terrestrial transmission network mentioned above, the transmission route utilizing the domestic satellite communication system is also established. Exchanges covered by the satellite transmission system are:

(1) Nusa Tenggara Barat Area

- Mataram

(2) Nusa Tenggara Timur Area

- Ende
- Maumere
- Larantuka
- Waingapu
- Waikabubak
- Kupang
- Atambua
- Kalabahi

All other exchanges are not included in the trunk transmission network. Telegram service by HF system is the sole telecommunication service that is offered by those exchanges.

CHAPTER 3

DEMAND FORECAST AND TRAFFIC FORECAST

CHAPTER 3 DEMAND FORECAST AND TRAFFIC FORECAST

PERUMTEL has formulated the Long Term Plan, a long term improvement and expansion plan for telephone and non-telephone services. Repelita IV, the Fourth Five-year Plan to start in 1984, marks one step to achieve the long term objectives. Its formulation is now in the final stage.

For a long term plan having Nusa Tenggara Timur included in the coverage area, the Master Plan is available.

Thus, for demand forecast and traffic forecast, information contained in the abovementioned data is taken into full account. At the same time, the forecasted demand and traffic are checked and reviewed with the aid of new data obtained in the field survey. Demand forecast for telecommunication services is made from macroscopic and microscopic viewpoints.

Each forecast is made for every five years beginning in 1990. This is in consideration of requirements relating to the transmission system construction plan. The final year of all forecasts is set for 2010 with a view to study of alternative plans.

3-1 Macroscopic Forecast

3-1-1 Telephone Service

Results of macroscopic demand forecast for telephone service are given in Table 3-1.

(1) Method of Forecast

Intimate correlation between telephone density and economic indexes is a proven fact. For macroscopic demand forecast for telephone service, regression analysis utilizing that correlation is effective. Here, regression analysis is made, using the number of telephone sets installed per 100 inhabitants for the telephone density and GDP per capita for the economic index.

Correlation between telephone density and GDP per capita, based on latest data in 60 countries, is graphically presented in ANNEX-6.
The regression formula that can be obtained from that correlation is:

$$Y = 0.000286 \cdot X^{1.27}$$

(Correlation coefficient: 0.96)

where

Y : Number of telephone sets installed per 100 inhabitants

X : GDP per capita
(Based on price level as of 1980. Given in U.S. dollars.)

Using this regression formula, first, the nationwide macroscopic demand forecast for telephone service was made; then, from this nationwide forecast result, the macroscopically forecasted demand value for Nusa Tenggara area was calculated. The demand distribution ratio of the area, calculated from the telephone expansion program (as of 1989) by Repelita IV, is 1.14%. This demand distribution ratio of 1.14% is considered not to vary broadly in the future, so that it was used to obtain the macroscopically forecasted telephone demand value for Nusa Tenggara area.

(2) Population Forecast

As regards the population trend in Indonesia, Bureau of Statistics estimates up to the year 2001 are available. These estimates are used in the Master Plan. In Repelita IV draft, however, the Bureau of Statistics estimates are revised, where necessary, based on the 1980 census result. In this study, the Repelita IV forecast is adopted. Details of forecast by Repelita IV are attached as ANNEX-7.

(3) GDP Growth Estimate

The past trends of GDP growth in Indonesia are given in Table 3-2.

During eight years from 1973 to 1981, the real growth rate of GDP in Indonesia remained at a high level of about 7.5% annually. This high growth rate of GDP attests to the steady economic development of Indonesia.

In the Long Term Plan, the GDP growth rate of 7.0% in real terms is upheld as a guideline for reasonable national economic development up to the year 2000. Here, the study is made for the following three cases:

A. Real growth rate of GDP: 7.5%
(This represents the optimistic consideration that the high growth rate will continue.)

B. Real growth rate of GDP: 7.0%

C. Real growth rate of GDP: 6.5%

(This represents the pessimistic consideration taking into account the global trends of economy.)

Table 3-1-1 Estimated Gross Domestic Product and Population in Whole Indonesia

GDP Growth Rate	Item \ Year	(1980)	1990	1995	2000	2005	2010
6.5%	GDP in US$ (x 10^6)	69,800	131,024	179,514	245,950	336,973	461,682
	GDP per Capita in US$	471.4	727.4	908.8	1,142.9	1,450.7	1,845.0
7.0%	GDP in US$ (x 10^6)	69,800	137,307	192,580	270,104	378,834	531,335
	GDP per Capita in US$	471.4	762.3	974.9	1,255.1	1,630.9	2,123.3
7.5%	GDP in US$ (x 10^6)	69,800	143,860	206,530	296,500	425,664	611,096
	GDP per Capita in US$	471.4	798.7	1,045.6	1,377.8	1,832.5	2,442.1
Estimated Population (x 10^3)		148,055.2	180,124.8	197,530.6	215,197.2	232,285.4	250,237.3

Note: GDP per Capita at Constant Price in 1980

Table 3-1-2 Estimated GDP per Capita and Number of Main Telephones in Whole Indonesia

GDP Growth Rate	Item \ Year	(1980)	1990	1995	2000	2005	2010
6.5%	GDP per Capita in US$		727.4	908.8	1,142.9	1,450.7	1,845.0
	Main Telephones/100 Inhabitants		1.23	1.64	2.19	2.96	4.02
	Total No. of Main Telephones (x 10^3)		2,215.5	2,239.5	4,712.8	6,875.7	10,059.5
7.0%	GDP per Capita in US$		762.3	974.9	1,255.1	1,630.9	2,123.3
	Main Telephones/100 Inhabitants		1.31	1.79	2.46	3.44	4.80
	Total No. of Main Telephones (x 10^3)		2,359.6	3,535.8	5,293.9	7,990.6	12,011.4
7.5%	GDP per Capita in US$		798.7	1,045.6	1,377.8	1,832.5	2,442.1
	Main Telephones/100 Inhabitants		1.39	1.95	2.77	3.99	5.74
	Total No. of Main Telephones (x 10^3)		2,503.7	3,851.9	5,961.0	9,268.2	14,363.6

Note: GDP per Capita at Constant Price in 1980

Table 3-1-3 Macroscopic Telephone Demand Forecast in Whole Indonesia and Nusa Tenggara Area

GDP Growth Rate	Item \ Year	(1980)	1990	1995	2000	2005	2010
6.5%	Nusa Tenggara Area		25,300	36,900	53,700	78,400	114,700
	Whole Indonesia		2,215,500	3,239,500	4,712,800	6,875,700	10,059,500
7.0%	Nusa Tenggara Area		26,900	40,300	60,400	91,100	136,900
	Whole Indonesia		2,359,600	3,535,800	5,293,900	7,990,600	12,011,400
7.5%	Nusa Tenggara Area		28,500	43,900	68,000	105,700	163,700
	Whole Indonesia		2,503,700	3,851,900	5,961,000	9,268,200	14,363,600

Table 3-2 Gross Domestic Product

Year	Gross Domestic Product in Billion Rupiahs		Growth Rate (%)
	Current Price	1973 Constant Price	
1973	6,753.4	6,753.4	-
1974	10,708.0	7,269.0	7.63
1975	12,642.5	7,630.8	4.98
1976	15,466.7	8,156.3	6.89
1977	19,010.7	8,870.9	8.76
1978	19,367.6	9,566.5	7.84
1979	27,146.8	10,164.9	6.26
1980	38,820.3	11,169.2	9.88
1981	46,355.2	12,017.4	7.59

Source: Statistik Indonesia 1979/1980
Statistik Indonesia 1982

3-1-2 Non-telephone Services

Results of macroscopic demand forecast for various kinds of non-telephone services are given in Table 3-3.

(1) Telegram Service

Annual growth trends in the number of telegram messages handled during the period from 1976 to 1981 are given in Table 3-4.

The number of telegram messages per year in the whole of Indonesia records an about 10% growth. The corresponding growth rate in WITEL VIII district that includes Nusa Tenggara area is about 14%, exceeding the national average.

Generally, telegram service is the kind of service that can be replaced by telephone service to a great extent. In other words, the high growth rate of telegram service in WITEL VIII district is due to the extremely low telephone density in the district, especially in Nusa Tenggara area. Considering that it will be considerable time before the telephone density in Nusa Tenggara area reaches the national level, the high growth rate of telegram service in the area will continue for some time to come. Only after the saturation of such growth potential, the growth tempo will begin to slow down.
In this study, the annual growth rate of telegram service in WITEL VIII district is set at 14% up to 1984, 10% for 1984-1989, 6% for 1989-1994, and 3% for 1994-1999, with the growth trend reaching the saturation point in 1999. The setting of these growth rates is in due consideration of the growth rates used in the Master Plan.

About 50% of telegram messages in WITEL VIII district are concentrated in Nusa Tenggara ares, so that this 50% value is regarded as the number of telegrams annually handled in Nusa Tenggara area.

(2) Telex and Leased Circuit Services

Demand for telex terminals is estimated in the Long Term Plan also. This demand estimate is adopted in the Master Plan. (Refer to ANNEX-8.)

The number of telex terminals as of July 1983, made known by the field survey, includes 180 terminals in WITEL VIII district, and out of these 180, 41 are in Nusa Tenggara area. These figures coincide with the corresponding figures used in the Long Term Plan. Hence the judgment that the Long Term Plan figures can be used for planning up to 1999.

Part of demand for telex service will possibly be diverted to newly introduced services, and this is why the telex service growth rate after 1999 is set at 6% annually.

For telex service demand distribution to Nusa Tenggara area, calculation is made, using the present concentration ratio of the area (23%).

Demand for point-to-point telegraphic service utilizing leased circuits can be estimated at about 10% of the existing number of telex terminals. Therefore, the demand for leased circuit service is set at the value equal to 10% of the sum total of telex terminals in Secondary areas (in Primary area, in the case of Mataram).

(3) New Services

New services will mainly consist of data communication and facsimile. As in the case of telex service, principal users will be government and public offices and commercial business organizations.

Demand forecast is extremely difficult at the present stage because of the lack of service records whereby to make forecast.

In this study, 20% of demand estimated in WITEL VIII district is allocated to Nusa Tenggara area. This arrangement is based on the number of terminals and the growth rate of new services used in the Master Plan.

Table 3-3 Macroscopic Demand Forecast for Non-telephone Services in Nusa Tenggara Area

Service	Area	Year				
		1990	1995	2000	2005	2010
Telegram Messages per Year ($\times 10^3$)	Nusa Tenggara	571.3	742.8	836.0	836.0	836.0
	WITEL VIII	1,142.5	1,485.8	1,672.0	1,672.0	1,672.0
Telex Lines	Nusa Tenggara	86	130	191	256	341
	WITEL VIII	370	564	827	1,106	1,481
Leased Circuits	Nusa Tenggara	10	16	21	28	36
	WITEL VIII					
New Services	Nusa Tenggara	7	17	38	90	224
	WITEL VIII	25	70	160	450	1,120

Table 3-4 Number of Telegram Messages

Year	Indonesia	WITEL VIII	Remarks
1976	4,470,639	237,958	
1977	4,754,933	273,309	Annual Growth Rate
1978	5,212,696	326,244	Whole Indonesia: 10%
1979	5,771,171	347,456	WITEL VIII : 14%
1980	6,687,043	406,508	
1981	7,104,451	451,650	

Source: Statistik Indonesia 1979/1980
Statistik Indonesia 1982
Statistik Telecomunikasi 1979, 1980 and 1981

Table 3-5 Estimated Number of Telegram Messages in Nusa Tenggara Area

	1981	1984	1989	1990	1994	1995	1999	2000	2005	2010
WITEL VIII ($\times 10^3$)	451.7 14%	669.2	1,077.8 10%	1,142.5 6%	1,442.3	1,485.6 3%	1,672.0	1,672.0 0%	1,672.0	1,672.0
Nusa Tenggara				571.3		742.8		836.0	836.0	836.0

3-2 Microscopic Forecast

Terrestrial transmission system to be constructed by this project is to interconnect all exchanges - Primary Centers and above in network hierarchy - in Nusa Tenggara area. Therefore, microscopic demand forecast for all kinds of services is made for each Primary area, in principle.

3-2-1 Telephone Service

Results of microscopic demand forecast for telephone service are given in Table 3-6. Forecast is made for each local exchange in each Primary area.

PERUMTEL, for its part, made microscopic demand forecast up to 1990 for each local exchange.

Microscopic demand forecast, this time, is by the method employed by PERUMTEL and with latest data collected by field survey.

This application of PERUMTEL's method is selected after comparative study with demand forecast up to 1990, obtained by the following methods:

Case 1 Forecast by actual growth rate of the past.

Case 2 Forecast by application of regression formula obtained in nationwide macroscopic forecast, to Nusa Tenggara area.

For Case 2, study was made in two ways: a) By using the regression formula ($Y = 0.000286 \cdot X^{1.27}$) intact; b) By using the modified regression formula ($Y = 0.000154 \cdot X^{1.27}$) to suit the actual situation of Nusa Tenggara area. For calculation of regression formula parameters, i.e., population by year and GRDP per capita, the corresponding growth rates in Nusa Tenggara area in the past several years (population: 2%; GRDP per capita: 5%) were used.

For demand forecast after 1990, the average annual growth rate is set at 10%. This is because in PERUMTEL's Long Term Plan, the subscriber growth rate turns out to be about 10% for the whole country.

(1) Study of Forecast Results Up to 1990

Demand forecast results in the aforementioned three cases are graphically presented in Figure 3-1.

In this illustration, the demand forecasted by actual growth rate of the past exceeds broadly the forecast results in two other cases. As a matter of fact, Nusa Tenggara area telephone growth rate of the past are conspicuous. That is to say, the average annual growth rate per local exchange is 20.3% in Nusa Tenggara Barat and 13.9% in Nusa Tenggara Timur (Refer to ANNEX-9). Reasons are:

1) Local exchanges are of small scale so that telephone service diffusion is in the inceptive stage.

2) Therefore, main telephone users up to now are government/public offices and relatively large business organizations.

3) In view of satellite system earth stations having been constructed in the past several years, it is considered that this construction accelarated the growth rate of telephone subscribers because of its qualitative improvement.

Such being the circumstances, it is difficult to consider that the high rate of subscriber growth up to the present will continue unabated in the future.

From now forward, major demand sources will be small business and general household segments. In other words, telephone demand will depend a great deal upon the degree of economic activities in the area concerned.

For demand forecast in due consideration of such economic activities, the use of regression formula will give a reasonable guideline. In this respect, the forecast method employed by PERUMTEL can be judged as being well-advised.

Therefore, the demand forecasted by PERUMTEL and corrected, where necessary, with up-to-date data is adopted as the microscopically forecasted demand size.

Table 3-6 Microscopic Telephone Demand Forecast

Ex.	Growth Rate up to 1990	1983	1989	1990	1995	2000	2005	2010
Mtr	11.2	3,603	6,813	7,576	12,202	19,652	31,650	50,973
Lar	9.9	55	97	107	173	279	450	725
Sel	9.0	269	452	492	793	1,278	2,059	3,316
Pya	9.3	345	589	643	1,036	1,669	2,688	4,329
SUB TOTAL		4,272	7,951	8,818	14,204	22,878	36,847	59,343
Sbw	8.9	666	1,111	1,210	1,949	3,139	5,056	8,143
Als	9.1	177	299	326	525	846	1,363	2,196
Tlw	9.1	95	161	175	282	455	733	1,181
Dpu	9.9	411	725	796	1,282	2,065	3,326	5,357
Bim	9.8	1,030	1,805	1,982	3,192	5,141	8,280	13,335
Tet	9.8	67	118	129	208	335	540	870
Sil	9.8	24	42	47	76	123	198	319
SUB TOTAL		2,470	4,261	4,665	7,514	12,104	19,496	31,401
End	6.7	577	852	909	1,464	2,358	3,798	6,117
Ww	10.9	10	19	21	34	55	89	144
Mse	7.0	598	898	961	1,548	2,493	4,015	6,467
Lrt	(10.0)	80	142	157	253	408	657	1,059
Bjw	(10.0)	199	353	389	627	1,010	1,627	2,621
Rtg	8.9	410	684	745	1,200	1,933	3,114	5,016
Ro	9.2	93	158	173	279	450	725	1,168
Wgp	(10.0)	385	683	752	1,212	1,952	3,144	5,064
Wkb	(10.0)	(257)	456	502	809	1,303	2,099	3,381
SUB TOTAL		2,609	4,245	4,609	7,426	11,962	19,268	31,037
Kp	10.4	1,647	2,982	3,293	5,304	8,542	13,757	22,156
Cpg	25.0	12	46	58	94	152	245	395
Se	9.0	178	299	326	525	846	1,363	2,196
Nkn	9.9	21	37	41	66	107	173	279
Kef	23.1	181	630	776	1,250	2,014	3,244	5,225
Ull	23.2	8	28	35	57	92	149	240
Uks	(10.0)	(8)	15	17	28	45	73	118
Atb	11.0	261	489	542	873	1,406	2,265	3,648
Baa	9.9	35	62	68	110	178	287	463
Seb	(10.0)	(18)	32	36	58	94	152	245
Kai	8.5	172	281	305	492	793	1,278	2,059
SUB TOTAL		2,541	4,901	5,497	8,857	14,269	22,986	37,024
GRAND TOTAL		11,892	21,358	23,589	38,001	61,213	98,597	158,805

Note: Parenthesized fingures are estimated.

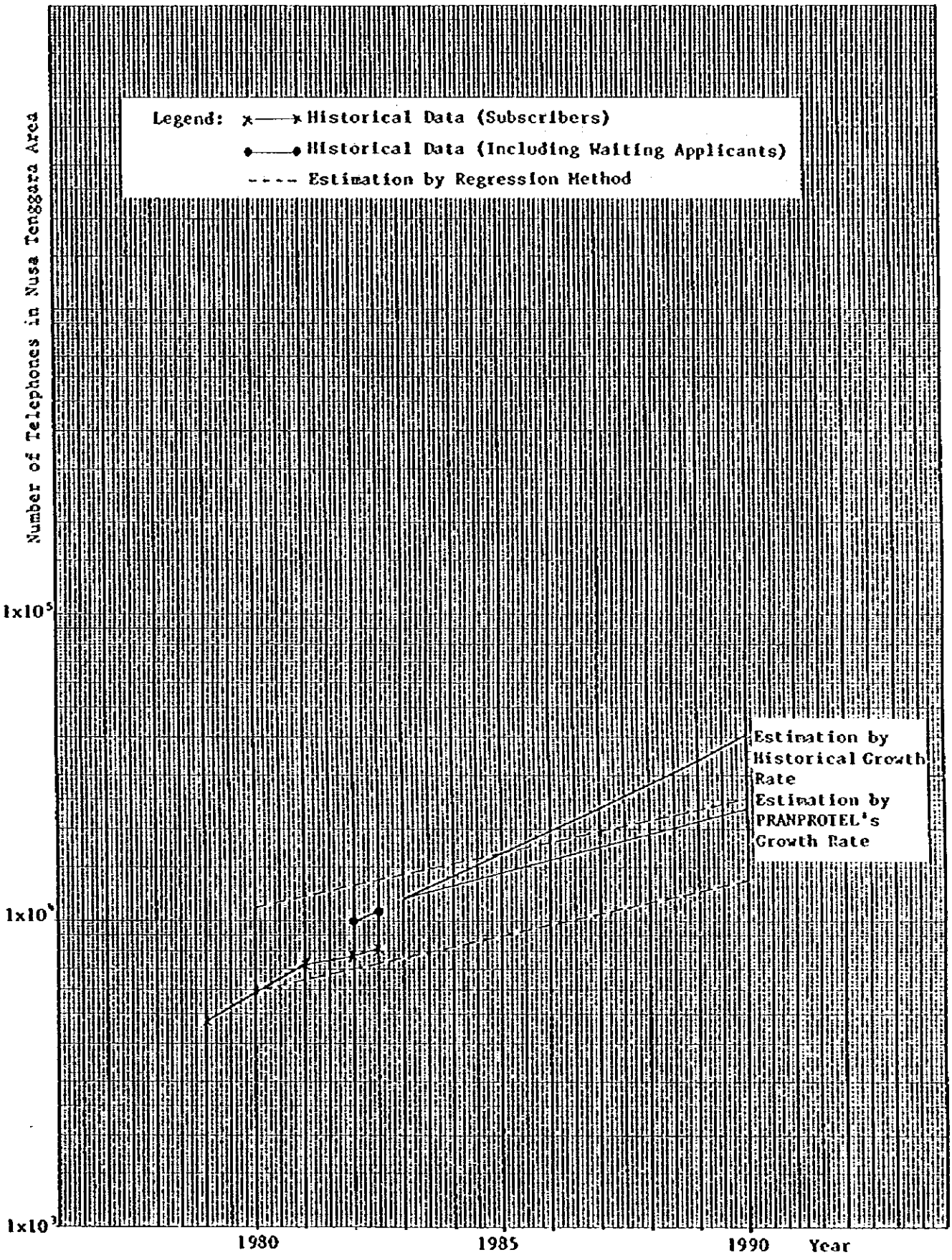


Figure 3-1 Comparison of Microscopic Telephone Demand Forecast

3-2-2 Non-telephone Services

Microscopic demand forecast for non-telephone services consists of macroscopic demand forecast distributed to each Primary area or Secondary area. Results obtained by calculation are given in Table 3-7.

