

THE REPUBLIC OF ZAMBIA
FEASIBILITY STUDY REPORT
ON
THE MICROWAVE RADIO RELAY PROJECT

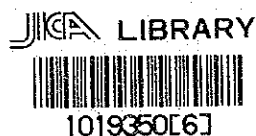
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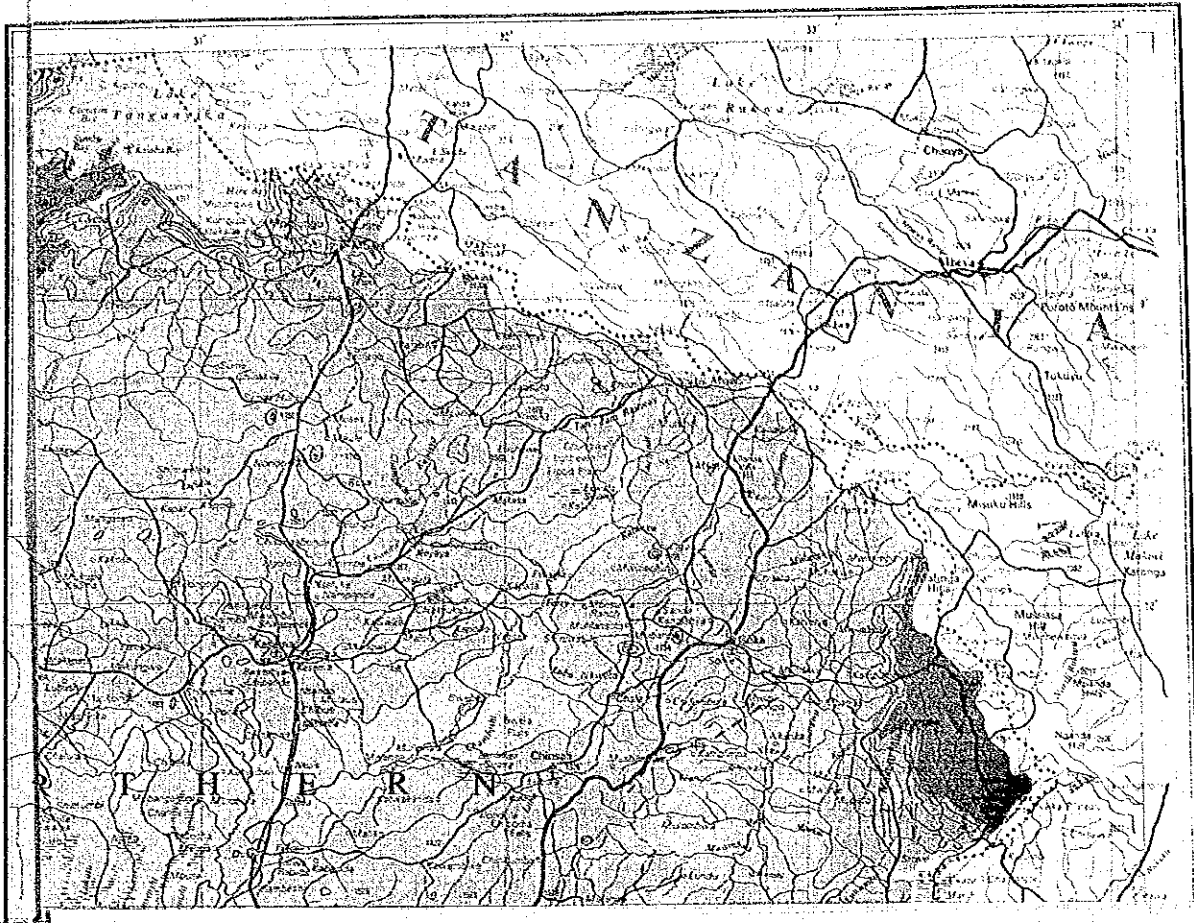
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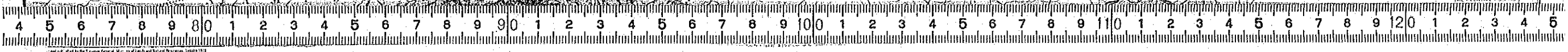
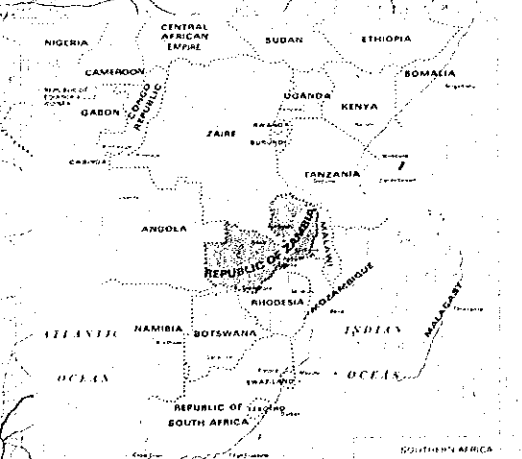
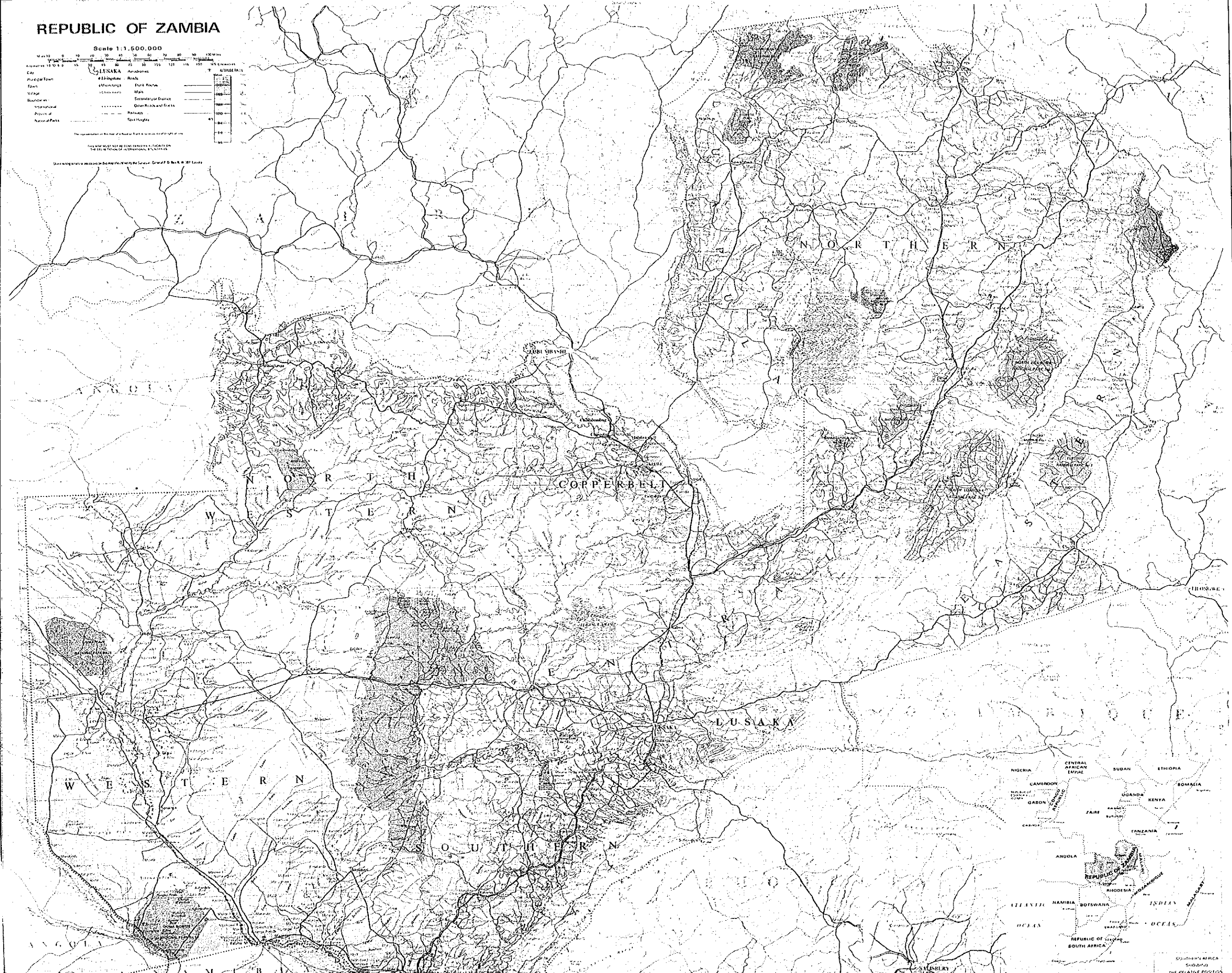
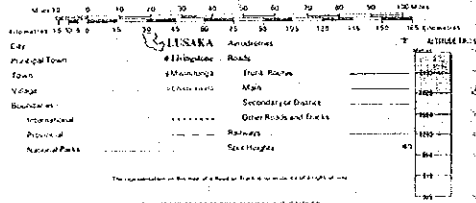
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REPUBLIC OF ZAMBIA

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P R E F A C E

In response to the request of the Government of the Republic of Zambia, the Japanese Government decided to conduct a survey on feasibility of the Microwave Radio Relay Project and entrusted the survey to the Japan International Cooperation Agency (J.I.C.A).

