BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE DEVELOPMENT
OF
DOMESTIC TELECOMMUNICATION NETWORK
IN
KINGDOM OF BHUTAN

VOLUME I

SEPTEMBER, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR THE DEVELOPMENT
OF
DOMESTIC TELECOMMUNICATION NETWORK
IN
KINGDOM OF BHUTAN

VOLUME I

SEPTEMBER, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Royal Government of the Kingdom of Bhutan, the Government of Japan decided to conduct a basic design study on the Project for Development of Domestic Telecommunication Network in the Kingdom of Bhutan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Bhutan a study team headed by Mr. Toru Fujita, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from February 28 to April 18, 1991.

The team held discussions with the officials concerned of the Royal Government of Bhutan, and conducted a field study at the study areas. After the team returned to Japan, further studies were made. Then, a mission was sent to the Kingdom of Bhutan in order to discuss a draft report and the present report was prepared.

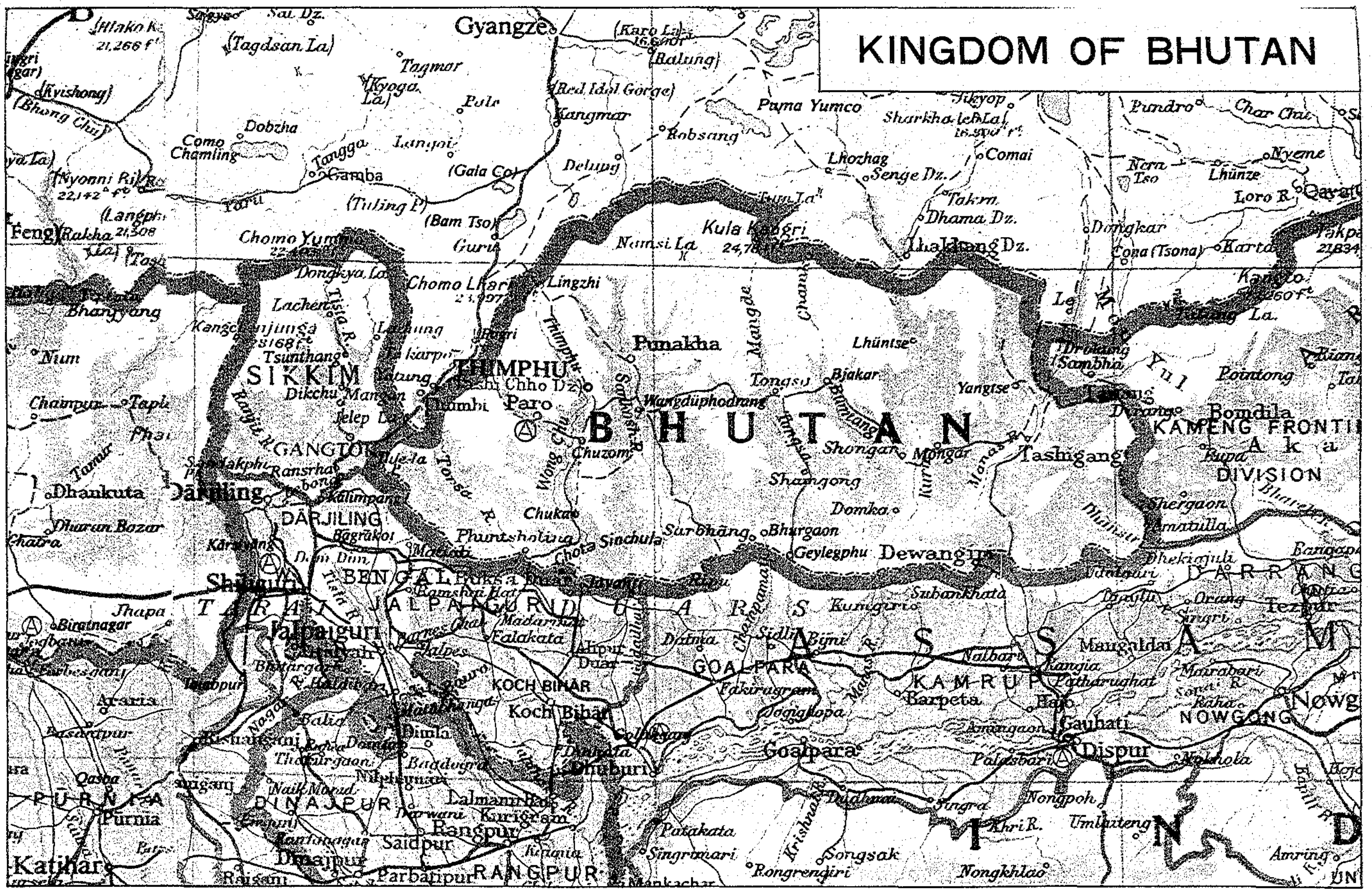
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Royal Government of the Kingdom of Bhutan for their close cooperation extended to the teams.