In the macroscopic demand forecast distibution by Primary/Secondary areas, the number of non-telephone service terminals at each local exchange and the number of telegram messages handled annually are taken into consideration. For, in Nusa Tenggara area, the telephone density still remains low so that the demand for telecommunications service itself may well be known especially from the number of telegram messages handled.

Table 3-7-1 Estimated Number of Telegram Messages

Exchange	Percentage (%)	Year				
		1990	1995	2000	2005	2010
Mataram	17.15	97,980	127,390	143,370	143,370	143,370
Sumbawa Besar	7.00	39,990	52,000	58,520	58,520	58,520
Taliwang	0.35	2,000	2,600	2,930	2,930	2,930
Dompu	3.50	20,000	26,000	29,260	29,260	29,260
Bima	7.00	39,990	52,000	58,520	58,520	58,520
Ende	10.40	59,420	77,250	86,940	86,940	86,940
Maumere	3.90	22,280	28,970	32,600	32,600	32,600
Larantuka	3.90	22,280	28,970	32,600	32,600	32,600
Bajawa	1.30	7,430	9,660	10,870	10,870	10,870
Ruteng	5.85	33,420	43,450	48,900	48,900	48,900
Waingapu	4.55	25,990	38,800	38,040	38,040	38,040
Waikabubak	1.95	11,140	14,480	16,300	16,300	16,300
Kupang	26.00	148,540	193,130	217,360	217,360	217,360
Soe	0.65	3,710	4,830	5,430	5,430	5,430
Kefamenanu	0.65	3,710	4,830	5,430	5,430	5,430
Atambua	2.60	14,850	19,310	21,740	21,740	21,740
Baa	0.65	3,710	4,830	5,430	5,430	5,430
Seba	0.65	3,710	4,830	5,430	5,430	5,430
Kalabahi	1.95	11,140	14,480	16,300	16,300	16,300
TOTAL	100.00	571,290	742,810	835,970	835,970	835,970

Table 3-7-2 Estimated Number of Telex Terminals

Exchange	Year				
	1990	1995	2000	2005	2010
Mataram	35	52	68	83	97
Sumbawa Besar	4	6	12	18	28
Taliwang	0	0	0	1	2
Dompu	1	2	3	5	8
Bima	3	5	12	21	36
Ende	2	4	6	10	16
Maumere	1	2	3	5	8
Larantuka	0	1	3	4	7
Bajawa	0	0	2	3	5
Ruteng	3	3	4	5	8
Waingapu	2	3	4	5	8
Waikabubak	0	0	2	3	5
Kupang	35	52	68	83	97
Soe	0	0	0	1	1
Kefamenanu	0	0	0	1	1
Atambua	0	0	2	3	5
Baa	0	0	0	1	2
Seba	0	0	0	1	2
Kalabahi	0	0	2	3	5
TOTAL	86	130	191	256	341

Table 3-7-3 Estimated Number of Leased Circuits

Secondary Area	Year				
	1990	1995	2000	2005	2010
(Mataram)	4	6	7	9	10
Sumbawa Besar	1	2	3	5	8
Ende	1	2	3	4	6
Kupang	4	6	8	10	12
TOTAL	10	16	21	28	36

Table 3-7-4 Estimated Number of Subscribers for New Services

Secondary Area	Year				
	1990	1995	2000	2005	2010
(Mataram)	3	7	14	31	65
Sumbawa Besar	1	2	5	14	47
Ende	0	1	4	12	37
Kupang	3	7	15	33	75
TOTAL	7	17	38	90	224

3-3 Macroscopic and Microscopic Forecasts

Results of macroscopic and microscopic demand forecasts for telephone service are graphically presented in Figure 3-2. Macroscopic forecast is just to obtain an outline of demand potential. Here, the result of microscopic forecast is taken up for study.

As seen in Figure 3-2, the result of microscopic forecast comes midway between the optimistic and pessimistic demand estimates by macroscopic forecast. Therefore, it can be considered to suggest an appropriately forecasted demand size.

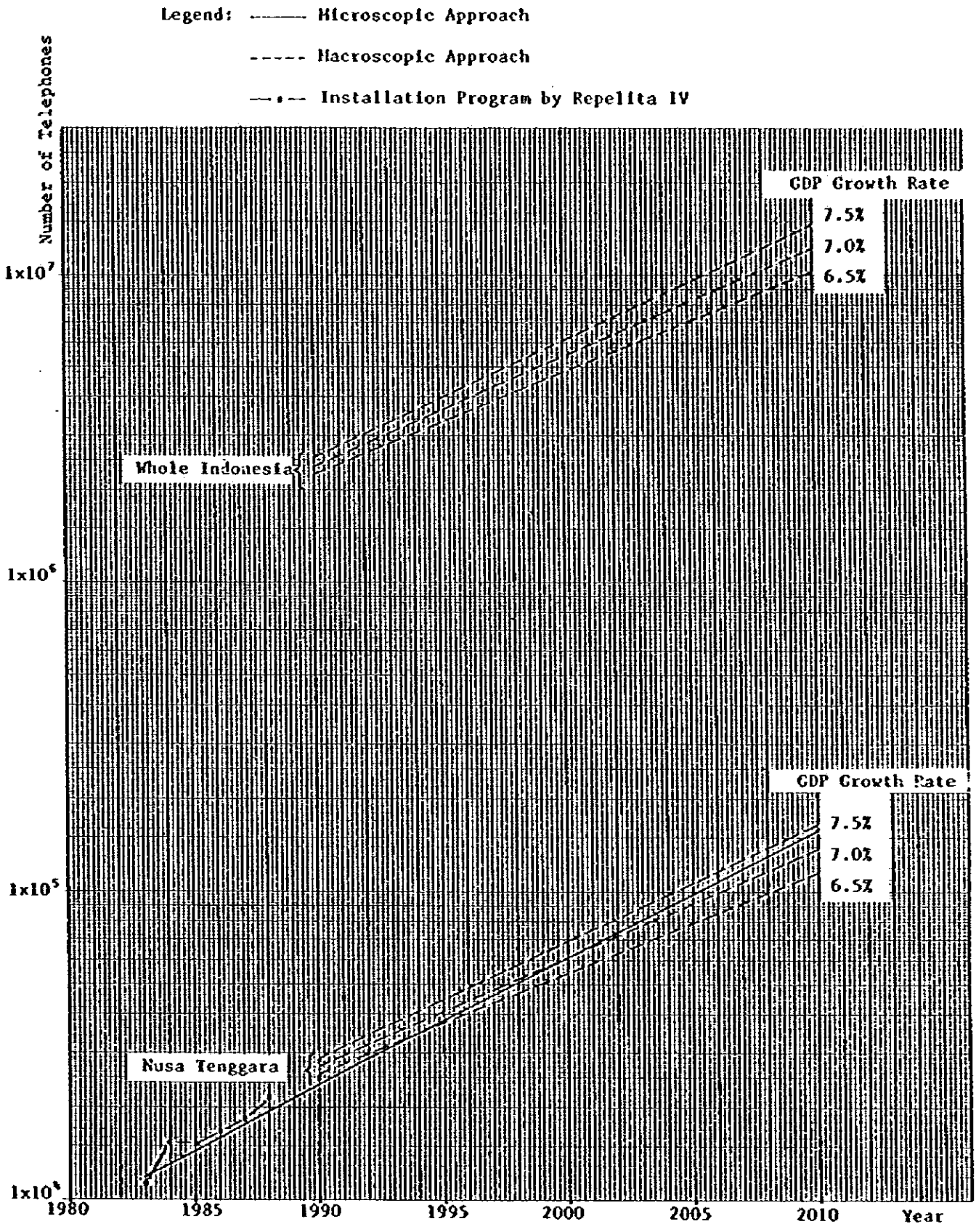


Figure 3-2 Comparison Between Macroscopic and Microscopic Telephone Demand Forecast

3-4 Traffic Forecast

3-4-1 SLDD Originating Calling Rate Estimate

Findings in the analysis of data obtained in the field survey are given in ANNEX-10.

It generally holds true that SLDD originating calling rate per subscriber degrades in accordance with the growth of operating scale of the exchange to which the subscriber concerned belongs. This is due to the increase of general residential telephones, in which case the calling rate is considered to be relatively low, in addition to the government/public offices as main subscriber categories at the inceptive diffusion stage of telephone service. As is evident in ANNEX-10, this trend is visible in the result of data analysis also.

Therefore, based on the result of data analysis, and also in consideration of the existing state of trunk transmission system in Nusa Tenggara area, SLDD originating calling rate in the area is estimated as follows:

Number of Subscribers	SLDD Originating Calling Rate (Erl.)
- 300	0.009
301 - 500	0.008
501 - 1,000	0.007
1,001 - 4,000	0.006
4,000 - 7,000	0.005
7,001 -	0.004

3-4-2 Trunk Traffic Calculation

Trunk traffic calculation steps are shown below. Results of calculation apper in Figure 3-3.

Step 1: To calculate mean busy-hour traffic per local exchange.

Step 2: To arrange mean busy-hour traffic concentration to each Primary Center.

Step 3: To make traffic distribution between terrestrial transmission route and satellite link.

Step 4: To arrange traffic concentration to each Secondary Center.

Step 5: To make traffic distribution between terrestrial transmission route and satellite link at each Secondary Center.

Step 6: To make inter-exchange distribution of traffic to flow via terrestrial transmission route.

(1) Mean Busy-hour Traffic

Results of calculation of trunk originating traffic per local exchange (A_{LD}) are given in Table 3-8. Calculation formula follows:

$$A_{LD} = N \cdot C_R \quad (Erl.)$$

where

A_{LD}: Trunk originating traffic of local exchange

N : Number of subscribers

C_R : SLDD originating calling rate

(2) Traffic Distribution between Terrestrial Transmission System and Satellite System

For traffic distribution between terrestrial transmission system and satellite system, the distribution ratios shown in the table below are used. This is based on agreement with PERUMTEL pertaining to this study.

However, for the time being, a provisional arrangement is to apply that at exchanges where construction of satellite system earth station is not scheduled, all traffic is to flow via terrestrial transmission route, and at exchanges where satellite system earth station already exists or is scheduled to be constructed and where trunk switching equipment is not yet for automatic switching, all traffic is to flow via satellite link.

Traffic Distribution between Terrestiral Transmission System and Satellite System

Crow-flight Distance (km)	Terrestrial System (%)	Satellite System (%)
< 500	80	20
$\geqq 500$	40	60

(3) Inter-exchange Traffic Distribution

Generally, inter-exchange traffic is such in nature that it is in direct proportion to the operating scale, i.e., the number of subscribers accommodated, of both exchanges, but is in inverse proportion to the distance between both exchanges. CCITT GAS 5 Manual introduces the gravity model wherein the abovementioned inter-exchange traffic characteristic is utilized for inter-exchange distribution of trunk traffic:

$$R_{ij} = \frac{\frac{S_j}{D_{ij}^{\alpha}}}{\frac{S_1}{D_{i1}^{\alpha}} + \frac{S_2}{D_{i2}^{\alpha}} + \ldots + \frac{S_j}{D_{ij}^{\alpha}} + \ldots + \frac{S_n}{D_{in}^{\alpha}}}$$

where

- i : Exchange to which the forecast applies.
- j : The other exchange
- R_{ij} : Traffic distribution ratio between exchanges i and j
- S : Number of subscribers
- D_{ij} : Crow-flight distance between both exchanges
- α : Coefficient for conversion of inter-exchange distance into social/economic distance
- n : Number of exchanges

In this study, traffic to be carried by terrestrial transmission system is first concentrated by Secondary Center unit. Then, such traffic is divided into traffic to terminate in Surabaya Tertiary area. Finally, between Secondary Centers located in Surabaya Tertiary area, inter-exchange traffic is calculated by use of the gravity model referred to above. Calculation results are given in ANNEX-11.

Traffic distribution by destinations, i.e., inside Surabaya Tertiary area and outside, is made by distribution ratios shown below. For determining these ratios, the existing state of traffic interflow (see ANNEX-10) and ITU's "Local Network Planning" (Geneva, 1979) are used as references.

Traffic Distribution by Destination Basis

Secondary Center	Surabaya Tertiary Area	Other Tertiary Areas
Sumbawa Besar	90%	10%
Ende	85%	15%
Kupang	65%	35%

When using the gravity model, the coefficient (α) whereby to convert inter-exchange distance into social/economic distance must be correctly determined. This decision of coefficient is of vital importance.

In Nusa Tenggara area, almost all trunk exchanges are manually operated, as previously stated. Therefore, data collected for this study, or, more precisely, traffic distribution by destinations of each exchange, certainly reflects the degrees of social/economic contact of Nusa Tenggara area with each other area.

The coefficient (α) used for each calculation, this time, can be found in the ANNEX-11.

Meanwhile, in the case of Mataram, belongs to Denpasar Secondary area and Denpasar Secondary Center is outside the coverage area of this study. Furthermore, transmission route covering Mataram Exchange is only the backbone route connecting Primary and Secondary Centers. Therefore, the use of gravity model is excluded for this section.

(4) Incoming Traffic to Nusa Tenggara Area

The coverage area of this study is just a part of Surabaya Tertiary area. Accurate estimate of traffic inflow from other than the coverage area is difficult because the actual state of traffic interflow cannot be correctly known. Therefore, the incoming traffic from other areas is estimated to be practically the same in volume as the outgoing traffic to other areas.