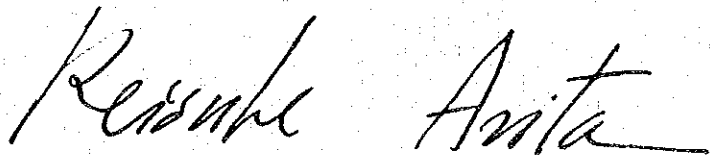
The J.I.C.A. sent to Zambia a survey team headed by Mr. Tohru Hasegawa from February 16 to March 18, 1981.

The team had discussions with the officials concerned of the Government of the Republic of Zambia and conducted a field survey in Mansa 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 the two countries.

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

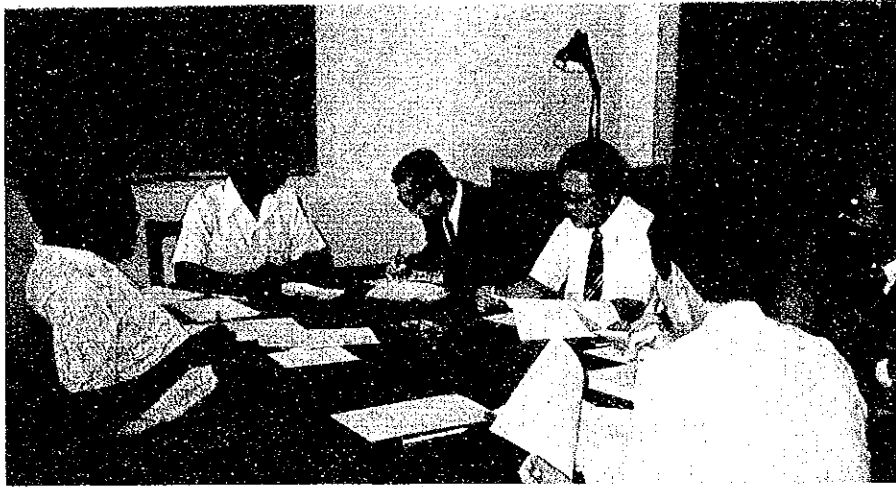
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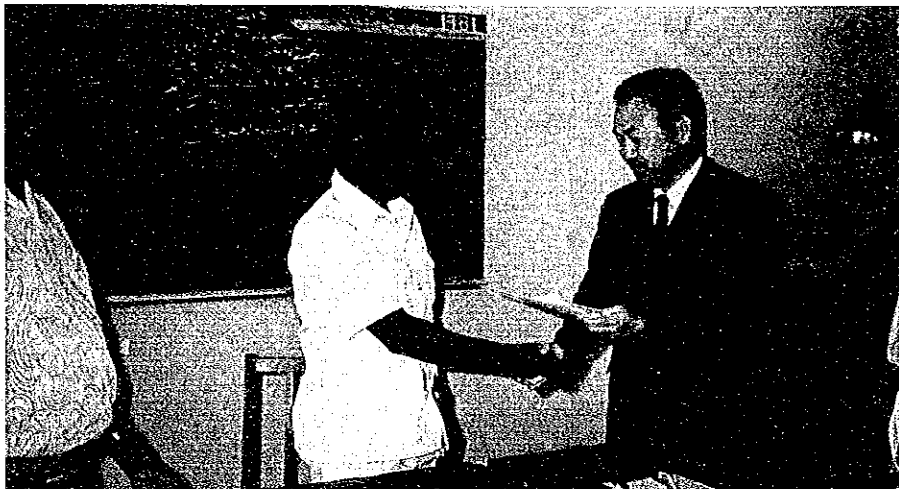
Keisuke Arita

President

Japan International Cooperation Agency



Mr. Hasegawa, Leader of Japanese Study Team, signing the meeting minutes for the final draft report of feasibility study at the PTC head office in Ndola



Mr. P.Ng'oma, Director General of PTC, and Mr. Hasegawa shaking hands after signing of the meeting minutes



The field survey for the microwave radio system in Mansa-Samfya link

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SUMMARY AND RECOMMENDATIONS

SUMMARY AND RECOMMENDATIONS

The government of the Republic of Zambia has been promoting the construction of the national microwave communication network to connect major cities and towns as part of the Second and Third National Development Plans.

When President Kaunda visited Japan in 1980 as a guest of the state, the cooperation of Japan to these plans was requested.