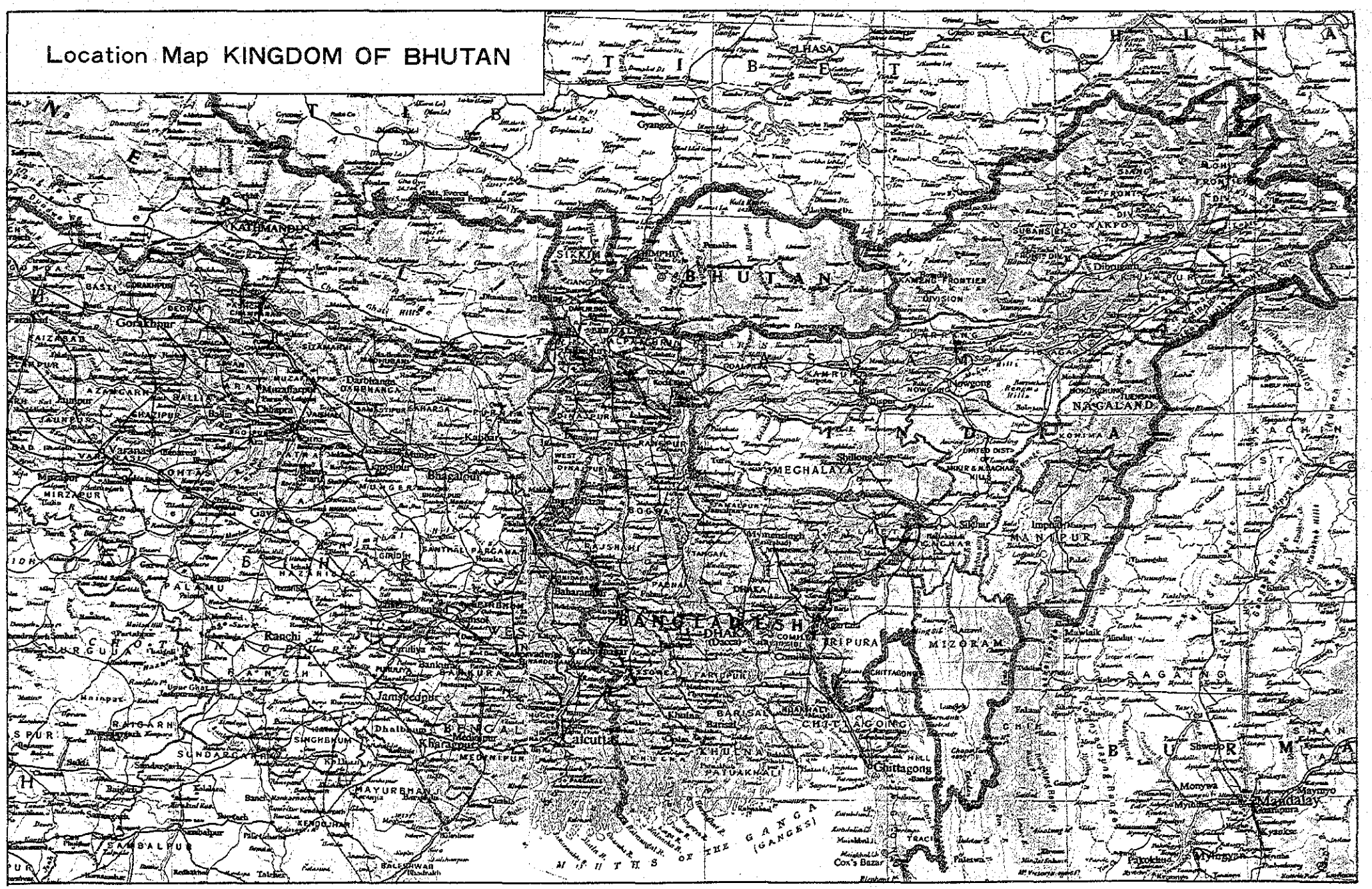
September, 1991

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency


KINGDOM OF BHUTAN
BHUTAN
THIMPHU
Paro
Punakha
Wangdüphodrang
Tongsa
Bjakar
Lhüntse
Shongar
Mongar
Yangtse
Tashigang
Shamgong
Domka
Bhurgaon
Sarbhang
Geylegphu
Dewangiri
Chukha
Phuntsholing
Chota Sinchula
Lingzhi
SIKKIM
GANGTOK
Därjiling
DÄRJILING
Kalimpong
Gyangze
Pama Yumco
Kula Kangri
Chomo Lhari
Lhalung Dz.
KAMENG FRONTIER
DIVISION
Bomdila
BENGAL
JALPAIGURI
Jalpaiguri
Siliguri
KOCH BIHAR
Koch Bihar
GOALPARA
Goalpara
KAMRUP
Barpeta
Gauhati
Dispur
Dhuburi
RANGPUR
Rangpur
DINAJPUR
Dinajpur
Saidpur
Purnia
Katihar
Dhankuta
NOWGONG

Location Map KINGDOM OF BHUTAN



SER ES OF VARIOUS DEP TMENTS UNDER INISTRY OF COMMUNICATION & TOURISM

Radio Transmission Route

Radio Repeater Station

Radio Passive Repeater

Telephone Exchange

DRCS Subscriber Station

Future Pean

LEGEND	Nos.
International Boundary	
Dzongkhag Boundary	
Capital	
Dzongkhag Headquarter	
Major Town/Village	
Bhutan Tourism Corporation	
Campsite	77
Community Hall	6
Hotel	3
Cafeteria/Lounge	7
Trekking Route	14
Civil Aviation	
Airport	1
Information and Broadcasting	
Information Centre	1
Broadcasting Station	1
Post, Telegraph and Civil Wireless	
General Post Office	2
Branch Post Office	29
Post Office	54
Telegraph Office	8
Wireless Transmission	33
Hydromat	13
Telecommunication	
Telephone Station	14
Telex Office	2
Transport Routes	
BGTS Route	
Private Route	
Mixed Route	
Govt. Central Workshop (Managed by Pvt. Organisations)	3
Major Mountain (altitude in metres)	

1:500 000

0 5 10 20 30km

PUNAKHA · THIMPHU · PARO · HA · WANGDI PHODRANG · DAGA · SAMCHI · CHHUKHA · CHIRANG · GEYLEGPHUG · TONGSA · BUMTHANG · LHUNTSHI · MONGAR · SHEMGANG · PEMAGATSEL · TASHIGANG · SAMDRUP JONGKHAR

BGTS-Routes through India

BGTS-Routes through India

89° 90° 91° 92° 28° 27°

Printed at the Survey of Bhutan First Edition, 1988

SUMMARY

SUMMARY

Kingdom of Bhutan is a landlocked country situated in the north-east Himalayas between China and India. Most of the country is virtually mountainous and divided geographically into 3 parts of the western, central and eastern regions by deep valleys running from north to south. The inhabitants in respective regions also dwell separately from each other.