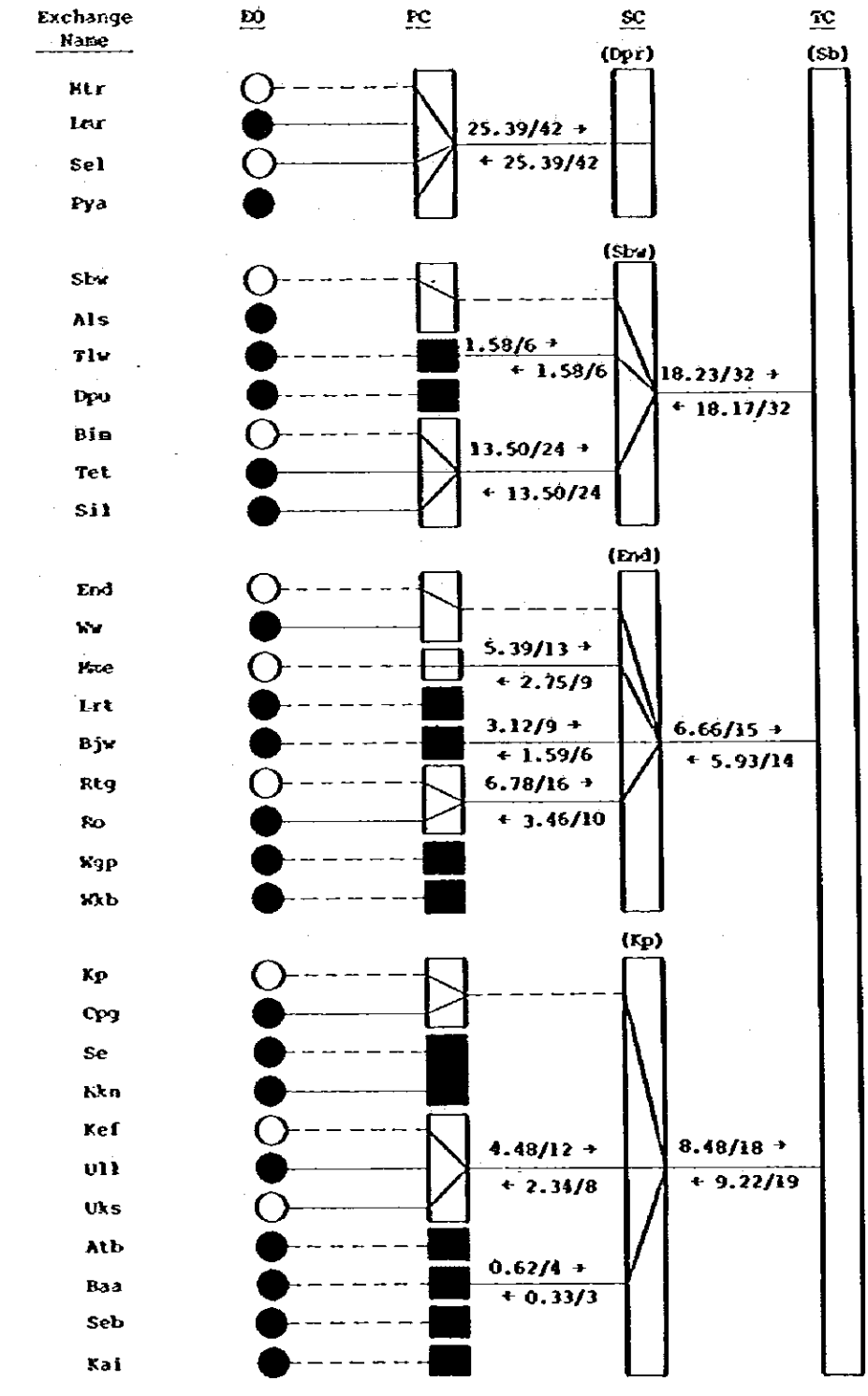


Figure 3-3 (1/5) Traffic on Terrestrial Link and Circuit Requirement - 1990 -

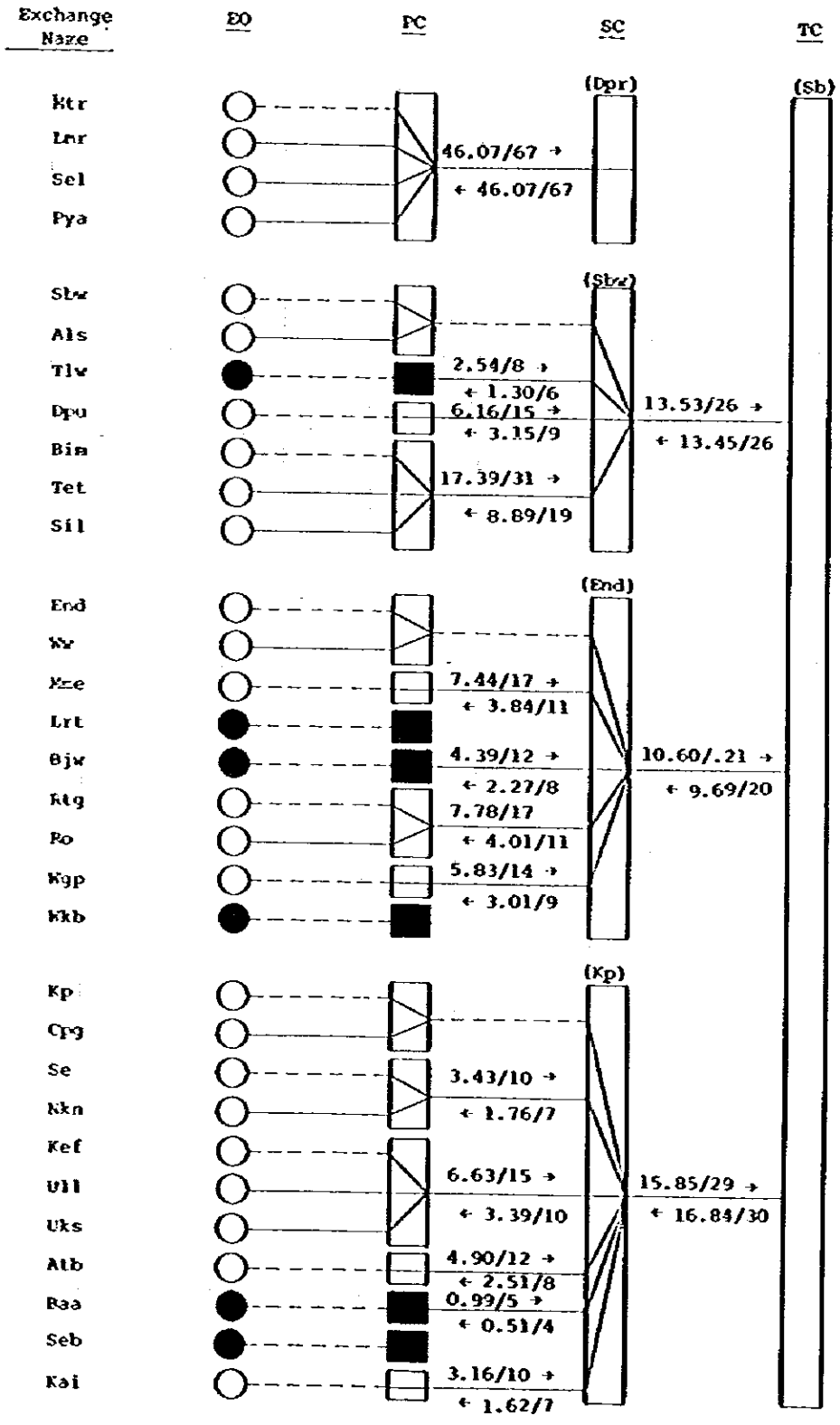


Figure 3-3 (2/5) Traffic on Terrestrial Link and Circuit Requirement - 1995 -

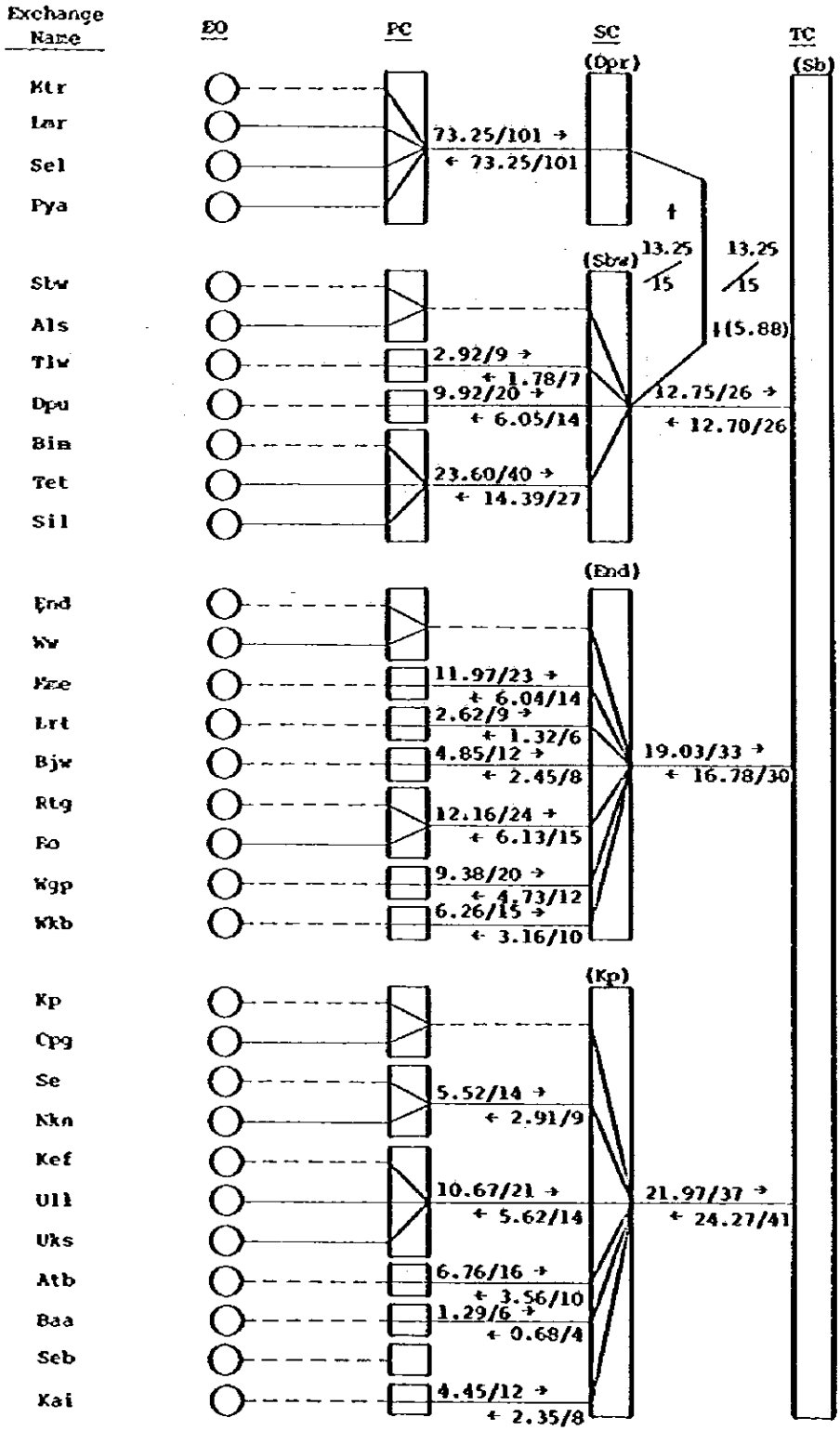


Figure 3-3 (3/5) Traffic on Terrestrial Link and Circuit Requirement - 2000 -

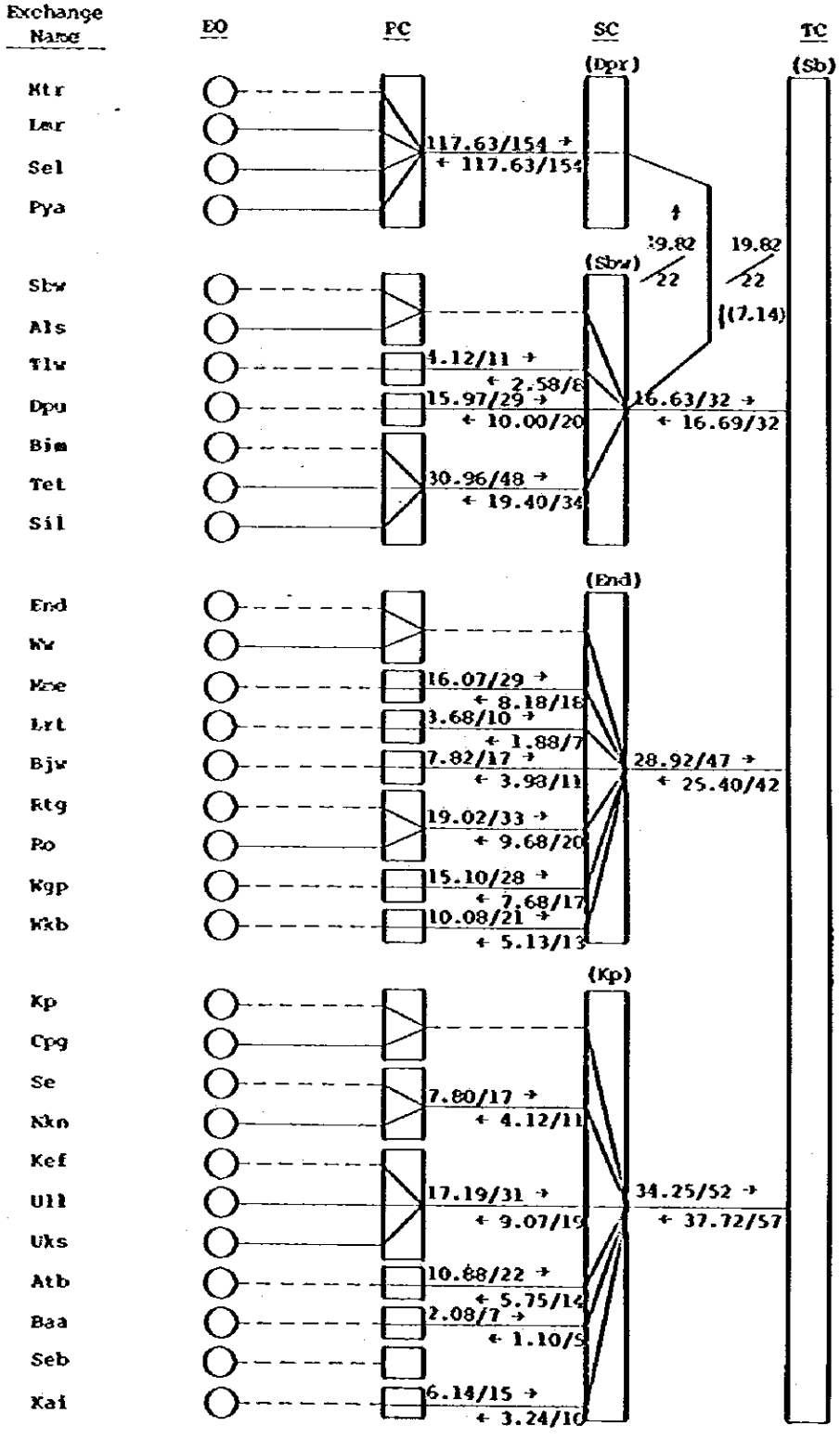


Figure 3-3 (4/5) Traffic on Terrestrial Link and Circuit Requirement - 2005 -

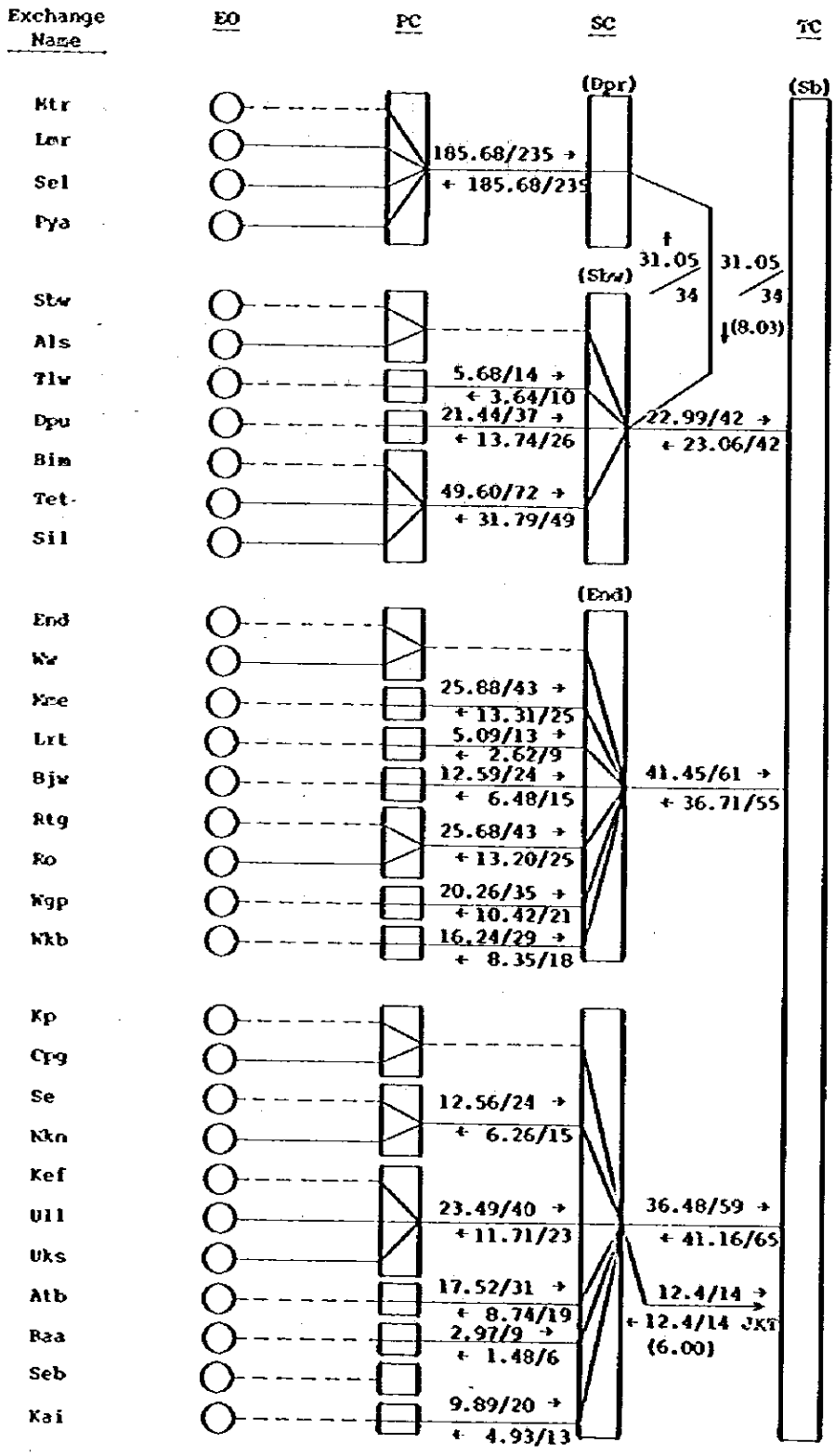


Figure 3-3 (5/5) Traffic on Terrestrial Link and Circuit Requirement - 2010 -

Table 3-8 (1/5) Mean Busy-hour Outgoing Traffic

(Year: 1990)

Area Code	Exchange Name	No. of Sub.	C.R.	A_{LD}	Total Traffic	Terrestrial Link			
						Ratio	Traffic	Arranged Traffic	No. of CCT (OG)
364	Mtr	7,576	0.004	30.31					
	Lar	(107)	0.009	(0.97)	31.74	0.8	25.39	30.47	42
	Sel	492	0.008	3.94	(5.48)	0.0			
	Pya	(643)	0.007	(4.51)					
TOTAL		8,818		34.25					
				(5.48)			25.39		
371	Sbw	1,210	0.006	7.26	7.26	-	-	-	
	Als	(326)	0.008	(2.61)	(2.61)	0.0			
372	Tlw	(175)	0.009	(1.58)	(1.58)	1.0	1.58	1.90	6
373	Dpu	(796)	0.007	(5.58)	(5.58)	0.0	-	-	0
374	Blm	1,982	0.006	11.90	11.90	1.0	13.50	15.12	24
	Tet	(129)	0.009	(1.17)	(1.60)	1.0			
	Sil	(47)	0.009	(0.43)					
TOTAL		4,665			30.53		15.08		
381	End	909	0.007	6.37	6.37	-	-	-	
	Ww	(21)	0.009	(0.19)	(0.19)	0.0			
382	Mae	961	0.007	6.73	6.73	0.8	5.39	6.47	13
383	Lrt	(157)	0.009	(1.42)	(1.42)	0.0	-	-	0
384	Bjw	(389)	0.008	(3.12)	(3.12)	1.0	3.12	3.75	9
385	Rtg	745	0.007	5.22	5.22	1.0	6.78	8.14	16
	Ro	(173)	0.009	(1.56)	(1.56)	1.0	-	-	
386	Wgp	(752)	0.007	(5.27)	(5.27)	0.0	-	-	0
387	Wkb	(502)	0.007	(3.52)	(3.52)	0.0	-	-	0
TOTAL		4,609			33.40		15.29		
391	Kp	3,293	0.006	19.76	19.76	-	-	-	
	Cpg	(58)	0.009	(0.53)	(0.53)	0.0			
392	Se	(326)	0.008	(2.61)	(2.98)	0.0	-	-	0
	Nkn	(41)	0.009	(0.37)					
393	Kef	776	0.007	5.44	5.60	0.8	4.48	5.38	12
	Ull	(35)	0.009	(0.32)	(0.32)	0.0			
	Uks	17	0.009	0.16					
394	Atb	(542)	0.007	(3.80)	(3.80)	0.0	-	-	0
395	Baa	(68)	0.009	(0.62)	(0.62)	1.0	0.62	0.75	4
396	Seb	(36)	0.009	(0.33)	(0.33)	0.0	-	-	0
397	Kal	(305)	0.008	(2.44)	(2.44)	0.0	-	-	0
TOTAL		5,497			36.38		5.10		

Table 3-8 (2/5) Mean Busy-hour Outgoing Traffic

(Year: 1995)

Area Code	Exchange Name	No. of Sub.	C.R.	A_{ID}	Total Traffic	Terrestrial Link			
						Ratio	Traffic	Arranged Traffic	No. of CCT (OG)
364	Mtr	12,202	0.004	48.81					
	Ler	173	0.009	1.56	57.59	0.8	46.07	52.99	67
	Sel	793	0.007	5.56					
	Pya	1,036	0.006	6.22					
TOTAL		14,204		62.15	57.59		46.07		
371	Sbw	1,949	0.006	11.70	15.38	-	-	-	
	Als	525	0.007	3.68					
372	Tlw	(282)	0.009	(2.54)	(2.54)	1.0	2.54	3.05	8
373	Dpu	1,282	0.006	7.70	7.70	0.8	6.16	7.40	15
374	Bln	3,192	0.006	19.16					
	Tet	208	0.009	1.88	21.73	0.8	17.39	20.87	31
	Sil	76	0.009	0.69					
TOTAL		7,514			47.35		26.09		
381	End	1,464	0.006	8.79	9.10	-	-	-	
	Ww	34	0.009	0.31					
382	Mae	1,548	0.006	9.29	9.29	0.8	7.44	8.93	17
383	Lrt	(253)	0.009	(2.28)	(2.28)	0.0	-	-	0
384	Bjw	(627)	0.007	(4.39)	(4.39)	1.0	4.39	5.27	12
385	Rtg	1,200	0.006	7.20	9.72	0.8	7.78	9.34	17
	Ro	279	0.009	2.52					
386	Wgp	1,212	0.006	7.28	7.28	0.8	5.83	7.00	14
387	Wkb	(809)	0.007	(5.67)	(5.67)	-	-	-	
TOTAL		7,426			47.73		25.44		
391	Kp	5,304	0.005	26.52	27.37	-	-	-	
	Cpg	94	0.009	0.85					
392	Se	525	0.007	3.68	4.28	0.8	3.43	4.12	10
	Nkn	66	0.009	0.60					
393	Kef	1,250	0.006	7.50					
	Ull	57	0.009	0.52	8.28	0.8	6.63	7.96	15
	Uks	28	0.009	0.26					
394	Atb	873	0.007	6.12	6.12	0.8	4.90	5.88	12
395	Baa	(110)	0.009	(0.99)	(0.99)	1.0	0.99	1.19	5
396	Seb	(58)	0.009	(0.53)	(0.53)	0.0	-	-	0
397	Kal	492	0.008	3.94	3.94	0.8	3.16	3.80	10
TOTAL		8,857			51.51		19.11		