The Ministry of Communications, Royal Government of Bhutan operates the telecommunication facilities and provides all telecommunication services, both domestic and international. During the sixth five year plan period, the telecommunication network centered on the capital city Thimphu has been partly improved, with new installation of Thimphu telephone exchange (combined with international, transit and local), a satellite earth station and digital radio concentration systems to provide telephone/telex services to surrounding areas of Thimphu.

However, a unified nationwide telecommunication network to connect the three regions has not been established yet, and such situation puts difficulties in the way of socioeconomic development of the country, as well as reduction of regional disparities.

At the present time, domestic telephone services are available only within each region and not extendable to other regions because the telephone networks are regionally independent of each other and not provided with trunk circuits to interconnect other regional networks. The international telephone services are available in the western region through Thimphu exchange. However, the communities of the central and eastern regions are isolated from international services as they cannot be connected to an international gateway, Thimphu exchange.

The telephone exchanges are located in each center of 11 among 18 Dzongkhags, but no exchanges in the remaining 7 Dzongkhags in the central and eastern regions. Telecommunication available throughout the whole country is only shortwave radio communication (civil wireless) which is mostly used for message transmission by morse code and operated under extremely unreliable conditions.

The existing telephone exchange facilities are of old type and already aged excepting Thimphu. Consequently, it is difficult to expand the exchange capacity to satisfy new subscribers. In addition, the operation and maintenance costs of the exchanges have become exceedingly heavy.

In view of the present situation of the telecommunication sector in Bhutan as mentioned above, the Royal Government of Bhutan requested a Grant Aid by the Government of Japan to execute the Project for Development of Domestic Telecommunication Network in Kingdom of Bhutan aiming at the establishment of a unified nationwide telecommunication network adequate in quality and reliability, in order to promote "regionally well balanced" social and economic development in the country.

The Government of Japan, in response to the request, decided to conduct a Basic Design Study on the Project and the Japan International Cooperation Agency (JICA) sent to Bhutan a Basic Design Study Team to carry out a field survey and to hold discussions on the Project with officials concerned of the Royal Government from February 28, 1991 to April 18, 1991. After the field survey and the discussion, JICA studied and examined the request and then drafted a basic design on an adequate scale for the Grant Aid. JICA sent a mission again to Bhutan in order to discuss the draft Basic Design Study Report from July 9, 1991 to July 21, 1991 and confirmed the Report finally.

Summary of the basic design is as follows:

(1) Scale of telecommunication network

The following telecommunication networks centered on Thimphu and covering the central and eastern regions will be established as a part of the unified nationwide telecommunication network:

- Digital microwave radio transmission network
- Digital telephone switching network
- Digital radio concentration system (DRCS) network
- Local subscriber line network

(2) Scope of telecommunication facilities

1) Digital microwave radio transmission facilities (8 GHz band, 34 Mbit/s, (1+1) system) to terminate at the following exchanges:

Route 1 Thimphu, Tongsa, Jakar, Mongar and Tashigang
Route 2 Tongsa, Shemgang, Geylegphug, and Damphu
Route 3 Tashigang, Pemagatsel and Samdrup Jonkar

The required repeater sites are as follows:

Route 1 5 radio repeaters and 6 passive repeaters
Route 2 5 radio repeaters and 4 passive repeaters
Route 3 1 radio repeater and 1 passive repeater

2) Digital telephone switching facilities with the following number of local line circuits:

Tongsa	500	(Host of Jakar)
Jakar (RSU type)	500	
Mongar (RSU type)	410	
Tashigang	810	(Host of Mongar)
Shemgang (RSU type)	200	
Geylegphug	650	(Host of Shemgang and Damphu)
Pemagatsel (RSU type)	200	
Samdrup Jonkar	600	(Host of Pemagatsel)

3) DRCS network facilities (2.4 Ghz band, 1024-line capacity) with following local line circuits:

Yongphula	190	(Tashigang base station)
Lhuntshi	90	(Mongar base station)
Sarbhang	150	(Geylegphug base station)
Daga	80	(Damphu base station)

The required numbers of DRCS repeaters are as follows:

Yongphula route	1
Lhuntshi route	3
Sarbhang route	1
Daga route	2

4) Power supply facilities for all the facilities listed above will be made by the following systems in case the public electricity is not available as the primary power sources:

-1. Solar power system by solar cells only
-2. Combined power system by solar cells and a diesel engine generator
-3. Prime engine generating system by two diesel engine generators

In case the public electricity is available as the primary power source, one set of diesel engine generator will be provided as the standby prime power source. In the case that the public power is not stable, dual diesel standby engine generator will be provided.

5) Prefabricated shelters to accommodate telecommunication facilities, storage batteries and diesel engine generators for the microwave and DRCS repeater stations:

Route 1	9 sites
Route 2	7 sites
Route 3	1 site

6) Antenna supporting structures for digital microwave radio transmission and DRCS:

Self-supporting tower	24 sites
Prefabricated mast	7 sites

7) Supply of cable, jointing materials, cable distribution boxes, etc. for local subscriber line networks in all local areas of the telephone exchanges and DRCS subscriber stations mentioned above.

8) Supply of equipment spare parts, tools and testing instruments for operation and maintenance works.

(3) Design policy

International standards such as CCITT, CCIRR recommendations and reports have been applied. Remote supervision and control have been considered for rationalization of the operation and maintenance works.