Table 3-8 (3/5) Mean Busy-hour Outgoing Traffic

(Year: 2000)

Area Code	Exchange Name	No. of Sub.	C.R.	A_{LD}	Total Traffic	Terrestrial Link			
						Ratio	Traffic	Arranged Traffic	No. of CCT (OG)
364	Mtr	19,652	0.004	78.61	91.56	0.8	73.25	84.24	101
	Iar	279	0.009	2.52					
	Sel	1,278	0.006	7.67					
	Pya	1,669	0.006	10.02					
TOTAL		22,878		98.82	91.56		73.25		
371	Sbw	3,139	0.006	18.84	24.77	-	-	-	
	Als	846	0.007	5.93					
372	Tlw	455	0.008	3.64	3.64	0.8	2.92	3.51	9
373	Dpu	2,065	0.006	12.39	12.39	0.8	9.92	11.91	20
374	Bln	5,141	0.005	25.71	29.50	0.8	23.60	28.32	40
	Tet	335	0.008	2.68					
	Sll	123	0.009	1.11					
TOTAL		12,104			70.30		36.44		
381	End	2,358	0.006	14.15	14.65	-	-	-	
	Ww	55	0.009	0.50					
382	Mne	2,493	0.006	14.96	14.96	0.8	11.97	14.37	23
383	Lrt	408	0.008	3.27	3.27	0.8	2.62	3.15	9
384	Bjw	1,010	0.006	6.06	6.06	0.8	4.85	5.82	12
385	Rtg	1,933	0.006	11.60	15.20	0.8	12.16	14.60	24
	Ro	450	0.008	3.60					
386	Wgp	1,952	0.006	11.72	11.72	0.8	9.38	11.26	20
387	Wkb	1,303	0.006	7.82	7.82	0.8	6.26	7.52	15
TOTAL		11,962			73.68		47.24		
391	Kp	8,542	0.004	34.17	35.54	-	-	-	
	Cpj	152	0.009	1.37					
392	Se	846	0.007	5.93	6.90	0.8	5.52	6.63	14
	Nkn	107	0.009	0.97					
393	Kef	2,014	0.006	12.09	13.33	0.8	10.67	12.81	21
	Ull	92	0.009	0.83					
	Uks	45	0.009	0.41					
394	Atb	1,406	0.006	8.44	8.44	0.8	6.76	8.12	16
395	Baa	178	0.009	1.61	1.61	0.8	1.29	1.55	6
396	Seb	94	0.009	0.85	0.85	0.0	-	-	0
397	Kal	793	0.007	5.56	5.56	0.8	4.45	5.34	12
TOTAL		14,269			72.23		28.69		

Table 3-8 (4/5) Mean Busy-hour Outgoing Traffic

(Year: 2005)

Area Code	Exchange Name	No. of Sub.	C.R.	A_{LD}	Total Traffic	Terrestrial Link			
						Ratio	Traffic	Arranged Traffic	No. of CCT (OG)
364	Mtr	31,650	0.004	126.60	147.03	0.8	117.63	135.28	154
	Lar	450	0.008	3.60					
	Sel	2,059	0.006	12.36					
	Pya	2,688	0.006	16.13					
TOTAL		36,847		158.69	147.03		117.63		
371	Sbw	5,056	0.005	25.28	33.46	-	-	-	
	Als	1,363	0.006	8.18					
372	Tlw	733	0.007	5.14	5.14	0.8	4.12	4.95	11
373	Dpu	3,326	0.006	19.96	19.96	0.8	15.97	19.17	29
374	Blm	8,280	0.004	33.12	38.69	0.8	30.96	35.61	48
	Tet	540	0.007	3.78					
	Sil	198	0.009	1.79					
TOTAL		19,496			97.25		51.05		
381	End	3,798	0.006	22.79	23.60	-	-	-	
	Ww	89	0.009	0.81					
382	Mse	4,015	0.005	20.08	20.08	0.8	16.07	19.29	29
383	Lrt	657	0.007	4.60	4.60	0.8	3.68	4.42	10
384	Bjw	1,627	0.006	9.77	9.77	0.8	7.82	9.39	17
385	Rtg	3,114	0.006	18.69	23.77	0.8	19.02	22.83	33
	Ro	725	0.007	5.08					
386	Wgp	3,144	0.006	18.87	18.87	0.8	15.10	18.12	28
387	Wkb	2,099	0.006	12.60	12.60	0.8	10.08	12.10	21
TOTAL		19,268			113.29		71.77		
391	Kp	13,757	0.004	55.03	57.24	-	-	-	
	Opg	245	0.009	2.21					
392	Se	1,363	0.006	8.18	9.74	0.8	7.80	9.36	17
	Nkn	173	0.009	1.56					
393	Kef	3,244	0.006	19.47	21.48	0.8	17.19	20.63	31
	Ull	149	0.009	1.35					
	Uks	73	0.009	0.66					
394	Atb	2,265	0.006	13.59	13.59	0.8	10.88	13.06	22
395	Baa	287	0.009	2.59	2.59	0.8	2.08	2.50	7
396	Seb	152	0.009	1.37	1.37	0.0	-	-	0
397	Kal	1,278	0.006	7.67	7.67	0.8	6.14	7.37	15
TOTAL		22,986			113.68		44.09		

Table 3-8 (5/5) Mean Busy-hour Outgoing Traffic

(Year: 2010)

Area Code	Exchange Name	No. of Sub.	C.R.	A_{LD}	Total Traffic	Terrestrial Link			
						Ratio	Traffic	Arranged Traffic	No. of CCT (OG)
364	Ktr	50,973	0.004	203.90	232.10	0.8	185.68	213.54	235
	Lnr	725	0.007	5.08					
	Sel	3,316	0.006	19.90					
	Pya	4,329	0.005	21.63					
TOTAL		59,343		250.51	232.10		185.68		
371	Sbw	8,143	0.004	32.58	45.76	-	-	-	
	Als	2,196	0.006	13.18					
372	Tlw	1,181	0.006	7.09	7.09	0.8	5.68	6.82	14
373	Dpu	5,357	0.005	26.79	26.79	0.8	21.44	25.73	37
374	Bin	13,335	0.004	53.34	61.99	0.8	49.60	57.04	72
	Tet	870	0.007	6.09					
	Sil	319	0.008	2.56					
TOTAL		31,401			141.63		76.72		
381	Bnd	6,117	0.005	30.59	31.89	-	-	-	
	Ww	144	0.009	1.30					
382	Mze	6,467	0.005	32.34	32.34	0.8	25.88	31.06	43
383	Lrt	1,059	0.006	6.36	6.36	0.8	5.09	6.11	13
384	Bjw	2,621	0.006	15.73	15.73	0.8	12.59	15.11	24
385	Rtg	5,016	0.005	25.08	32.09	0.8	25.68	30.82	43
	Ro	1,168	0.006	7.01					
386	Wgp	5,064	0.005	25.32	25.32	0.8	20.26	24.32	35
387	Wkb	3,381	0.006	20.29	20.29	0.8	16.24	19.49	29
TOTAL		31,037			164.02		105.74		
391	Kp	22,156	0.004	88.63	91.79	-	-	-	
	Opg	395	0.008	3.16					
392	Se	2,196	0.006	13.18	15.70	0.8	12.56	15.08	24
	Nkn	279	0.009	2.52					
393	Kef	5,225	0.005	26.13	29.36	0.8	23.49	28.19	40
	Ull	240	0.009	2.16					
	Uks	118	0.009	1.07					
394	Atb	3,648	0.006	21.89	21.89	0.8	17.52	21.03	31
395	Baa	463	0.008	3.71	3.71	0.8	2.97	3.57	9
396	Seb	245	0.009	2.21	2.21	0.0	-	-	0
397	Kal	2,059	0.006	12.36	12.36	0.8	9.89	11.87	20
TOTAL		37,024			177.02		66.43		

3-5 Number of Circuits Required

3-5-1 Preconditions of Calculation

As stated in the Master Plan, the network architecture is basically to follow "Fundamental Plan 1981 for the Telephone Network in Indonesia" formulated by PERUMTEL. Undermentioned are the preconditions of circuit establishment:

- To use DA (Demand Assignment) for satellite link to facilitate SLDD service from Primary and Secondary Centers. This is to avoid 2-hop or 3-hop radio propagation.

- To establish high usage circuits, when necessary, between Secondary Centers in Surabaya Tertiary area and to Secondary Centers in other Tertiary area. This is to economize network construction cost. High usage circuits are to be established on the route where bothway traffic is 36 Erl. or more from the viewpoint of effective utilization of digital transmission system and cable PCM system.

- Not to establish high usage circuits between Primary Center and Secondary Center, in principle.

3-5-2 Circuit Requirements in Telephone Network

Calculation results for the number of circuits required in telephone network are graphically presented in Figure 3-3. Calculation methods follow:

(1) Between Primary Center and Secondary Center

From traffic that flows via terrestrial transmission route (A_{p-s}), calculation is made for the number of circuits required. Condition used for this calculation is:

a) To remedy traffic fluctuations, traffic multiplied by the following coefficient be used for calculation:

$A_{p-s} < 30$ Erl. : 1.20

$A_{p-s} \geq 30$ Erl. : 1.15

b) Assuming Grade of Service to be 1%, required number of circuits be calculated, using non-delay full-availability trunk group load table (Erlang B Formula).

(2) Between Secondary Center and Tertiary Center

Condition for calculation is the same as in the preceding case.

However, the number of circuits required as backbone route including overflow traffic is to be 7% more than the number obtained by non-delay full-availability trunk group load table.

(3) High Usage Route

Generally, calculation of the number of circuits required is made by the condition wherein the following formula holds true:

$$LTC < \frac{ATC}{K}$$

where

LTC: Last Trunk Capacity
(Traffic volume to be carried by last trunk circuit in high usage route)

ATC: Additional Trunk Capacity
(Traffic increment requiring one additional circuit in backbone route)

K: Cost Ratio
(Backbone route cost vs high usage route cost)

In case where the backbone circuit group consists of 10 to 150 circuits, ATC averages 0.8 Erl. Assuming that cost ratio is 1.1, LTC becomes 0.75. By this assumption, calculation is made for the number of high usage circuits required.

3-5-3 Circuits Required for Non-telephone Services

Non-telephone services now available in Nusa Tenggara area are gentex and telex services. In the network configuration for these services, terminals are accommodated in switching equipment installed at Denpasar. This switching equipment hierarchy is the lowest in the national gentex network.

In Nusa Tenggara area, no much demand can be expected for non-telephone services including new services, and this poor demand outlook holds true for the foreseeable future (at least during this project life). Therefore, the network architecture will remain practically the same as at present. This means that the terrestrial transmission system to be constructed by this project is to provide part of subscriber lines to cater for non-telephone services. In other words, the terrestrial transmission system capacity is to be determined not by traffic volume at each terminal but by the number of terminals.

The number of terminals required for non-telephone services is determined as under.

(1) Number of Terminals for Gentex Service

For the number of terminals required for gentex service, calculation is made, based on the number of telegram messages handled per year given in Table 3-7-1 and by using formula stated in ANNEX-12. Calculation result appears in Table 3-9.

(2) Number of Terminals for Other Services

For the number of terminals required for other non-telephone services than gentex, data given in Table 3-7-2 to Table 3-7-4 are used.

Table 3-9 Estimated Number of Gentex Terminals

Exchange	Year				
	1990	1995	2000	2005	2010
Mataram	(5) 4	5	6	6	6
Sumbawa Besar	(3) 2	2	3	3	3
Taliwang	2	2	2	2	2
Dompu	2	2	2	2	2
Bima	(3) 2	2	3	3	3
Ende	(2) 3	3	4	4	4
Maumere	2	2	2	2	2
Larantuka	2	2	2	2	2
Bajawa	2	2	2	2	2
Ruteng	2	2	2	2	2
Waingapu	(2) 2	2	2	2	2
Waikabubak	2	2	2	2	2
Kupang	(5) 6	7	8	8	8
Soe	2	2	2	2	2
Kefamenanu	2	2	2	2	2
Atambua	2	2	2	2	2
Baa	2	2	2	2	2
Seba	2	2	2	2	2
Kalabahi	2	2	2	2	2
TOTAL	45	47	52	52	52

Note: Parenthesized fingures show number of existing gentex terminals

CHAPTER 4

TRANSMISSION ROUTE PLAN AND ROUGH SYSTEM DESIGN

CHAPTER 4 TRANSMISSION ROUTE PLAN AND ROUGH SYSTEM DESIGN

This project is to establish the trunk transmission system that interconnects Primary Centers and Secondary Centers in Nusa Tenggara Timur and Nusa Tenggara Barat. Primary requirement for this purpose is to select transmission route and type of transmission system.

At the present stage, in Nusa Tenggara Timur, terrestrial transmission system worthwhile to mention does not exist except the Eastern Microwave System. This sole existing system interconnects Jakarta, Denpasar and Ujung Pandang, extending by way of Poco Ranakah repeater station on Flores Island, with UHF spur systems established from Poco Ranakah repeater station to Ruteng on Flores Island and Waingapu on Sumba Island.

This project mainly aims at construction of terrestrial transmission system originating from Poco Ranakah repeater station to interconnect Primary Centers and Secondary Centers located in Nusa Tenggara Timur.

Nusa Tenggara Barat is covered by the Eastern Microwave System referred to above. Therefore, in this project, small capacity radio transmission system branching from the main system (Eastern Microwave System) is to be established to cover Dompu and Taliwang where trunk transmission system does not yet exist.

Alternative plan to connect Ende, Flores Island, and Kupang, Timor Island, by submarine cable system, as proposed in the Master Plan, is also examined by this study.

4-1 Transmission Route Selection and Circuit Grouping

4-1-1 Terrestrial Radio Transmission System

Transmission routes planned by this project consist of main route extending from the existing Poco Ranakah repeater station to Kupang and spur routes branching from the main route to each telephone exchange. In part of spur routes, where section distance is short, entrance cable will be used.

In Nusa Tenggara Barat, spur routes to Dompu and Taliwang, where trunk transmission system has not been constructed, will be established, branching from the existing main route.

In the selection of terrestrial radio transmission routes, the following matters are taken into consideration:

(1) To select radio repeater station sites near the public road so that access roads to be newly constructed can be as short as possible. This consideration is from the viewpoints of reducing initial cost of transmission system construction and facilitating system maintenance.

(2) The selected transmission system is to be compatible with the technical requirements, including the radio propagation requirement, on the transmission route.

(3) To avoid construction of radio repeater stations in the area where natural disaster due to volcanic activities or the like is anticipated.

(4) To establish radio terminal stations at the existing or planned telephone exchange sites. For buildings and power supply system also, telephone exchange facilities be utilized.

Transmission route plan based on the foregoing basic items appears in Figures 4-1 and 4-2. Presented in Figures 4-3 and 4-4 are the results of circuit grouping in the transmission route.

For transmission route plan, Plan A and Plan B are available. In both plans, initial year equipment installation is so arranged as to fulfill traffic requirement as of 1995 (five years after system commissioning) but, for final year, Plan A chooses 2005 and Plan B 2010.

For the number of circuits required, calculation is based on the telephone traffic forecast and the number of non-telephone services forecasts as per CHAPTER 3.

4-1-2 Submarine Cable System

The Master Plan proposes that the case of connecting Ende, Flores Island, and Kupang, Timor Island, by submarine cable be taken up for study. This submarine cable plan is among transmission route plans applicable to Nusa Tenggara Timur.

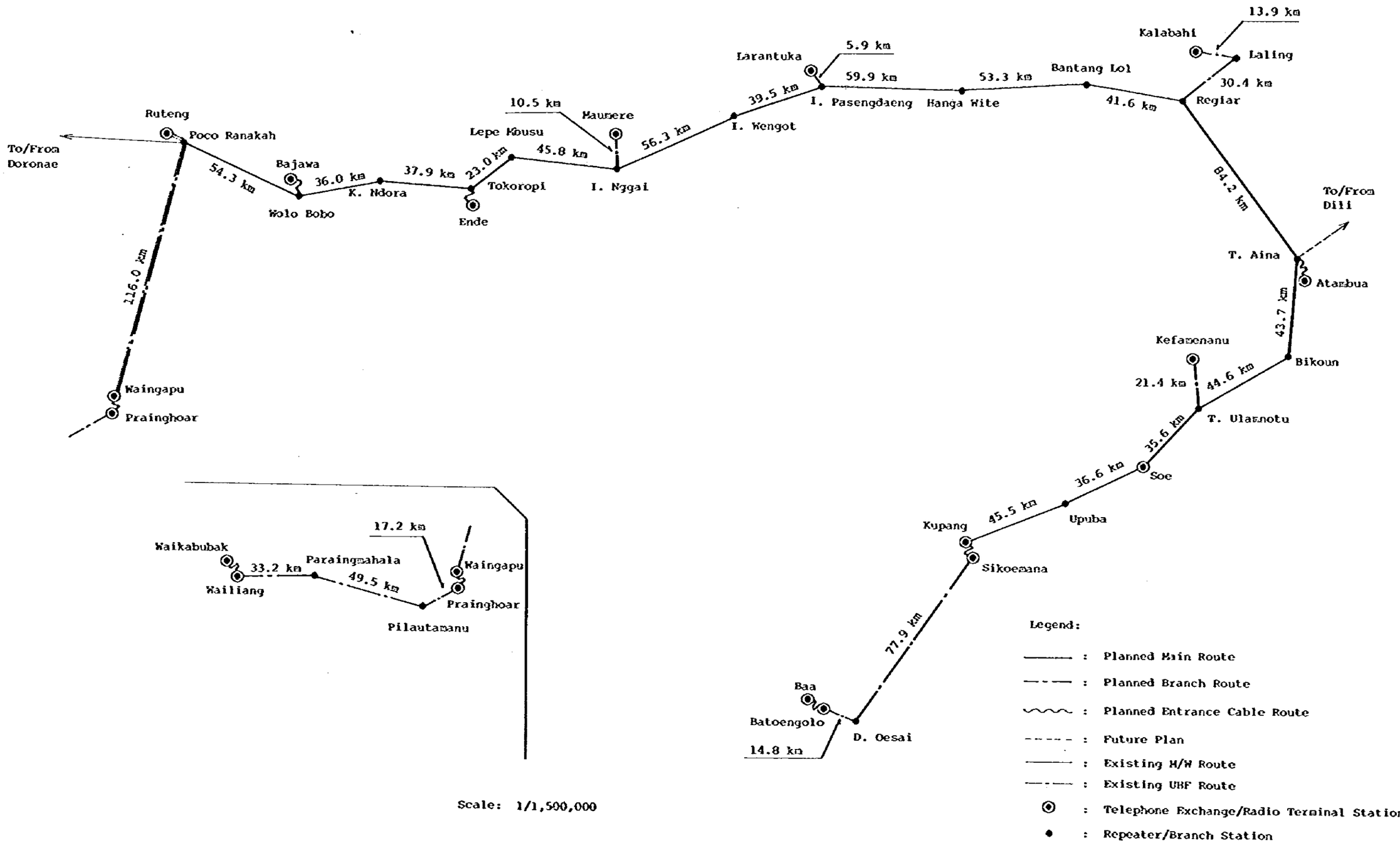
Following is the study of Ende-Kupang submarine cable link feasibility:

For submarine cable route selection, comprehensive study is necessary concerning, among other things, terms of location of cable landing points and sea bottom condition along the contemplated cable route. These requirements are described in details in the Master Plan.