(4) Scope of the works by Bhutan side

The basic design provide that the following works will be carried out by the Royal Government of Bhutan:

1) Construction of new buildings and/or modification of the existing buildings of the telephone exchanges and the DRCS subscriber stations
2) Land acquisition
3) Construction of access roads to the sites and site preparation with fencing
4) Detailed design of the local subscriber line networks
5) Procurement of cable laying materials, wiring materials for subscriber's premises and telephone instruments

(5) Implementation schedule

In view of the widely scattered sites, and the climatic and geographical conditions in Bhutan, the Project is to be divided into three phases as shown below:

First phase:

Route 1 of digital microwave radio transmission network

Second phase:

1) Routes 2 and 3 of digital microwave radio transmission network
2) Digital telephone exchanges:
   - Tongsa
   - Jakar
   - Mongar
   - Tashigang
   - Geylegphug
   - Samdrup Jonkar
3) Cables for 6 local networks

Third phase:

1) 4 DRCS networks:
   - Yongphula
   - Lhuntshi
   - Sarbhang
   - Daga
2) Digital telephone exchanges:
   - Shemgang
   - Damphu
   - Pemagatsel
3) Cables for 7 local networks

(6) Conclusion

When the telecommunication network has been established in accordance with the basic design, reliable telephone services will become available in all the Dzongkhag centers in the central and eastern regions, including 7 Dzongkhag centers where telephone services is not available at the present time, with the capital city Thimphu as its networking center. Since the network can further interwork with the existing western region network and also the international network through existing Thimphu exchange, a nationwide telecommunication network throughout the whole country will be formulated, although modernization of the existing western region network will remain yet to be done. In addition, the network facilities will be provided with possibilities to satisfy new telecommunication demands not only for telephone but also for none-telephone services such as telex, facsimile and data.

Consequently, this Project will be able to contribute greatly to socio-economic development of Kingdom of Bhutan, improvement of the people's living conditions and, at the same time, accomplishment of the target of the Seventh Five Year Plan as well. In view of the above, it is concluded that this Project is appropriate to be implemented under the Grant Aid of the Government of Japan.

CONTENTS

CHAPTER 1

INTRODUCTION

Chapter 1 Introduction

The Royal Government of Bhutan requested a Grant Aid by the Government of Japan for a Project to establish a unified nationwide telecommunication network adequate in quality and reliability, in order to promote regionally more balanced social and economic development in the country.

The Government of Japan, in response to the request, decided to conduct a Basic Design on the Project and Japan International Cooperation Agency (JICA) sent to Bhutan the Basic Design Study Team headed by Mr. Toru Fujita, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, to carry out a field survey from February 28, 1991 to April 18, 1991 (refer to Appendix 1 Member List of Survey Team).

The Study Team had a series of discussions on the Project with officials concerned of the Royal Government of Bhutan (refer to Appendix 2 Member List of Concerning Party and Appendix 3 Minutes of Discussions) and carried out field survey on the project areas concerned (refer to Appendix 4 Survey Schedule).

On the basis of the above survey findings and analysis carried out in Japan, JICA prepared the draft Basic Design Report and dispatched the draft final study team headed by Mr. Akira Nishiharaguchi, Communications Policy Bureau, Ministry of Posts & Telecommunications to Bhutan in order to finalize the draft report from July 9, 1991 to July 21, 1991. This Basic Design Study Report on the Project for Development of Domestic Telecommunication Network in Kingdom of Bhutan has been thus prepared. (Refer to Appendix 6 Member List of Draft Final Study Team, Appendix 7 Member List of Concerning Party, Appendix 8 The Minutes of Discussions and appendix 9 Itinerary of Draft Final Study Team)

CHAPTER 2

BACKGROUND OF THE PROJECT

Chapter 2 Background of the Project

2-1 Outline of Telecommunication Sector in Bhutan

2-1-1 Telecommunication Services

(1) Domestic Telecommunications

1) At present, the domestic telecommunication services are provided by 4 kinds of systems, i.e., telephone, telegraph, telex and radio communication (called "Civil Wireless").

2) Telephone exchanges are located in 13 towns in total: 8 exchanges in the Western region, 3 in the Central region and 2 in the Western region. The telephone network in each region is constructed independently and, therefore, inter-region telephone communication is not feasible at present.

3) Almost all the transmission circuits connecting the towns are open-wire lines and not reliable because, in addition to the low transmission quality, they often suffer damages due to wire breaking, falling down of poles, etc.

The existing national telecommunication networks and the administrative districts in the country are as shown in Fig. 1 and Fig. 2 attached.