Both Ende and Kupang are in the port area. Therefore, the prime requisite is to avoid the sea area where ships may frequently cast anchor, for cable landing sites.

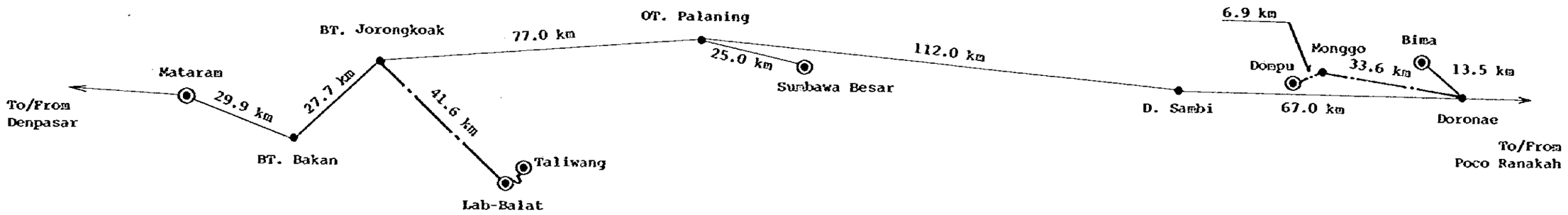
The sea where to install submarine cable is the deep sea for the most part. Hence no problem. Even if a part of sea bottom cable route is found to be accidented in the marine research that precedes cable laying, it must be possible to select cable route by means of detour to avoid the accidented spot. Details about cable landing point selection at Ende and Kupang are given in ANNEX-13.

Judging from the foregoing, submarine cable installation between Ende and Kupang is technically possible. Nusa Tenggara Timur transmisson route plan using submarine cable system for Ende-Kupang link appears as Plan C in Figure 4-5. Result of circuit grouping on this transmission route is in Figure 4-6. Condition that applies to circuit grouping is the same as in the case of terrestrial radio transmission system described in Paragraph 4-1-1.



Scale: 1/1,500,000

Figure 4-1 Transmission Route Plan (Nusa Tenggara Timur: Plan A, Plan B)



Scale: 1/1,000,000

Legend:

——— : Planned Main Route

—·— : Planned Branch Route

~~~ : Planned Entrance Cable Route

- - - - - : Future Plan

——— : Existing M/W Route

—·— : Existing UHF Route

◉ : Telephone Exchange/Radio Terminal Station

● : Repeater/Branch Station

Figure 4-2 Transmission Route Plan (Nusa Tenggara Barat)
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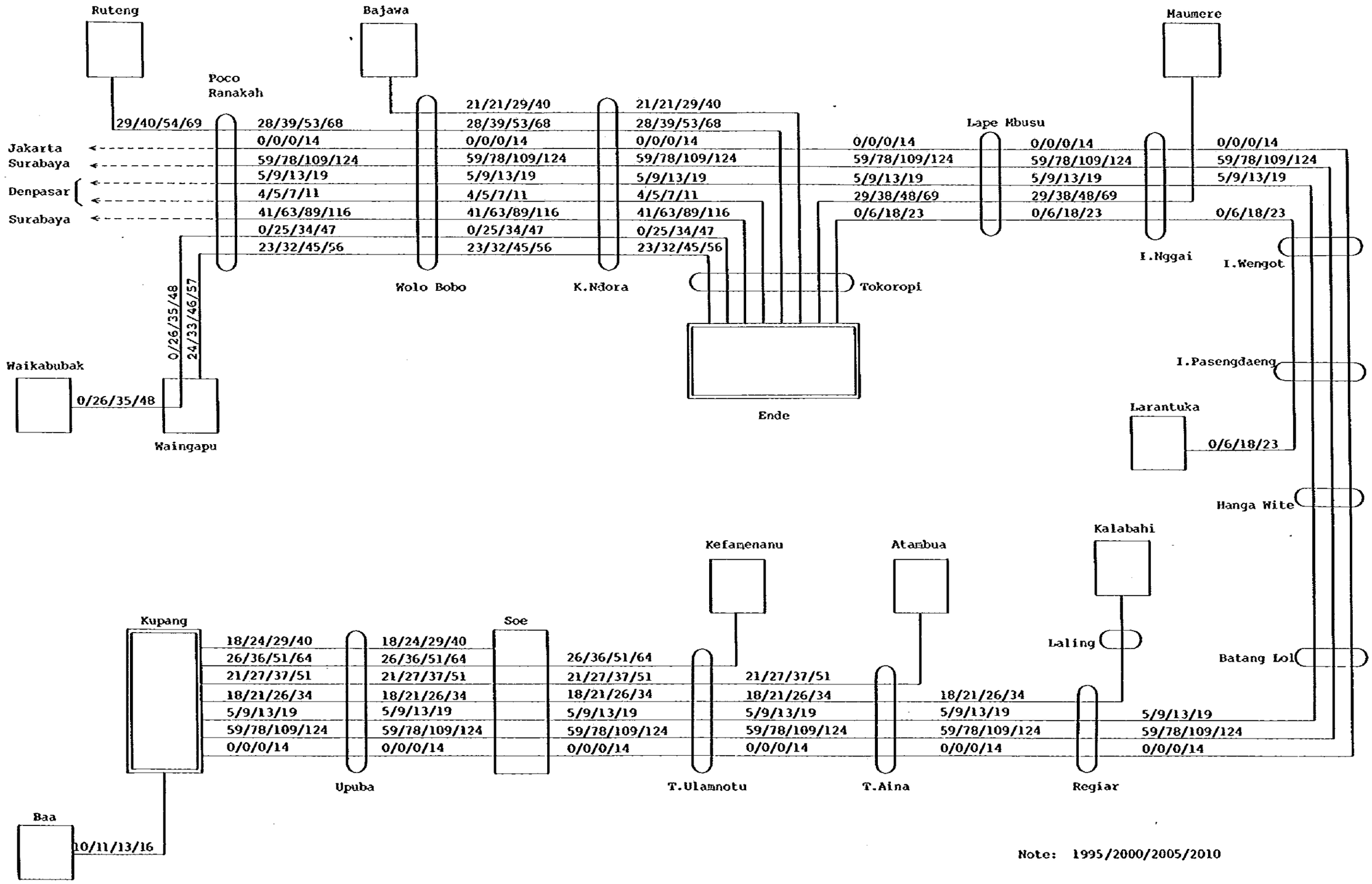


Note: 1995/2000/2005/2010

Figure 4-3 Circuit Grouping Diagram (Nusa Tenggara Timur: Plan A, Plan B)

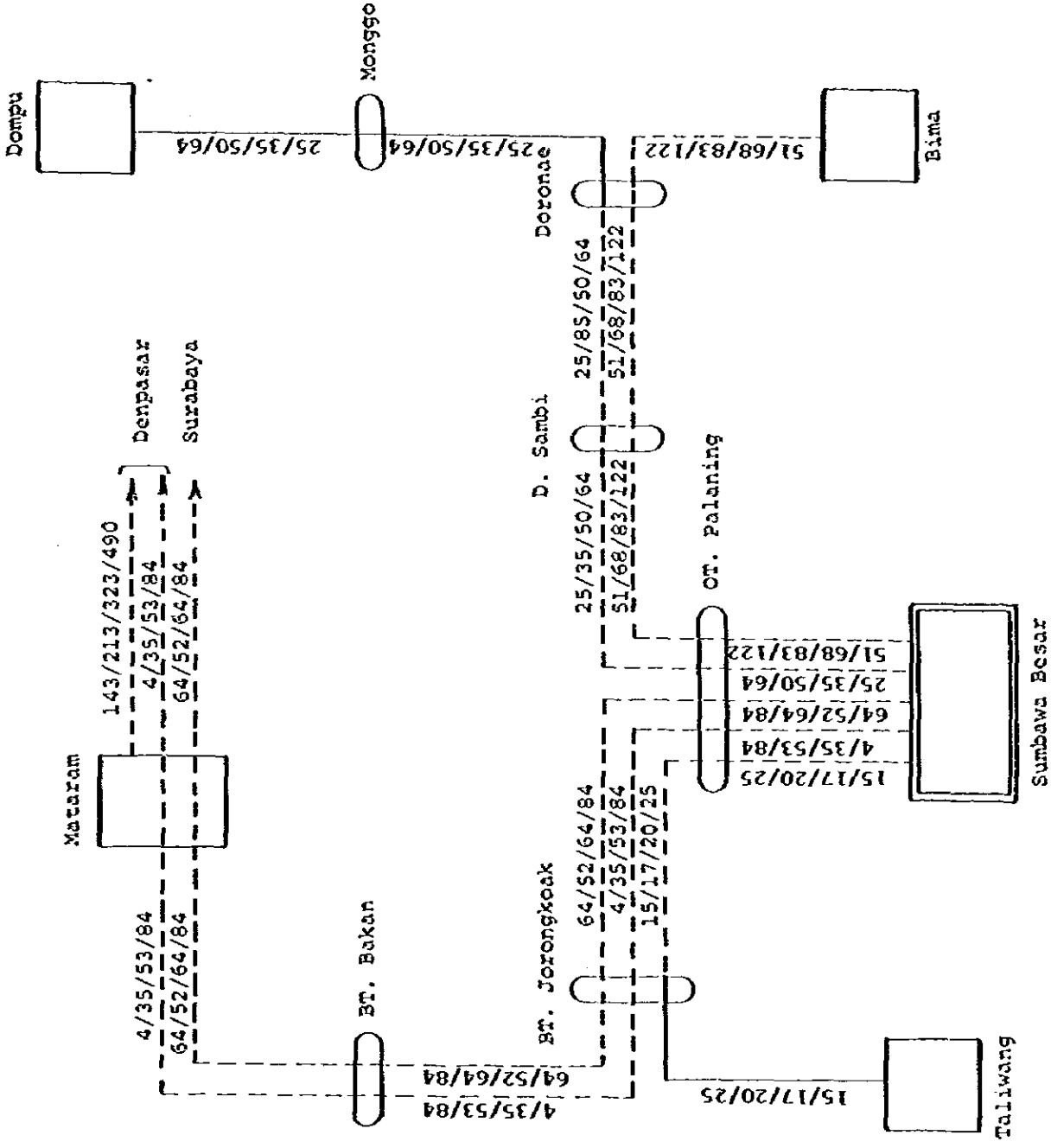


Figure 4-4 Circuit Grouping Diagram (Nusa Tenggara Barat)

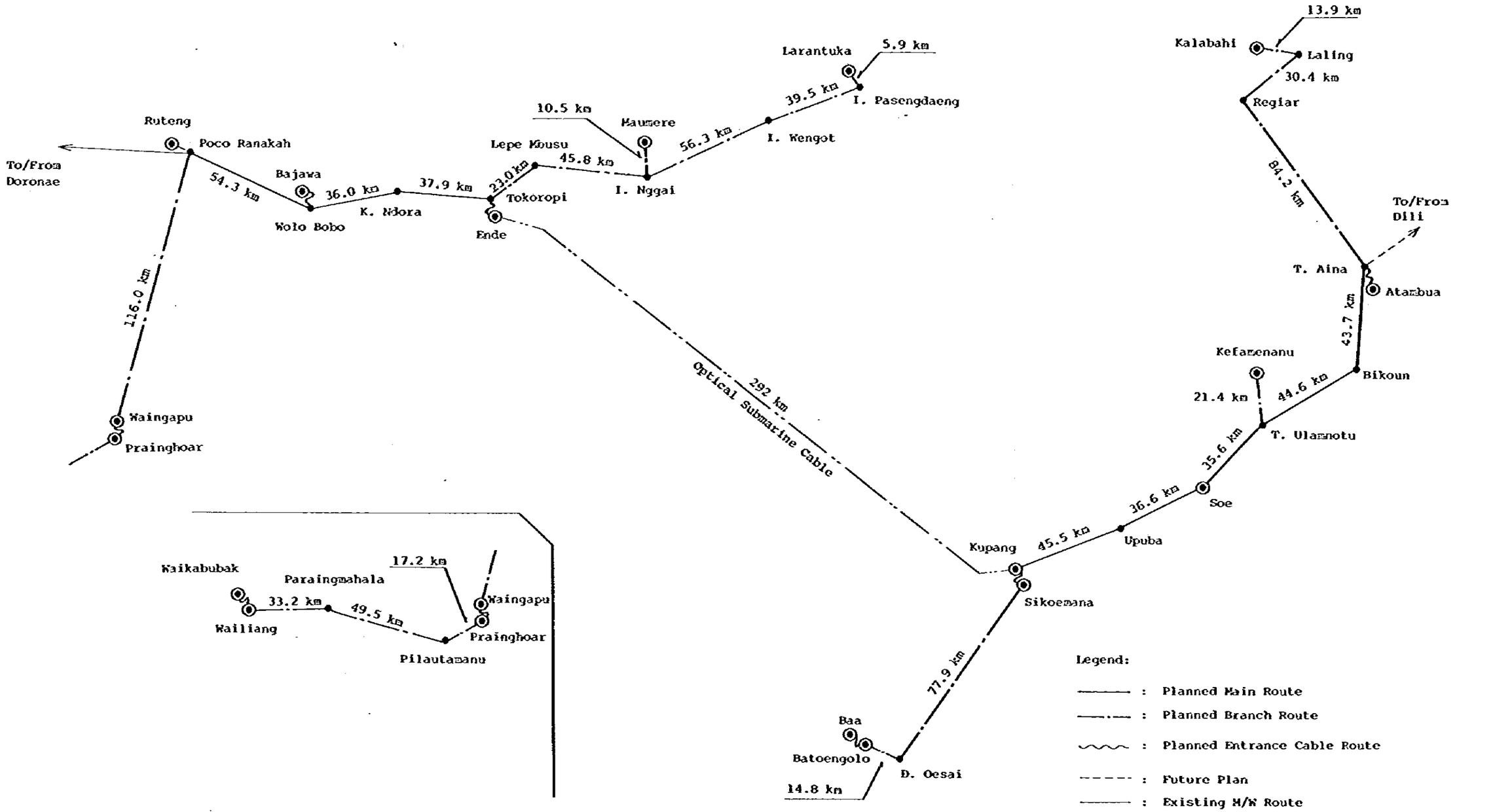


Figure 4-5 Transmission Route Plan (Nusa Tenggara Timur: Plan C)

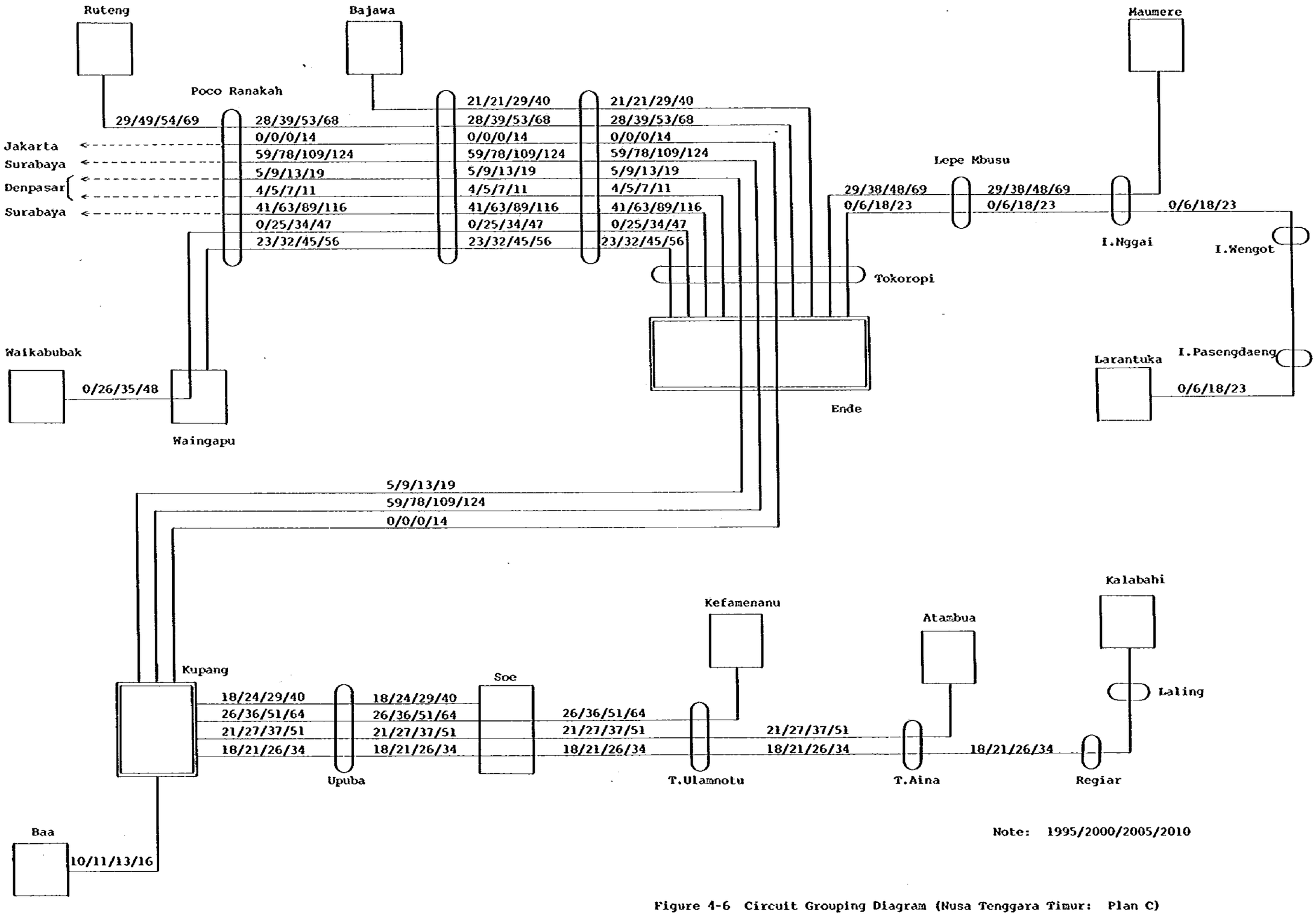


Figure 4-6 Circuit Grouping Diagram (Nusa Tenggara Timur: Plan C)

4-2 Transmission System Selection

Telecommunication network digitalization is now the worldwide trend. PERUMTEL, for its part, intends to adopt digital system for all automatic switching equipment to be introduced in Repelita IV and succeeding Repelita series. Adoption of digital transmission system is also planned.

Therefore, in this project also, the basic principle is to introduce digital transmission system as far as possible.

4-2-1 Terrestiral Radio Transmission System

For digital radio system, various types, one differing from another in assigned frequency band and bit rate, have been developed and are being put to use. After comparative study of these different types of digital radio system, selection is made for the type that uses 6 GHz frequency band (upper band) and holds bit rate of 68 Mbit/s (equivalent to 960 CH in telephony), for adoption on main route.

Selection made for use on spur route is for two types: 2 GHz frequency band, 4 Mbit/s (60 CH in telephony) bit rate type and 2 GHz, 8 Mbit/s (120 CH in telephony) type. For use on spur route of short span, selection is made for cable PCM system that uses symmetric pair cable.

Thus, in Nusa Tenggara Timur, Primary Center and Secondary Center are to be interconnected by digital transmission system. However, for Ruteng and Waingapu where terrestrial transmission system is already established, the existing system is to be utilized as much as possible, provided that capacity shortage to arise in the future be covered by additional installation of the same system as one that exists, i.e., analog system.

In Nusa Tenggara Barat, analog transmission system has already been constructed and is in operation. Therefore, to cover Dompu and Taliwang where terrestrial transmission system does not yet exist, analog radio system branching from the existing transmission system is to be established. For the type of system to adopt, selection is made for 800 MHz band, 120 CH type, after the study of circuit grouping result.

Table 4-1 presents section by section application of transmission system selected as per the foregoing. For Plan A wherein the final year is 2005 and Plan B that uses 2010 for final year, the transmission system to be adopted is the same.

Table 4-1 Applied Transmission System (Plan A, Plan B)

Section	Transmission System	Modulation
<Nusa Tenggara Timur>		
Poco Ranakah - Kupang (Main)	6 GHz (upper), 68 Mbit/s	8 PSK
I. Nggai - Maumere (Branch)	2 GHz, 8 Mbit/s	4 PSK
I. Pasengdaeng - Larantuka (")	" "	"
Regiar - Laling - Kalabahi (")	" "	"
T. Ulamnotu - Kefamenanu (")	" "	"
Sikoemana - D. Oesai - Batoengolo (")	" 4 Mbit/s	"
Prainghoar - Pilautamanu - Wiliang (")	" 8 Mbit/s	"
Poco Ranakah - Ruteng (")	400 MHz, 60 CH	FM
Poco Ranakah - Waingapu (")	" "	"
Wolo Bobo - Bajawa (")	Cable PCM	PCM
Tokoropi - Ende (")	"	"
T. Aina - Atambua (")	"	"
Kupang - Sikoemana (")	"	"
Batoengolo - Baa (")	"	"
Waingapu - Prainghoar (")	"	"
Wiliang - Waikabubak (")	"	"
<Nusa Tenggara Barat>		
Doronae - Monggo - Dompu (Branch)	800 MHz, 120 CH	FM
BT. Jorongkoak - Lab-Balat (")	" "	"
Lab-Balat - Taliwang (")	VP Cable	-

4-2-2 Submarine Cable System

These days, in the submarine cable system development, the transition to optical fiber cable system is a fait accompli. This project is scheduled to have Stage I work completed toward the end of fiscal year 1989 so that, in this project also, adoption of optical fiber cable system is taken for granted.

As is described in detail in the Master Plan, major importance of optical fiber cable system as applied to submarine cable system lies in developing a medium to large capacity system having bit rate of 140 Mbit/s or more. However, in Ende-Kupang section where submarine cable link is contemplated by this project, the number of circuits required is not more than 200 circuits or thereabouts even in the forecast for the year 2010, as is evident from the result of circuit grouping in Paragraph 4-1-2. Adoption of medium/large capacity system to meet a limited circuit requirement as in Ende-Kupang section will certainly be disadvantageous economically.

Even in case an extremely small capacity optical fiber submarine cable system having bit rate of 34 Mbit/s or so is to be adopted in Ende-Kupang section, cost of development, design and manufacture of such system is large enough not to allow expectation that a small capacity system can be more advantageous than the medium/large capacity standard system. In other words, no real merit in economic aspect derives from introducing a specifically small capacity system.

Therefore, in this study, decision is made to adopt the smallest capacity system out of all systems developed in various countries, i.e., a system with bit rate of 140 Mbit/s (equivalent to 1,920 CH in telephony).

Table 4-2 presents section by section application of transmission system on the assumption that optical fiber submarine cable system be adopted between Ende and Kupang. This case is classified as Plan C.

Table 4-2 Applied Transmission System (Plan C)

Section	Transmission System	Modulation
<Nusa Tenggara Timur>		
Ende - Kupang (Main)	Optical Submarine Cable	-
Poco Ranakah - Tokoropi (")	6 GHz (upper), 68 Mbit/s	8 PSK
Tokoropi - I. Nggai (Branch)	2 GHz, 17 Mbit/s	4 PSK
I. Nggai - Maumere (")	2 GHz, 8 Mbit/s	"
I. Nggai - Larantuka (")	" "	"