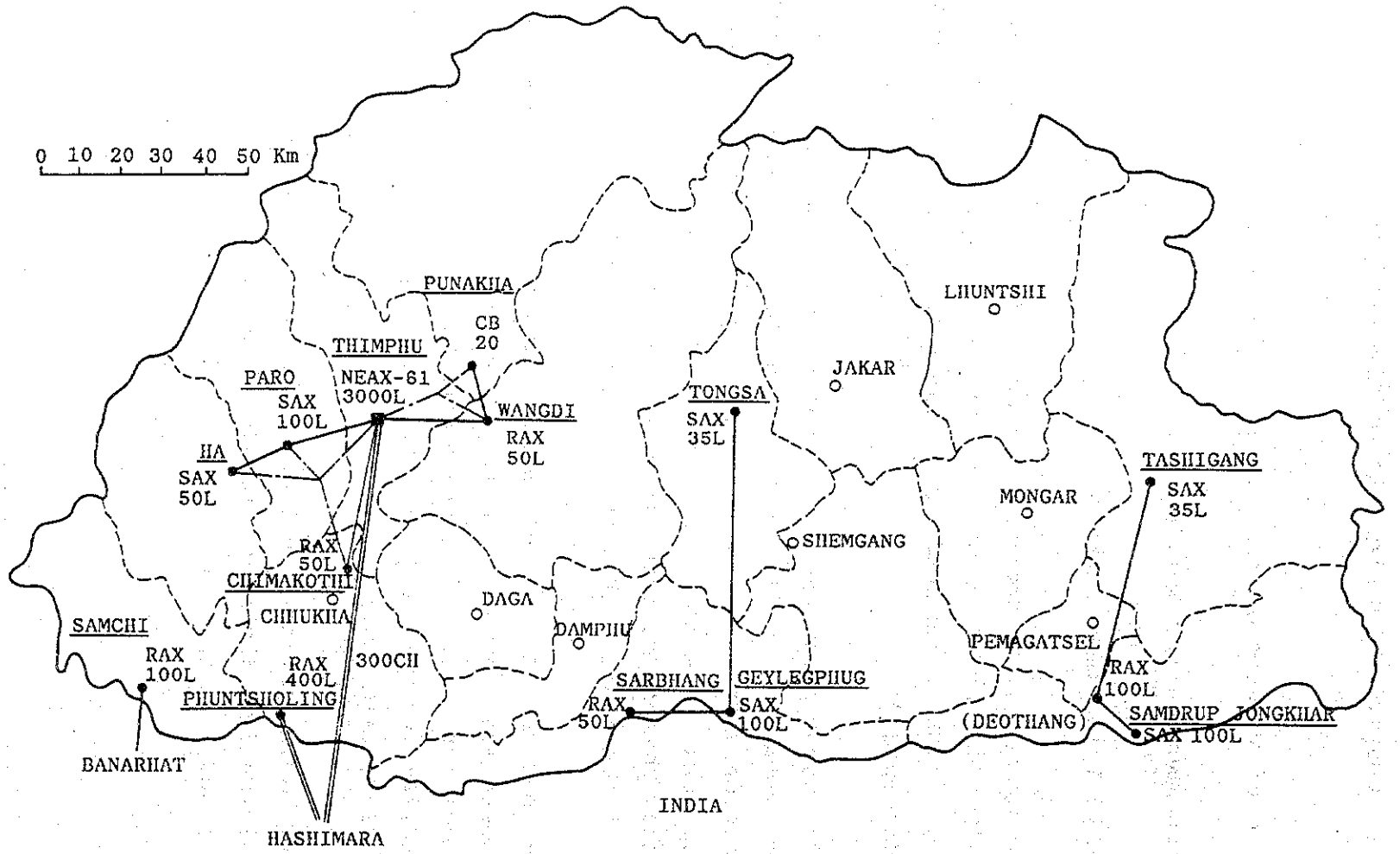


Fig. 1 Existing Telecommunication Facilities

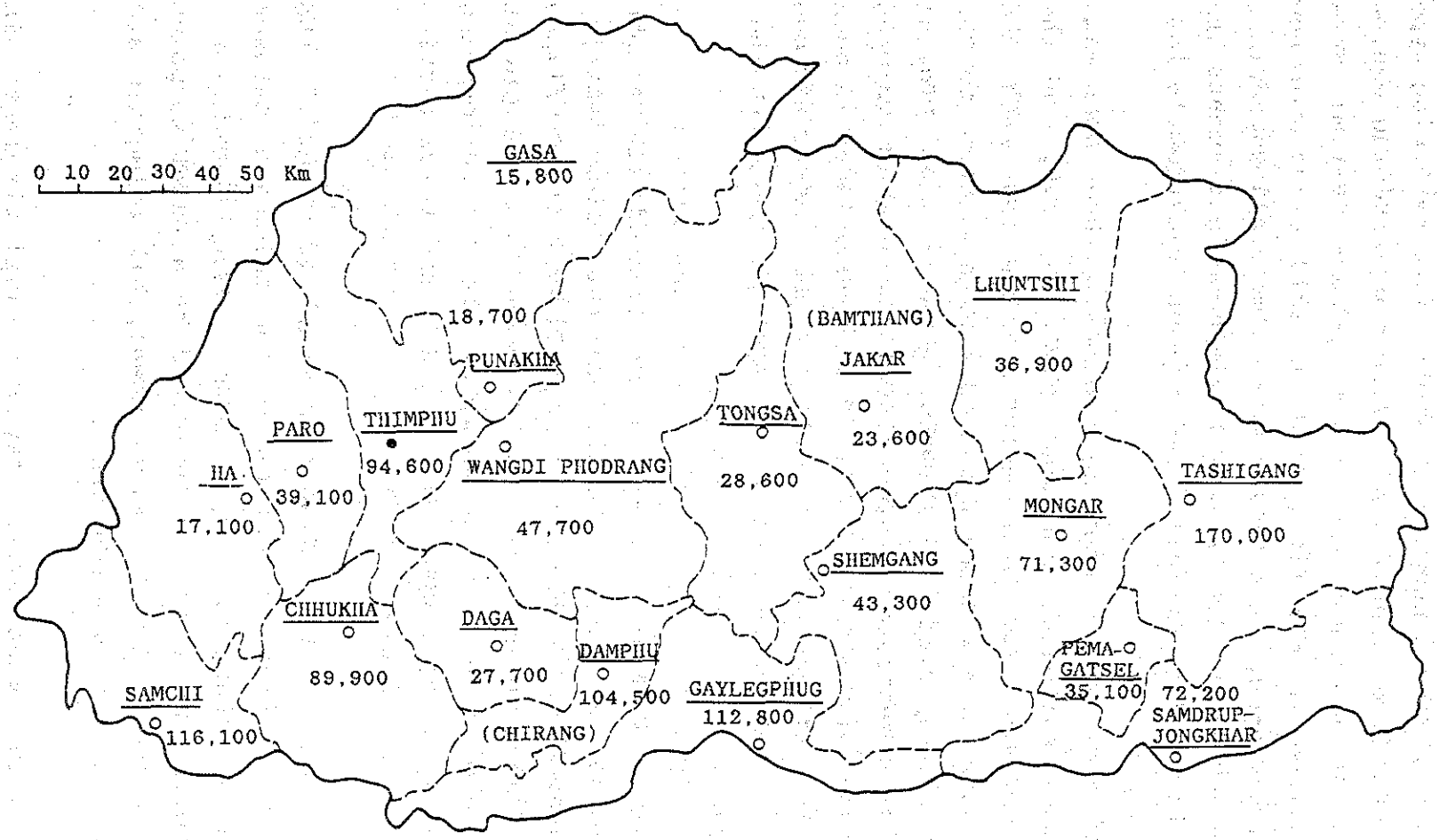


Fig. 2 Administrative Districts

4) Twelve of 13 exchanges are of automatic switching type and one is of manual. All automatic switching equipment of strowger type (step-by-step system) were installed in the first half of 1970's and are now entirely aged. In addition since almost all subscriber lines are open-wire lines and telephone instruments are low in quality, overall service grade is extremely low.

In Thimphu the exchange was replaced with a Japan make digital switching equipment (NEC) in 1990, and the subscriber line cable network connected with the exchange is now being upgraded. With respect to the surrounding areas of Thimphu, a Japan make Digital Radio Concentrator System (DRCS) parented at Thimphu exchange was installed with 19 telephone lines in each of the surrounding towns, and 2 telephone lines and one telex line in each of Paro, Paro airport, Punakha, Wangdi and Chimakothi towns.

5) A telex switching equipment is located at Thimphu exchange building to handle all the telex traffic. Because a microwave circuit is provided between Thimphu and Phuntsholing, the telex service is available at Phuntsholing as well as Thimphu. In the surrounding areas of Thimphu connected by DRCS, the telex service is also available.

6) Telegraph service is available at 8 towns in the country. Sending/receiving of the telegrams between Thimphu - Phuntsholing, Thimphu - Wangdi, Thimphu - Calcutta, India can be performed by a point-to-point teleprinter. For the other towns, all telegrams are sent/received by Morse codes.

7) The radio communication service, "civil wireless", is provided by 41 HF radio stations covering the whole country. The message transmission is made by Morse

codes. The service by such media is naturally not reliable as it easily suffers from bad weather conditions and signalling errors.

8) Radio broadcasting services by HF and FM are put into operation in Thimphu. No TV broadcasting service exists in the country.

(2) International Telecommunications

The international telecommunications services are provided by telephone, telex and telegraph systems. Two routes are available: one is the satellite circuit connected to London, UK and the other is the terrestrial microwave circuit connected to India. A satellite earth station (Standard A) was constructed in 1990 and is being operated in good conditions.

The international telephone and telex services are available in the Western region only. Especially the international subscriber dialling service is available only in Thimphu, and in other towns of the Western region, the operator dialling service is available.

2-1-2 Telecommunication Facilities

(1) Telephone Switching Equipment

The existing telephone switching equipment is summarized as follows:

Region	City	Sw. Sys.	Equi't type	Line capa.	Install. year	Working conn.	Interconn.	
							Auto.	Manu.
West	Thimphu	Dig	NEAX	3,000	1990	1,000	o	o
	Phuntsholing	SXS	RAX	400	1965	873	o	o
	Paro	SXS	SAX	100	1967	75		o
	Ha	SXS	SAX	50	1965	39		o
	Punakha	CB		20	1979	19		o
	Wangdi	SXS	RAX	50	1971	48		o
	Chimakothi	SXS	RAX	50	1980	49		o
	Samchi	SXS	RAX	100	1976	58		
Cent	Tongsa	SXS	SAX	35	1974	34		o
	Geylegphug	SXS	SAX	100	1973	98		o
	Sarbhang	SXS	RAX	50	1976	47		o
East	Tashigang	SXS	SAX	35	1968	34		o
	Samdrup-Jonkhar	SXS	SAX	100	1966	87		o

where, all the SXS and CB switching equipment are of Indian make (ITI).

(2) Transmission

The existing transmission links are summarized as follows:

Section			Medium	Capacity
Thimphu	- Hashimara		SHF	300 CH
Hashimara	- Phuntsholing		UHF	60 CH
Thimphu	- Phuntsholing	(174 km)	Open-wire	8 CH
Thimphu	- Paro	(72 km)	Open-wire	8 CH
Paro	- Ha	(13 km)	Open-wire	1 line
Thimphu	- Wangdi	(74 km)	Open-wire	1 line
Wangdi	- Punakha	(23 km)	Open-wire	1 line
Thimphu	- Chimakothi	(90 km)	Open-wire	8 CH
Tongsa	- Gaylegphu	(237 km)	Open-wire	1 line
Gaylegphu	- Sarbhang	(33 km)	Open-wire	1 line
Tashigang	- Samdrup Jonkhar	(180 km)	Open-wire	1 line

Two pairs of open-wire are used for a transmission link: one is for the public service and the other for the maintenance use. Some telephones for maintenance use are installed along the wiring routes. When they are free from the maintenance work, they can be used as the public telephones.

(3) Telex Switching Equipment

An automatic telex switching equipment of France make (ALCATEL) is installed at Thimphu telephone exchange building, with 2 TDM multiplexers: one is connection to Phuntsholing and the other to Delhi, India. The final capacity of the system is 256 subscriber lines and 5 TDM multiplexers.

(4) Telegraph

Telegraph offices are located as follows:

Western region	Central region	Eastern region
Thimphu Phuntsholing Paro Samchi Chhukha Wangdi	Nil	Tashigang Samdrup-Jongkhar

(5) Civil Wireless

Civil wireless stations are located as follows:

Western region		Central region		Eastern region	
Location	Dzongkag	Location	Dzongkag	Location	Dzongkag
Thimphu	TH1	Tongsa	TON	Lhuntshi	LH11
Lingshi		Jakar	BUN	Mongar	MON
Paro	PAR	Shemgang	SHE	Kurizampe	
Sibsu	SAO	Mangdichu		Tashigang	TAS
Dorokha		Pangbang		Khaling	
Gomtu		Pardho		Sakteng	
Samchi		Sarbhang	GAY	Tashi-Yangtse	
Chhuka	CHU	Gongkhola		Pemagatsel	PEM
Gedu		Lodari		Samdrup-Jonkhar	
Phuntsholing		Geylegphug			
Gasa	PUN	Kalikhola		Nganglam	SAJ
Lunana		Dagapela	CH1	Manas	
Wangdi	WAN	Damphu		Bhangtar	
		Dobani	DAG	Daifam	
		Daga			

2-1-3 6th 5-Year Development Plan

Major projects realized during the 6th Development Plan period are those for the capital Thimphu and its surrounding area as shown below:

1987 - Telex exchange in Thimphu

1990 - Telephone exchange combined with national/international exchange in Thimphu
- Satellite earth station in Thimphu
- Spur microwave link from the existing route to Phuntsholing
- DRCS parented at Thimphu to Punakha, Wangdi, Paro, Paro airport and Chimakothi

1990 - 1991
- Upgrading of the local network in Thimphu

2-1-4 Problems of Telecommunication in Bhutan

Since 1960's, the Royal Government of Bhutan has been making efforts for the development of telecommunication sector.