Kupang - T. Aina (Main)	6 GHz (upper), 68 Mbit/s	8 PSK
T. Aina - Kalabahi (Branch)	2 GHz, 8 Mbit/s	4 PSK
T. Ulamnotu - Kefamenanu (")	" "	"
Sikoemana - D. Oesai - Batoengolo (")	" 4 Mbit/s	"
Prainghoar - Pilautamanu - Wiliang (")	" 8 Mbit/s	"
Poco Ranakah - Ruteng (")	400 MHz, 60 CH	FM
Poco Ranakah - Waingapu (")	" "	"
Wolo Bobo - Bajawa (")	Cable PCM	PCM
Tokoropi - Ende (")	"	"
T. Aina - Atambua (")	"	"
Kupang - Sikoemana (")	"	"
Batoengolo - Baa (")	"	"
Waingapu - Prainghoar (")	"	"
Wiliang - Waikabubak (")	"	"
<Nusa Tenggara Barat>		
Same as Plan A and B		

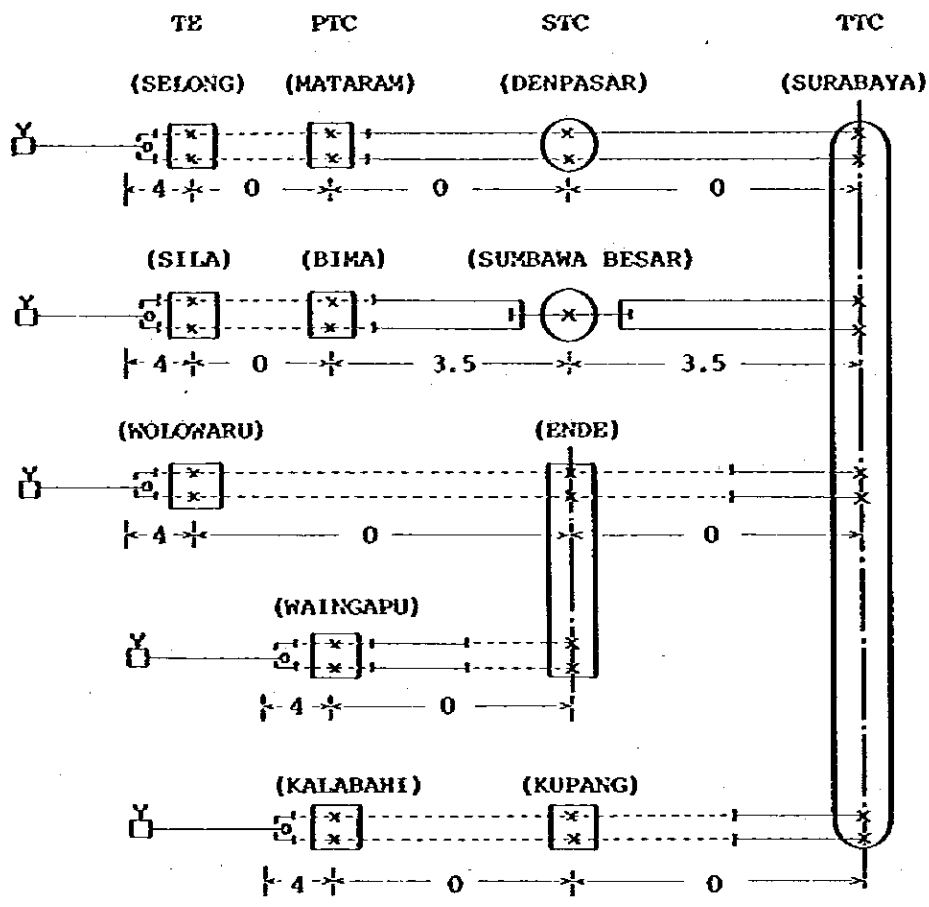
4-3 Transmission Loss Distribution Plan

Transition from analog network to digital network is the worldwide trend. And, in the course of this transition, the mixed operation of analog and digital transmission systems is unavoidable.

In due time, both these systems will be integrated into IDN (Integrated Digital Network). IDN itself will be replaced sooner or later by ISDN (Integrated Services Digital Network).

This project is to introduce digital transmission facilities in the existing analog network. Therefore, it is not advisable to apply to this project the transmission loss distribution plan based on the existing analog system.

The provisional transmission loss distribution plan applicable to the initial step of transition to digital network appears in Figure 4-7. The study of this transmission loss distribution plan is made in ANNEX-15.



Legend:

- Digital switching
- Analog 4W switching
- Analog 2W switching
- 2W/4W terminating unit with a mean balance network
- 2W/4W terminating unit with an individual balance network
- Analog circuit
- Digital circuit
- A/D or D/A coder (decoder)
- Telephone set

Figure 4-7 Transmission Loss Distribution Plan

4-4 Conditions for Interface

In Nusa Tenggara Timur, the most part of transmission route planned by this study is of digital system though analog transmission route exists in part of the area. For transmission route up to Surabaya Tertiary Center and west of Poco Ranakah repeater station on Flores Island, the existing analog transmission route is to be utilized. Thus the need arises for considering optimum interface design. Following are the conditions for interface:

(1) Between digital transmission system and digital switching equipment

2,048 kbit/s as recommended by CCITT (Rec. G.734)

(2) Between digital transmission system and analog switching equipment

Interface by voice frequency

(3) Between analog transmission system and digital switching equipment

Interface by voice frequency

(4) Between digital transmission system and analog transmission system

Interface by Transmultiplexer (CCITT Rec. G.793) and/or by voice frequency

(5) Between existing analog transmission system and projected analog transmission system

Interface by baseband branching and/or at supergroup level

As for non-telephone services, up to voice frequency or 64 kbit/s digital path will be included in this project coverage. However, associated data multiplexer, etc., beyond the limit of digital path above are not to be included in this project coverage.

4-5 Channel Accommodation Plan

Figure 4-8 and Figure 4-9 present the results of circuits in demand as of 1995 and 2010 accommodated in transmission system, based on circuit grouping result described in Paragraph 4-1.

In the formulation of circuit accommodation plan, the undermentioned conditions are used.

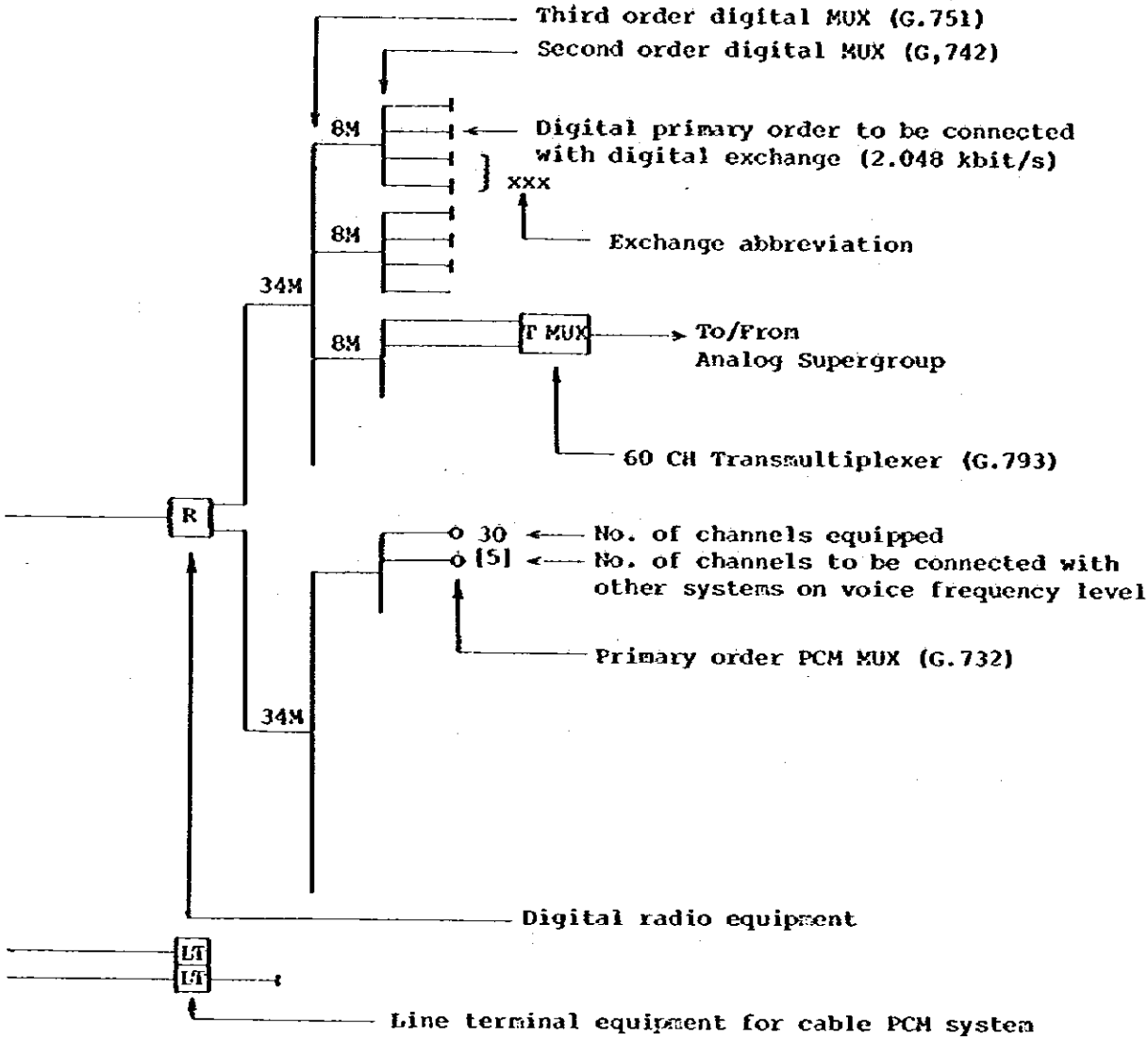
(1) Trunk circuits from Ruteng and Waingapu Exchanges covered by the existing analog transmission system are presently connected to Denpasar Secondary Center. Both are to be newly connected to Ende Secondary Center by this project. For this modification, both will be connected to the projected digital transmission system by voice frequency and Transmultiplexer at the existing Poco Ranakah repeater station.

(2) Prior to the completion of this project, all trunk switching equipment are to be digitalized. The digitalized trunk switching equipment interface with digital transmission system is to be at 2,048 kbit/s. For Baa and Bajawa where service will be by manual board until 1995, interface with transmission system is to be by voice frequency.

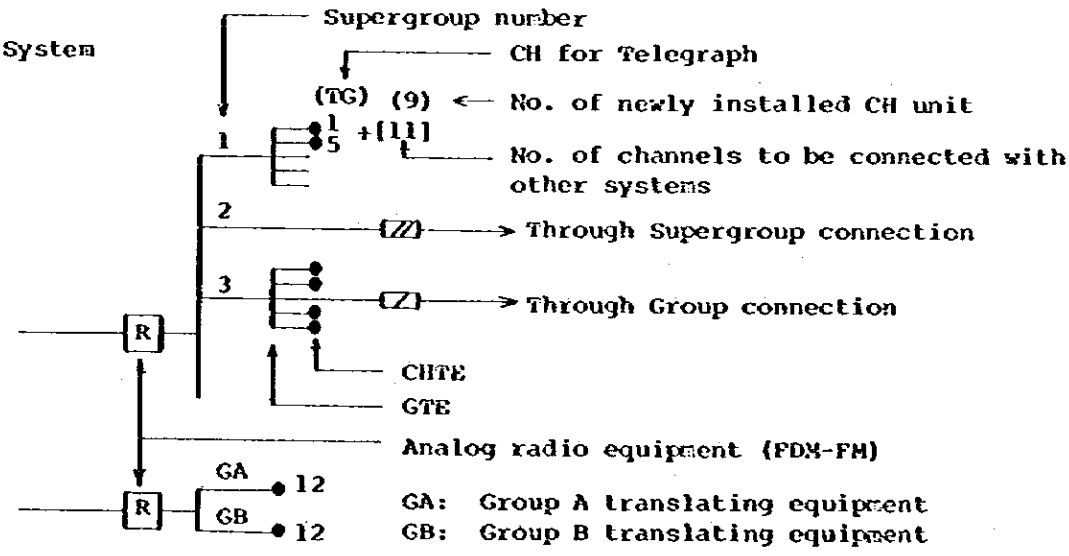
(3) In Nusa Tenggara Barat, analog transmission system exists so that interface between transmission system and switching equipment is to be by voice frequency. For multiplexing equipment at existing stations, existing ones are to be utilized.

Channel accommodation in the case of Ende-Kupang submarine cable link is given in the ANNEX-14 for the purpose of reference.

1. Digital System



2. Analog System



Legend for Channel Accommodation Plan

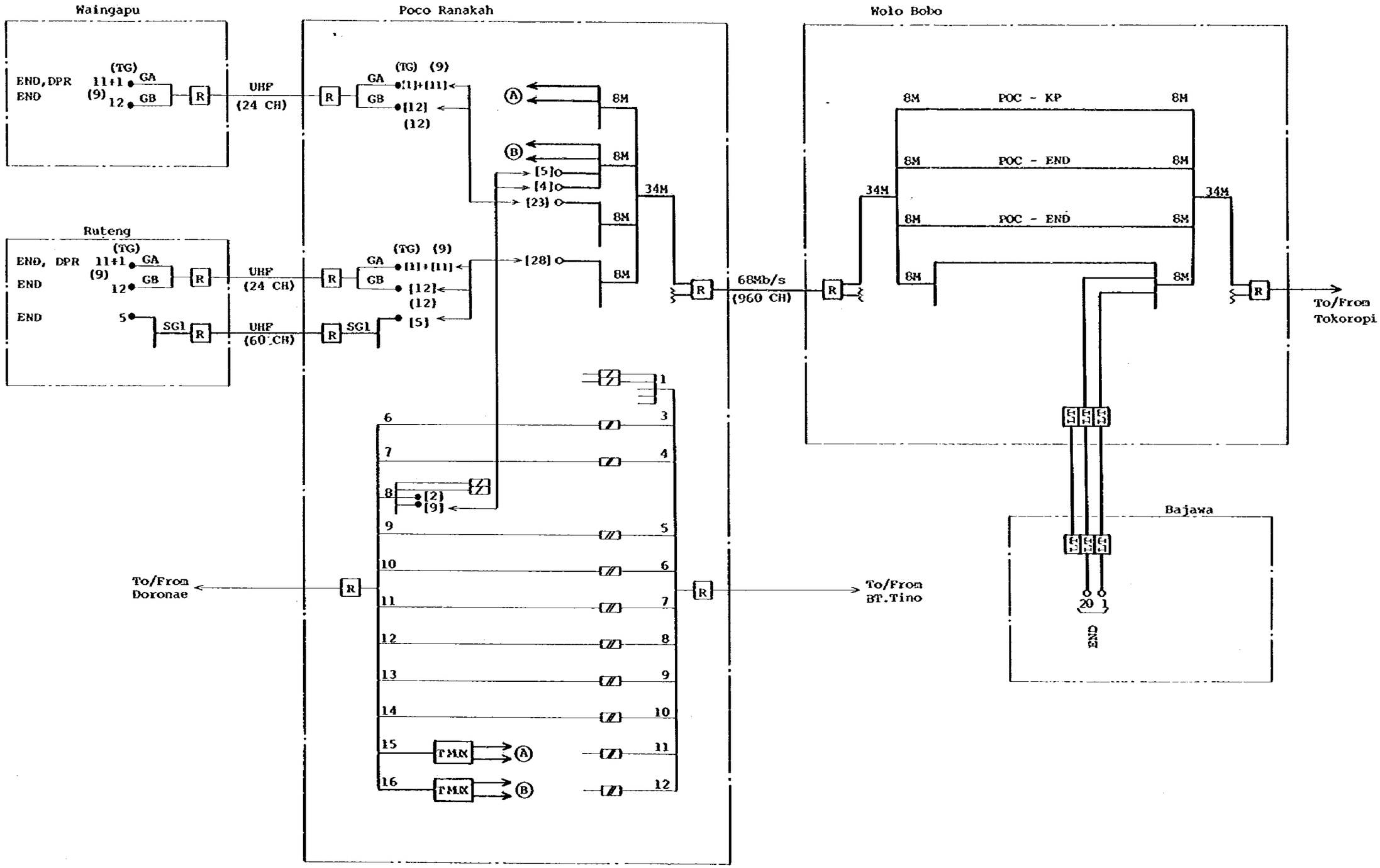


Figure 4-8 (1/5) Channel Accommodation Plan (1995)

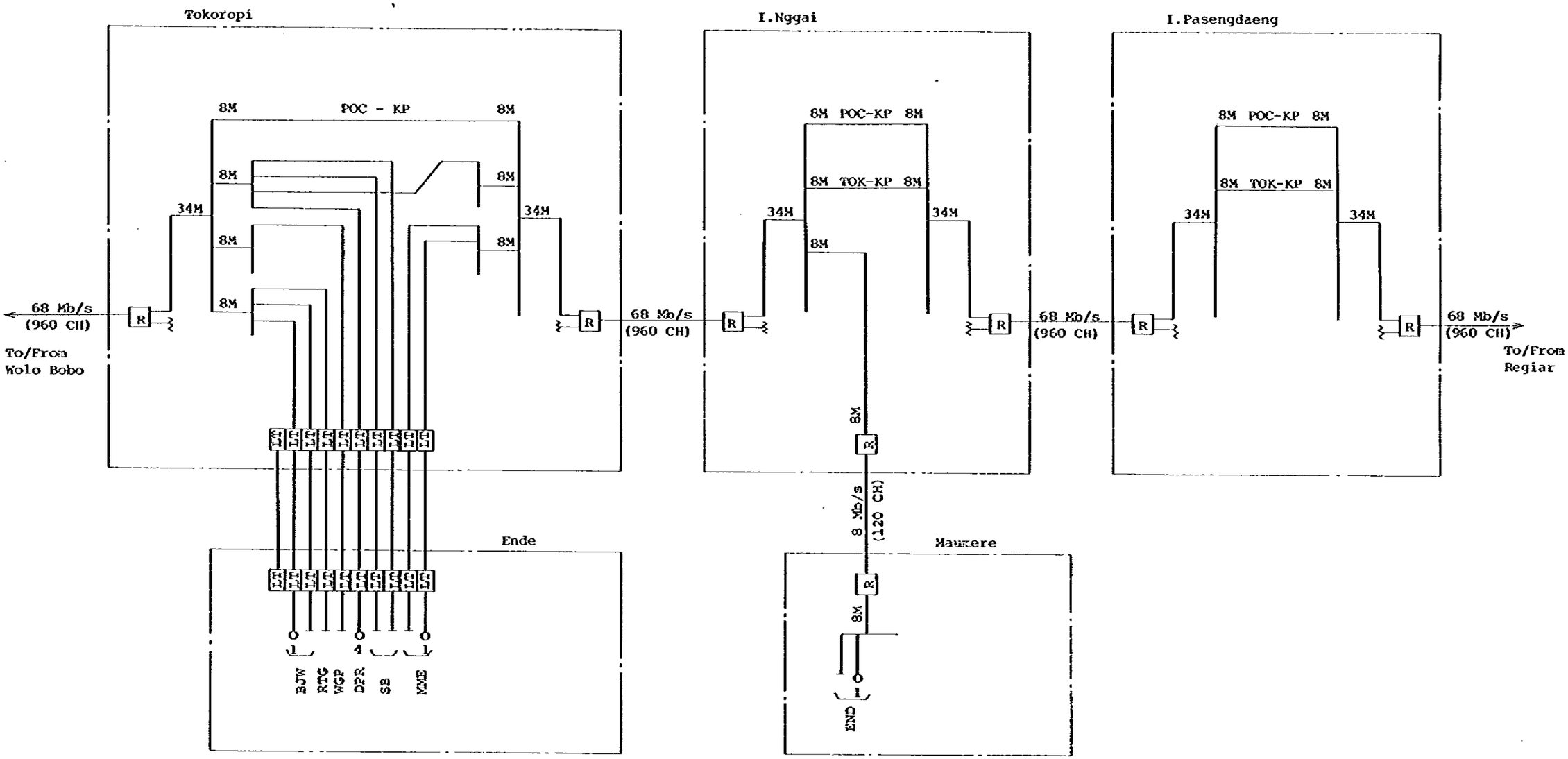


Figure 4-8 (2/5) Channel Accommodation Plan (1995)

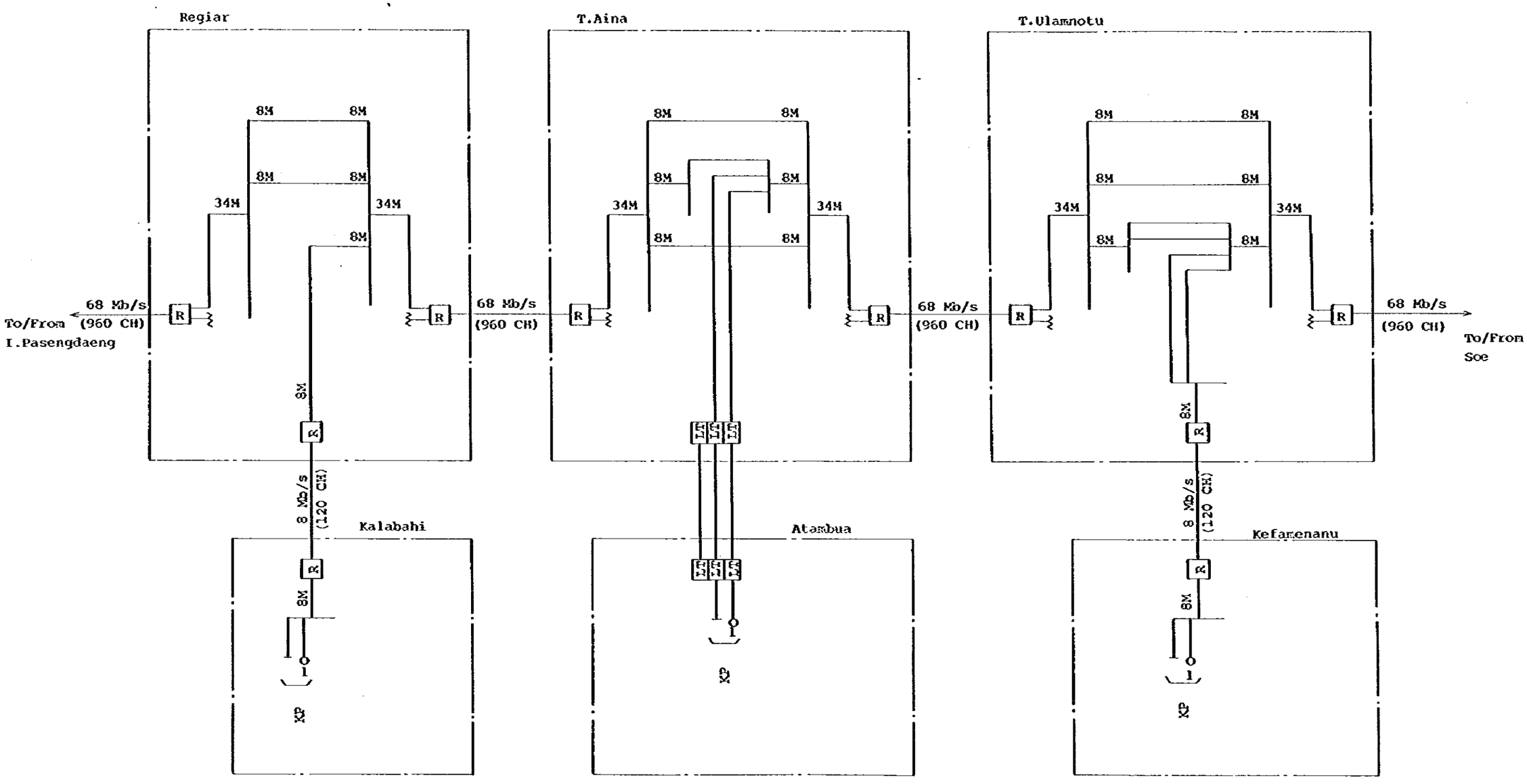


Figure 4-8 (3/5) Channel Accommodation Plan (1995)

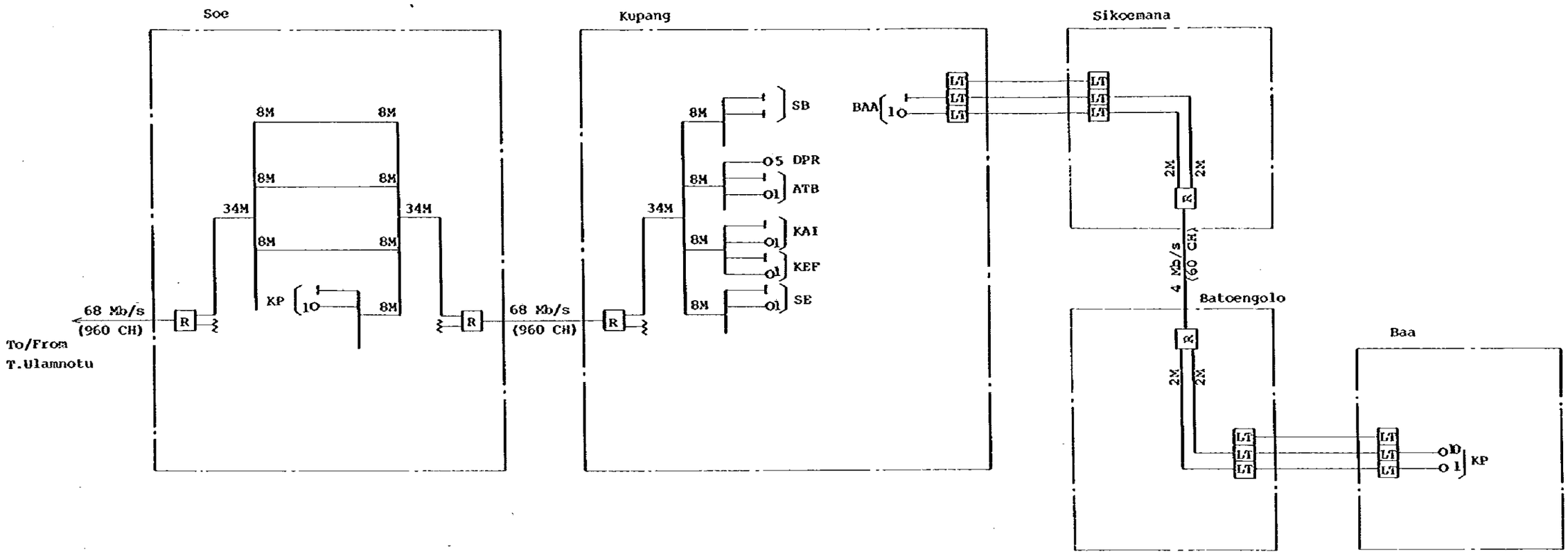


Figure 4-8 (4/5) Channel Accommodation Plan (1995)

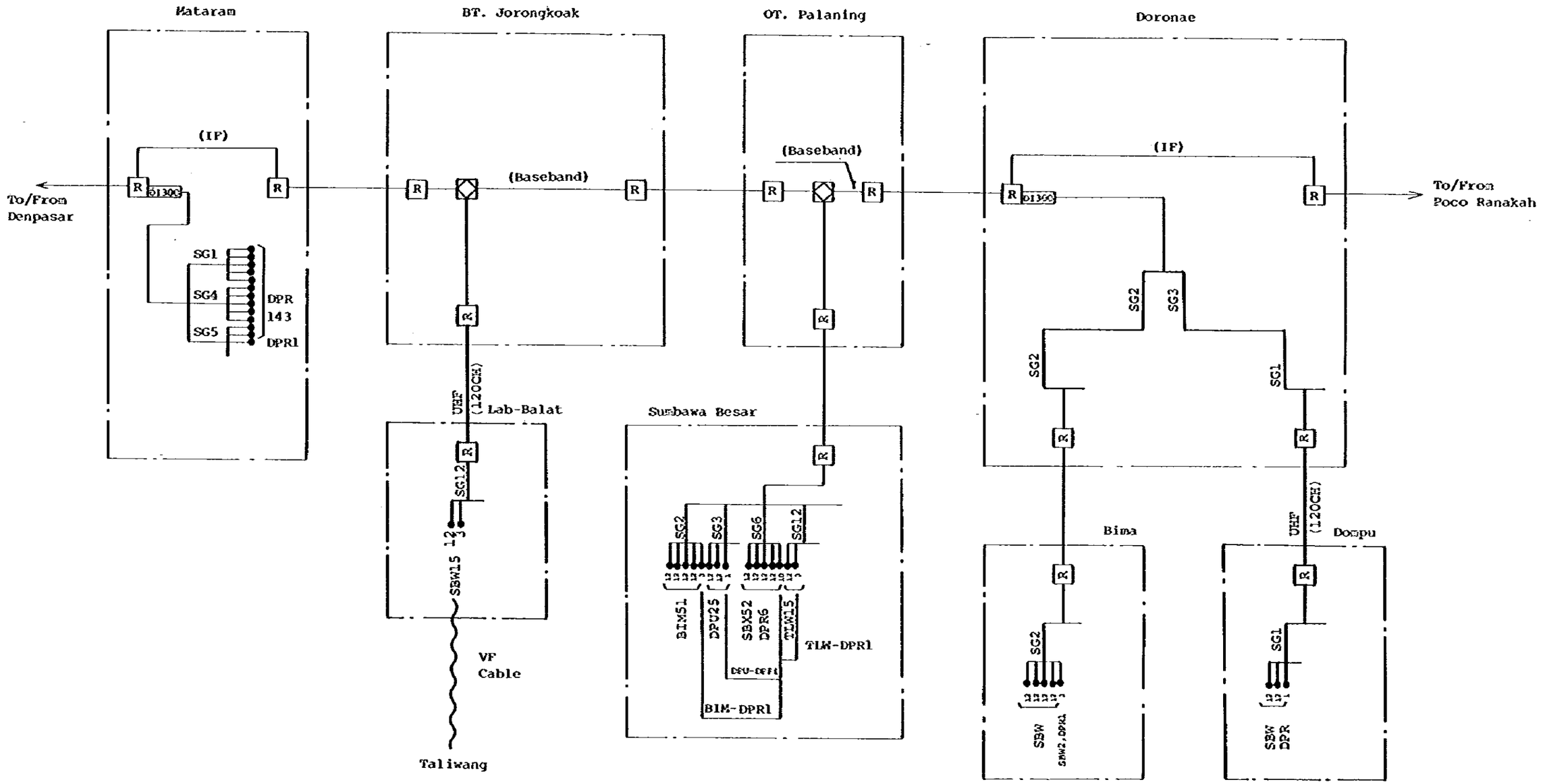


Figure 4-8 (5/5) Channel Accommodation Plan (1995)

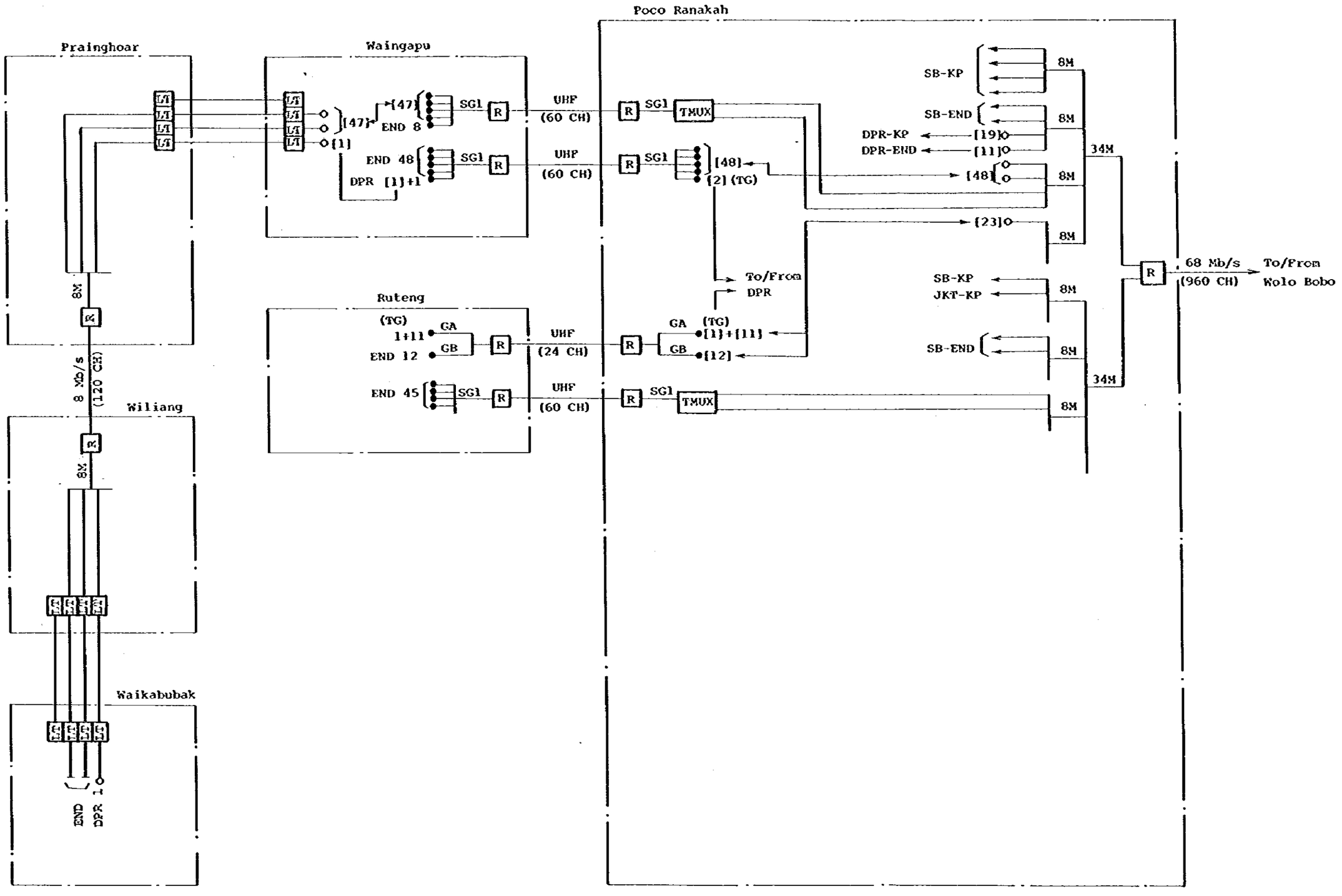


Figure 4-9 (1/5) Channel Accommodation Plan (2010)

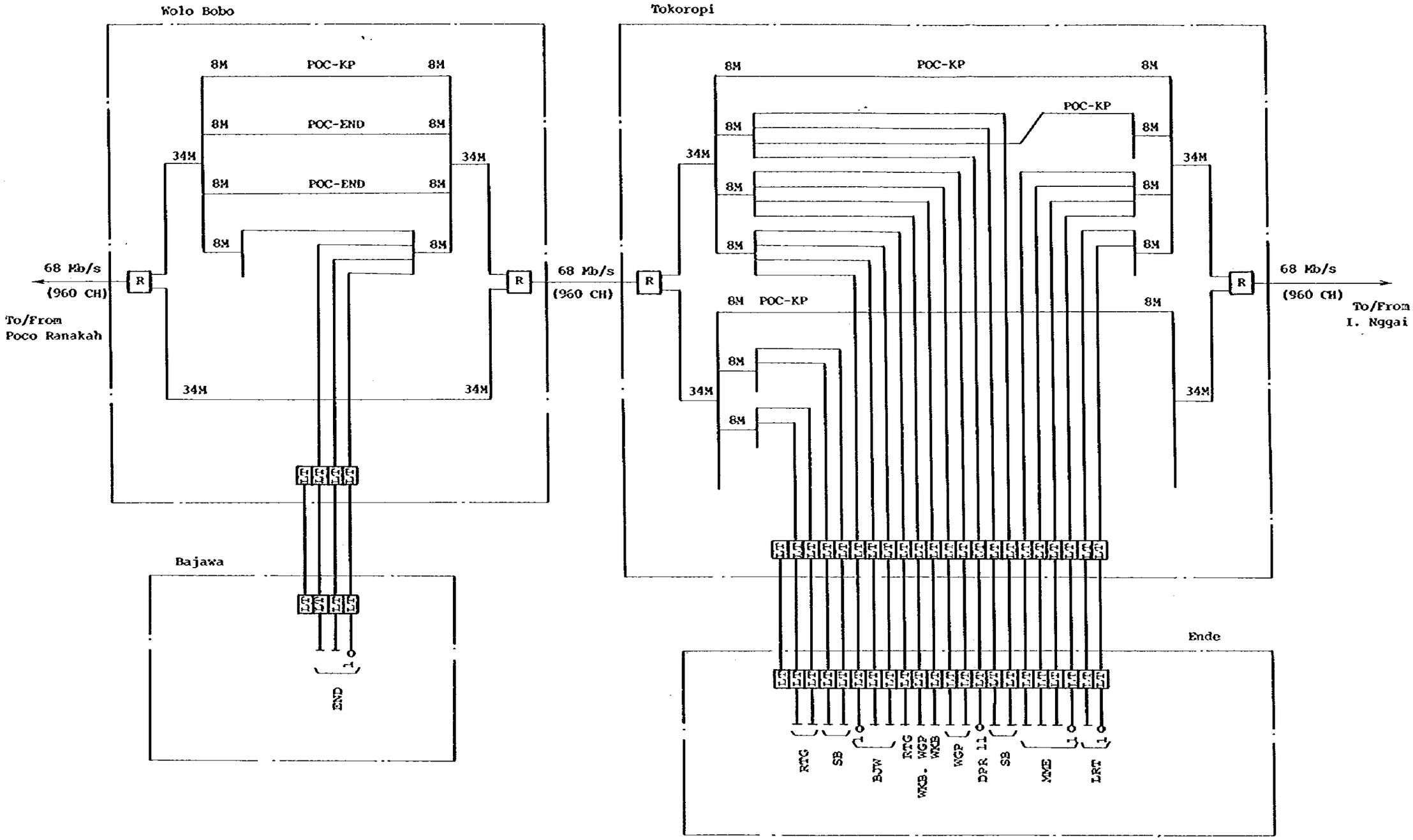


Figure 4-9 (2/5) Channel Accommodation Plan (2010)

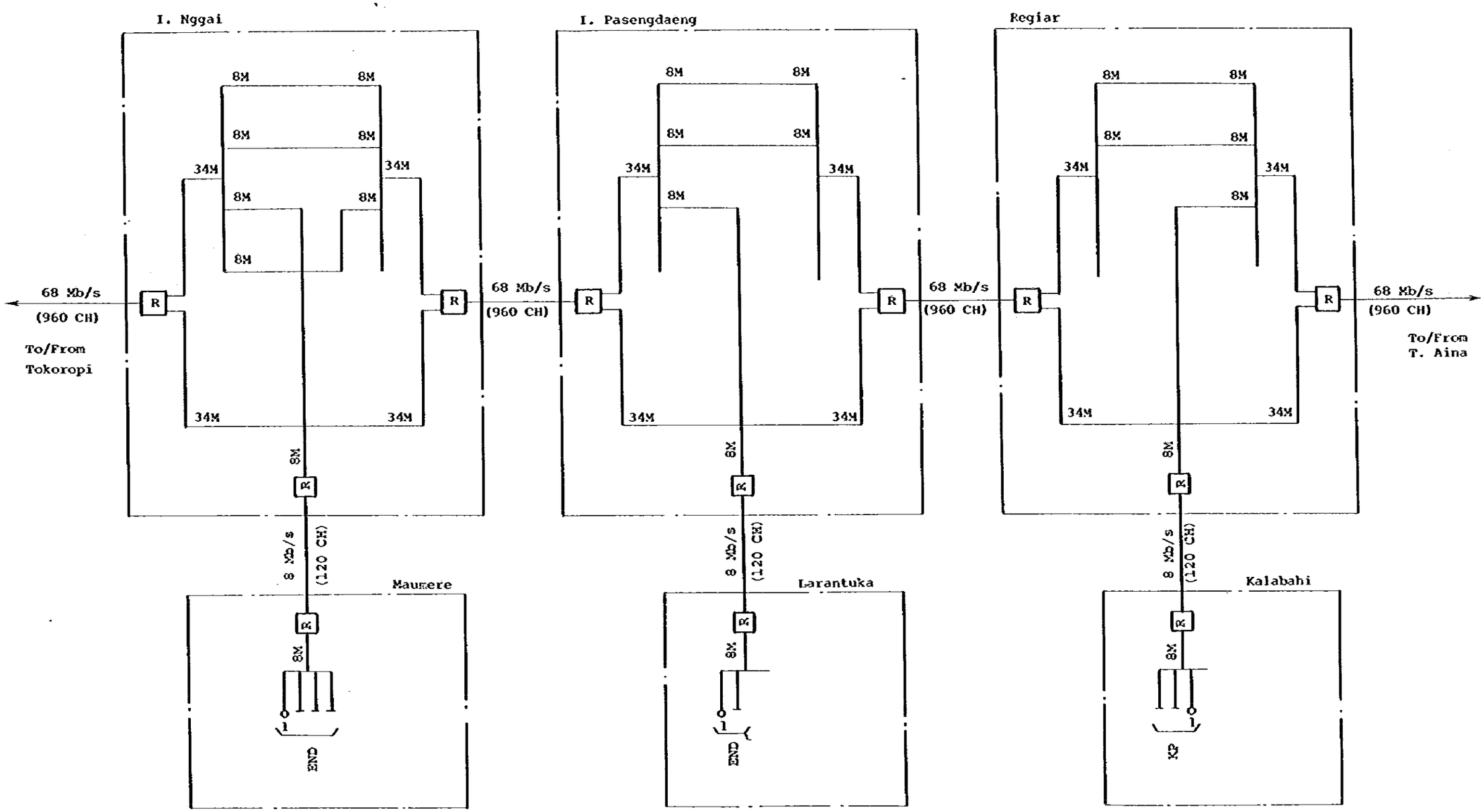
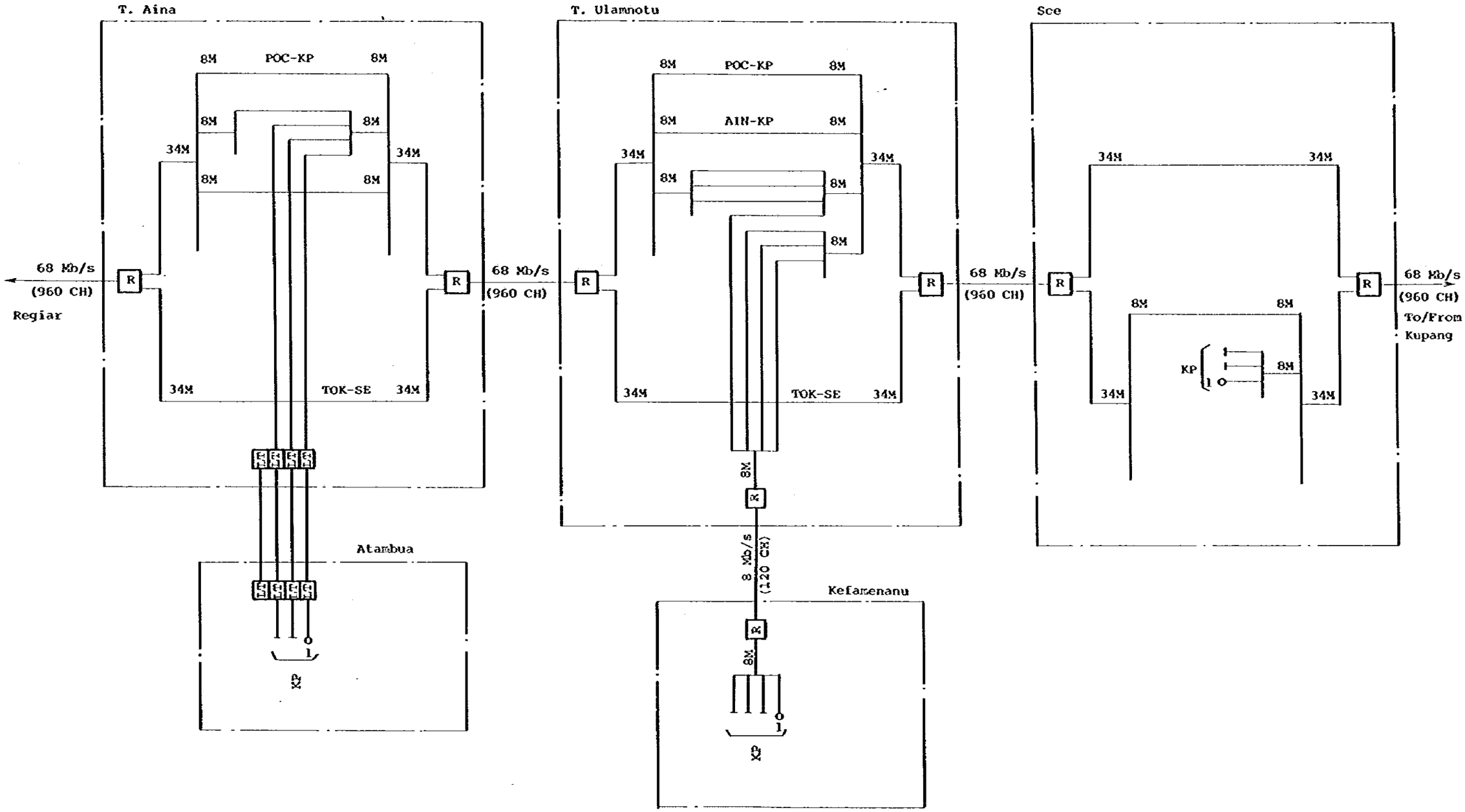


Figure 4-9 (3/5) Channel Accommodation Plan (2010)



Figrue 4-9 (4/5) Channel Accommodation Plan (2010)

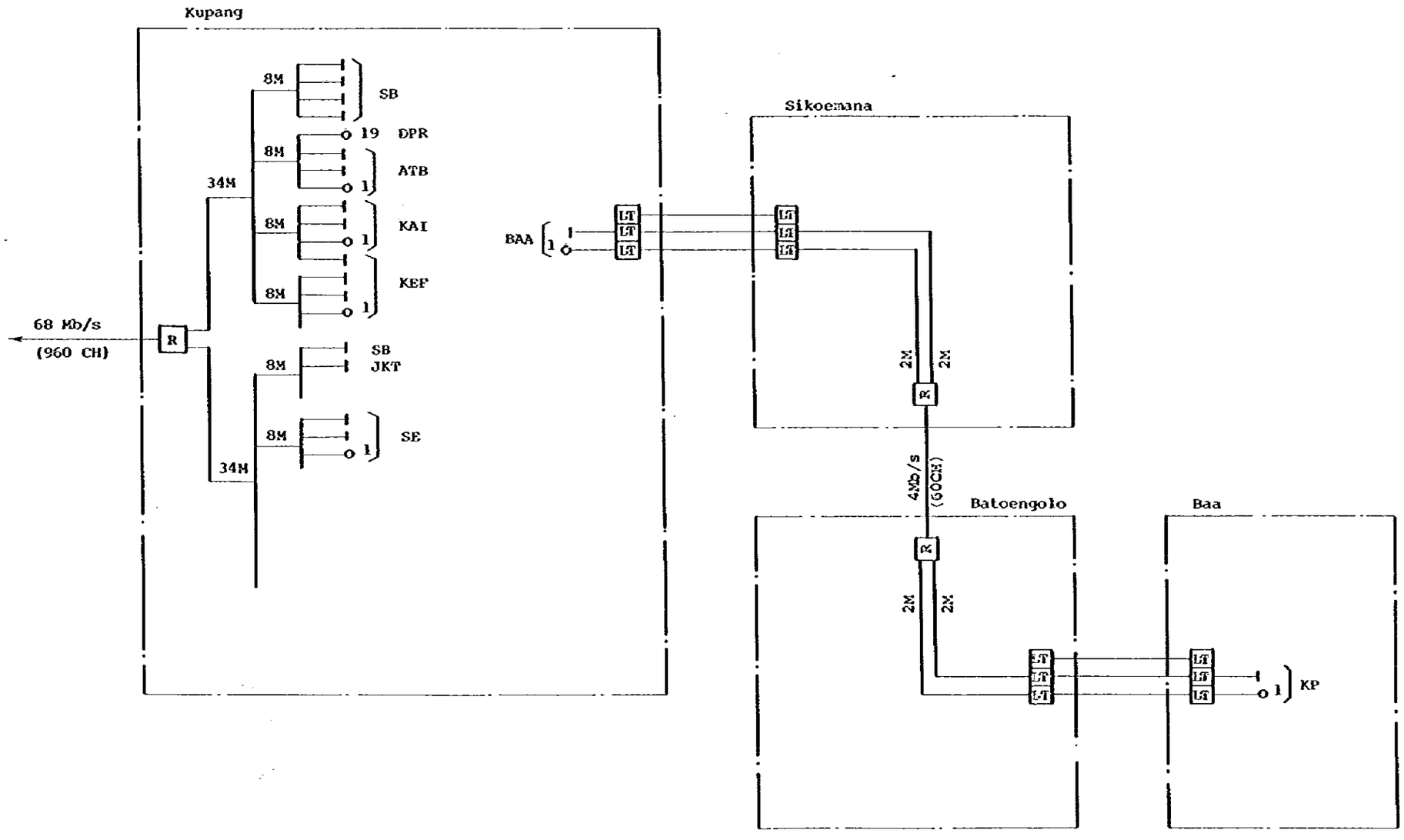


Figure 4-9 (5/5) Channel Accommodation Plan (2010)

4-6 Rough System Design of Radio System

4-6-1 Frequency Assignment Plan

(1) In the digital radio system to be established by this project, 6 GHz band (upper band) frequency will be assigned to the main route and 2 GHz band frequency to the spur route.

For radio channel arrangement in the frequency bands mentioned above, CCIR Rec. 384-3 and 283-4 will be observed.