However, the development of the domestic telecommunications network is not adequate and there remain some problems to be solved urgently as described below.

(1) No telephone service is available in 7 Dzongkags and 179 Gewogs in the country.

(2) The civil wireless service provided throughout the country is not reliable because it depends on HF radio system of Morse signalling.

(3) People in the Central and Eastern regions have no access by telephone to thimphu.

(4) Aged telecommunication facilities not meeting the international standard are still used. As the result, the Royal Government is to cope with high running costs.

(5) Expansion of telephone channels is difficult, and there is no transmission circuit for TV and radio broadcasting to remote areas in the country.

2-1-5 Bhutan Telecommunication Development Plan

The ITU experts studied the Bhutan Telecommunication Master Plan in 1988-1990 and completed the study in December, 1990. The Master Plan thus prepared was approved by the Royal Government. Then, ITU through Telecom Australia (International) prepared the detailed national trunk network plan to realize the Master Plan.

The major elements of the Master Plan are to establish both a basic digital microwave transmission network and a digital telephone switching network. The planned networks are summarized below:

(1) Digital microwave transmission network linking:

Route 1	Thimphu - Tongsa - Jakar - Mongar - Tashigang
Route 2	Tongsa - Shemgang - Geylegphug - Damphu
Route 3	Tashigang - Pemagatsel - Samdrup Jonkhar
Route 4	Thimphu - Paro - Ha - Chimakothi - Phuntsholing - Samchi
Route 5	Thimphu - Punakha - Wangdi

(2) Telephone switching network with the following main exchanges:

Phuntsholing	Tashigang	Tongsa
Samchi	Samdrup Jonkhar	Damphu
Paro	Geylegshug	

2-2 Outline of the Request

The request to the Japanese Government is to establish a unified telecommunication network to cover the whole country, through the realization of the following:

(1) New installation of digital microwave transmission links:

- 1. Thimphu to Tongsa
- 2. Tongsa to Tashigang
- 3. Tashigang to Mongar
- 4. Tongasa to Bumthang
- 5. Tongsa to Geylegphug
- 6. Gaylegphug to Shemgang
- 7. Geylegphug to Damphu
- 8. Tashigang to Samdrup Jonkhar
- 9. Samdrup Jonkhar to Pemagatsel
- 10. Phuntsholing to Samchi
- 11. Thimphu to Paro
- 12. Thimphu to Ha
- 13. Thimphu to Chimakothi
- 14. Thimphu to Punakha
- 15. Thimphu to Wangdi
- 16. Thimphu to Phuntsholing

(2) New installation of digital telephone exchanges:

- 1. Tongsa:

*1000 local lines
-300 for Tongsa and surrounding areas
-200 for Bumthang and surrounding areas
-500 for spares

*7x2 Mbps transit route
-2 for Thimphu
-2 for Geylegphug
-2 for Tashigang
-1 for Phuntsholing

- 2. Tashigang:

*1500 local lines
-400 for Tashigang and surrounding areas
-600 for Mongar, Lhuntsi, Yongphula and surrounding areas
-500 for spares

*6x2 Mbps transit routes for Thimphu, Tongsa, Samdrup Jonkher

- 3. Geylegphug:

*1000 local lines
-400 for Geylegphug local and surrounding areas
-400 for Shemgang, Sarbhang and surrounding areas
-200 for spares

*3x2 Mbps transit routes
-2 to Tongsa
-1 to Thimphu

- 4. Samdrup Jonkhar:

*1000 local lines
-300 for Samdrup Jonkhar local and surrounding areas
-100 for Pemagatsel and surrounding areas
-100 for Deothang, Bhangtar and surrounding areas
-500 for spares

*3x2 Mbps transit routes
-2 to Tashigang
-1 to Thimphu

- 5. Samchi:

*1000 local lines
-400 for Samchi local and surrounding areas
-100 for Sibsoo, Changmari and surrounding areas
-500 for spares

*2x2 Mbps transit routes
-1 to Phuntsholing
-1 to Thimphu

- 6. Phuntsholing:

  *2000 local lines for Phuntsholing and surrounding areas

  *4x2 Mbps transit routes
  -1 for Samchi
  -2 for Thimphu
  -1 for Tongsa

- 7. Paro:

  *500 local lines for Paro and surrounding areas
  *2x2 Mbps transit routes to Thimphu

- 8. Damphu:

  *1000 local lines
  -500 for Damphu and surrounding areas
  -200 for Daga and surrounding areas
  -100 for Lamidara and surrounding areas
  -200 for spares

  *4x2 Mbps transit routes
  -1 to Geylegphug
  -1 to Tongsa
  -2 to Thimphu

(3) Upgrading of existing subscriber lines:

- 1.	Phuntsholing	- 7.	Samdrup Jonkhar
- 2.	Samchi	- 8.	Tongsa
- 3.	Tashigang	- 9.	Geylegphug
- 4.	Paro	- 10.	Sarbhang
- 5.	Wangdi	- 11.	Ha
- 6.	Chimakothi		

(4) New installation of subscriber lines:

- 1.	Mongar	- 5.	Jakar
- 2.	Lhuntshi	- 6.	Shemgang
- 3.	Daga	- 7.	Yongphula
- 4.	Damphu	- 8.	Pemagatsel

(5) New installation of DRCS:

- 1. Lhuntshi
- 2. Daga
- 3. Yongphula
- 4. Sarbhang

2-3 Location and Condition of Project Sites

2-3-1 Location of the Project Sites

The project sites are two fold: sites for exchanges (including radio, multiplex and switching equipments and outside plant) and those for repeater stations. The former number 21 and the latter 23. They are scattered all over the country.