(2) Radio channels required in this project are two RF channels (1 working and 1 standby). For the main route where 6 GHz band frequency will be used, the number of RF channels that can be accommodated in the antenna system (including branching filter) should be obtained. In other words, the antenna system should be so composed that it can accommodate additional RF channels that may be required in the future.

In this project, sending/receiving antenna with capacity for up to four RF channels (3 working and 1 standby) is to be used for the main route.

(3) For Ruteng and Waingapu in Nusa Tenggara Timur, 60 CH analog system using 400 MHz frequency band is to be adopted. At these two stations, the analog system using 400 MHz frequency band is already in operation so that radio channel arrangement must be so determined that mutual radio interference can be avoided.

(4) In Nusa Tenggara Barat, 120 CH analog system using 800 MHz frequency band will be adopted.

4-6-2 System Performance Objectives

Performance of digital radio system is evaluated by the bit error ratio (BER) and percentage of time which exceeds BER objective. CCIR in its Rec. 594 provides the following provisional BER objectives applicable to hypothetical reference digital path for radio relay systems.

(1) Low BER Objectives

BER should not exceed 1×10^{-7} for more than 1% of any month. (Integration time; Under study. One minute has been proposed.)

(2) High BER Objective

BER should not exceed 1×10^{-3} for more than 0.05% of any month. (Integration time; 1 second)

For the actual circuit differing from the hypothetical reference digital path (CCIR Rec. 556), CCIR Rep. 930 proposes the following real circuit standards as being appropriate:

(1) High BER objective: To distribute the time percentage allowable to the hypothetical reference digital path in proportion to the actual circuit length. Provided that the time percentage distribution by distance applies only in case where the transmission route length exceeds 280 km, and that where the transmission route length is less than 280 km, the time percentage allowable for 280 km be applied.

(2) Low BER objective: Preferably to distribute the time percentage in proportion to the transmission route length and, at the same time, analyze BER by statistical method and distribute such BER.

4-6-3 Radio Propagation Path and Tower

(1) Radio Propagation Path

Radio propagation path to be used in this project is one selected first by desk study with maps of reduced scales of 1/50,000 and 1/250,000, and then by summary field survey. In-depth study including line-of-sight confirmation by mirror test was not carried out.

The selected radio propagation paths are twofold. One is from Poco Ranakah, Flores Island, to I. Pasengdaeng, Adonara Island. The other is from Kupang, Timor Island, to T. Aina, near Atambua, where the repeater station is scheduled to be established. These paths are classified as a mountain propagation path with a length of about 50 km so that favorable circuit performance can be expected.

However, the three hops between I. Pasengdaeng, the scheduled repeater station site on Adonara Island, and Ragiar, the scheduled repeater station site on Alor Island, are the hops including oversea propagation. Therefore, in these three sections, circuit performance deterioration due to fading is anticipated. Hence the adoption of space diversity.

The hop between Alor Island and Timor Island is for about 85 km long oversea propagation. In this hop, special design, such as adoption of automatic equalizer, in addition to space diversity will be required.

The hop between Sikoemana, the scheduled repeater station site near Kupang, and D. Oesai, the scheduled repeater station site on Rote Island, is nearly 80 km long comprising the oversea propagation hop. Hence the adoption of space diversity in this hop also.

The whole propagation path profile map is given in ANNEX-17 as reference.

(2) Tower

All towers planned in this project are of self-supporting type. Antenna heights are determined as required to meet the following conditions:

a) Radio path clearance factor be 1 or more when the coefficient of effective radius of the earth is K = 4/3, 0.3 or more when K = 2/3.

b) In consideration of trees and buildings on the radio propagation path and in the neighborhood of each scheduled site, antenna height be at least 30 m or preferably more.

4-6-4 Design of Long Distance Oversea Propagation Path

As previously stated, the radio propagation path between Alor Island and Timor Island is for oversea propagation for the most part. The distance is about 85 km long. Therefore, in this section, circuit performance deterioration due to fading and wave form distortion is apt to take place. Following are the matters that require special consideration in the technical design of this section:

In the digital radio system, interruptions are due either to wave form distortion or to thermal/ interference noise.

In the digital system, if the amplitude deviation within the transmission frequency band exceeds the allowable value, wave form distortion takes place, causing BER to increase conspicuously, and this, in turn, leads to interruptions. In the case of oversea propagation and where the path distance is long, the reflected wave whose path difference from the direct wave is long exists, causing the amplitude deviation in the frequency band to enlarge. In this connection, there arises need to estimate interruption probability due to wave form distortion.

In the case of fading also, when the quantity of fading exceeds the allowable limit, interruptions occur.

In view of the foregoing, at the stage of implementation work for this section, in-depth study must be made about interruptions, considering both the interruption due to wave form distortion and the interruption due to fading. And, based on study findings, the radio system that complies with the objective standard should be formulated.

For the digital radio system, the technology to compensate the effect of fading, as well as the wave form distortion compensating technology that utilizes automatic equalizer, etc., has already been developed. Therefore, in the selection of optimum system, these technologies should be fully taken advantage of.