Twenty-one areas to be covered by the exchanges for telecommunications services are important centers of respective administration districts, subdistricts or the equivalents. In the following are shown their features and the number of households.

Administrative District	Project Site	Features	Number of Households
1. Thimphu	Thimphu	Capital city	4,350
2. Punakha	Punakha	District Center	410
3. Wangdi	Wangdi	District Center	490
4. Paro	Paro	District Center	560
5. Ha	Ha	District Center	540
6. Chhuka	Chimakothi	District Center	240
7. Chhuka	Phuntsho-ling	Center of commercial activity (including trade with India)	3,900
8. Samchi	Samchi	District Center, Border town for trade with India	1,150
9. Tongsa	Tongsa	District Center	580
10. Bumtang	Jakar	District Center	780
11. Shemgang	Shemgang	District Center	520
12. Sarbhang	Geylegphug	District Center, Border town for trade with India	2,070
13. Sarbhang	Sarbhang	Border town for trade with India	820
14. Chirang	Damphu	District Center	1,360
15. Daga	Daga	District Center	560
16. Tashigang	Tashigang	District Center	1,090
17. Tashigang	Yongphula	Center of East Bhutan	790
18. Lhuntshi	Lhuntshi	District Center	670
19. Mongar	Mongar	District Center	980
20. Pemagatsel	Pemagatsel	District Center	960
21. Samdrup Jonkhar	Samdrup Jonkhar	District Center, Border town for trade with India	1,690

2-3-2 Condition of Project Sites

(1) Topography and Relationship with India

Bhutan's terrain is among the most rugged in the world since the entire country is virtually mountainous. Rivers swiftly flow from the great Himalayas and deep valleys, i.e., from north to south through steep mountains, and reach the plain of India. Bhutan is located between India and Tibet of China and, therefore, has maintained close relationship, in trades and communications with these countries from ancient times along these rivers.

The relationship with India is continued up to now and the economic and cultural exchanges between the countries has been developed through the following 3 routes.

	Major border town	Role
Western route:	Phuntsholing	Trade with India
		Trade with all countries
	Samchi	Trade with India
Central route:	Geylegphug	Trade with India
	Sarbhang	Trade with India
Eastern route:	Samdrup Jonkhar	Trade with India

Five major border towns mentioned above hold a strategic position of Bhutan's economy.

(2) Development of Socio Economy

Bhutan's key industry, agriculture (including livestock) and forestry, have developed on the folds of mountains along the 3 routes described above.

These cultivation areas were isolated from each other by the steep mountains. Therefore, each area have been individually developed.

Bhutan started the first 5 Years Development Plan in 1961, and now the sixth 5 Years Development Plan is under implementation. In these plans, Bhutan constructed the roads from east to west to connect these isolated areas, and thereby develop the blanaced socio-economy.

In view of the fact that connection of these areas largely depends upon the roads, urgent development of telecommunications is quite essential for the socio-economic development in Bhutan.

2-3-3 Topography of Project Sites

All the exchange sites are located in district centers on the equivalent as described in paragraph 2-3-1. The topography of these locations is the basin, ridge or slope of a mountain. Only 5 of the border towns with India are located on a piedmont. The repeater stations which connect the exchanges are also to be positioned on the top, ridge or slope of a high and steep mountain. The highest is located at more than 4,000 m above sea level. Even in such high altitude, mountains are covered by forests dense with trees more than 20 m in height, and bears, dears, snow-lepards, etc. are observed. The place higher than 3,500 m is covered by heavy snow in winter and no household exists.

The nature of the project sites soil ranges from hard clay to sandy clay, and base rock is scarce. A landslide is apt to happen frequently especially in the rainy season.

2-3-4 Natural Conditions

(1) Meteorological Data

The Data on the monthly rainfall and average temperature in 75 points in the country are published by the Department of Agriculture. They are the only available official data, and no official data are available concerning the sunshine and insolation.

The Bhutan Urban Development Agency, has the average monthly sunshine data in Thimphu, Paro and Bumtang, from 1979 to 1982, as its internal data. However, these data cannot be used for the Project design because Project sites are located on the top of mountains while the data are those collected in the town. They can be used just for reference.

(2) Rainfall

The whole area of Bhutan belongs to the monsoon region and rainfall is abundant. In the monsoon season (from June to September), the southern part of Bhutan (near the border with India) has the rainfall of one thousand and several hundreds milimeter per month in rainy season, with the record of 2,254.6 mm/month in Sarbhang in July, 1988.

The rainfall is decreasing in the northern part of Bhutan. In this part, including Thimphu, Tongsa, Bhumtang and Tashigang, the rainfall data on the top of mountains where repeater stations will be established are not available.

(3) Temperature

According to the data published by the Department of Agriculture, the places where the temperature was less than 0°C, but not less than -10°C number 10 in 1988.

On the other hand, according to data obtained by the hearing during the field survey, the temperature of the Project sites having an elevation of over 3,000 m above sea level is less than 10°C, and over 4,000 m, it reaches -20°C. Maximum temperature in Bhutan is recorded in the southern part near India, because the altitude is low (about 200 m above sea level). There are so many places where temperature exceeds 30°C. In the town of Soembatar in Geylegphug district, the temperature rose up to 37°C in 1988.

(4) Wind Velocity

There are no data about wind velocity in Bhutan.

(5) Snowfall

No data about snowfall are available. According to the inhabitants near the project sites, the average depth of snowfall is 1 m at the height of 2,500 m above sea level. On the level of 4,000 m (2 repeater sites), the depth reaches to 2 m. Even at the level of less than 2,500 m, the project sites in the northern part of the East-West Route have snowfalls, 0.3 - 0.5 m in depth.

(6) Earthquake

Bhutan belongs to an earthquake zone, and great earthquake hit the whole country in 1983. However, no seismic data exist.