Upon this request, the Government of Japan sent a preliminary study team to the Republic of Zambia from 26th November to 17th December, 1980. The study team, after holding consultations with Posts and Telecommunications Corporation (PTC) and the Zambian Government concerned and conducting field surveys in main districts, determined the project scale and established scope of works for feasibility study on microwave radio relay project.

The Japanese Government sent a feasibility study team for the "Microwave Radio Relay Project in the Republic of Zambia" to the country from February 16th to March 18th, 1981.

The team conducted the field surveys for a route plan, telecommunications demand and traffic forecast, system design and economic evaluation on the basis of the scope of works determined by the preliminary study.

The following is a summary of the result of the feasibility study for this project.

The composition of the study team is shown in Table 1.

1. Microwave Network Construction Project

During the time period of the Third National Development Plan of the Republic of Zambia (TNDP : 1979-1983), a number of 58 automatic telephone exchange facilities will be newly established by the year 1984, as well as expansion and replacement of the existing exchanges. At present, the installation of those telephone exchanges is being implemented in the whole area of Zambia. In addition to the on-going project, further

construction of approximately 20 exchanges has been planned by the Government in the time period of this Development Plan.

It is, therefore, foreseen that the nation-wide telecommunication network will remarkably progress during the planned period of time. As a result, the demand of the toll trunk calls will greatly increase in the near future.

On the other hand, the Information and Broadcasting Sector, Ministry of Information, is now promoting expansion of the nation-wide television broadcasting in order to fulfill the economic and cultural gaps that exists between various parts of the country.

Considering such background mentioned above, the earliest establishment of the long distance telecommunication network is no doubt needed.

The outline of the Project is itemized below:

- (1) Replacement and improvement of performance for the over-aged microwave radio system between Lusada and the Copperbelt.
- (2) Multiplex channel expansion for the above route.
- (3) Extension of television signal transmission system to the provincial centers.
- (4) Construction of the rural microwave telecommunication network in the Northern, Luapula and Eastern Provinces.

2. Transmission System

The FDM transmission system, the line-of-sight microwave is to be adopted as it will be easy to interface with the existing microwave network, and also for economy of project execution.

3. Transmission Routes

Proposed transmission routes are shown in Figure 1. Selection of the site for radio stations was made in due consideration of the radio propagation characteristics, construction of access roads and convenience of transportation of the equipment and materials.

4. Power Supply System

For the stations where the A.C. commercial power can be utilized, the full floating system with a stand-by engine generator will be used. The full floating system by dual engine generators will be applied to the non-A.C. mains stations with D.C. load power of 100 Watts or more, and where load power is less than 100 Watts the Solar cell system will be used.

5. Radio Frequency Channel Arrangement

The transmission capacity of each projected microwave system requires 120, 960 or 1,800 telephone channels. Taking into account the radio frequencies now in use, the 6 GHz upper frequency band will be used for the routes Lusaka-Copperbelt, Chingola-Solwezi, and Lusaka-Mwembeshi Satellite Earth Station.

For other routes, the 2 GHz frequency band is to be applied except for the NEW MASS MEDIA CENTER - LUSAKA TELEPHONE EXCHANGE Link where the 8 GHz frequency band is recommended.

6. Maintenance and Operation

For maintenance and operation of trunk networks, several maintenance centers will be designated at the terminal stations which will be equipped with the remote supervisory and control functions that will serve the purpose of centralization maintenance activities.

Since the number of trunk circuits will be greatly increased in the Lusaka-Copperbelt route after completion of this project, the automatic trunk circuit testing equipment is to be supplied at the Lusaka and Kitwe radio terminals for better system maintenance.

7. Construction Cost and Implementation Plan

Construction work will be carried out in stages and the whole project will be completed in two phases, except for the Mass Media Television Link.

In the first phase, Lusaka-Copperbelt, Kasama-Mansa, Kasama-Mbala, Kasama-Mporokoso and Chipata-Lundazi routes will be constructed at a cost of 7,714.8 million Yen (5,933 million Yen in foreign currency portion and 1,781.8 million Yen in local portion).

In the second phase, remainder routes will be constructed at a cost of 2,044.136 million Yen (1,528 million Yen in foreign currency portion and 516.136 million Yen in local currency portion).

Estimates of construction costs are shown in Tables 2 and 3. The project in the first phase will cover a period of three years. Remainder routes in the second phase will be started two years after starting the first phase programme.

Local portion of the phase I project expenditure will be approximately K7,550,000 based on the current estimated cost of works; therefore, the sum of K3,500,000 should be provided by the Government of the Republic of Zambia, and the remaining portion K4,050,000 should be borne by PTC.

Should, however, the projects be delayed due to delay in construction or delay on the part of the Government of the Republic of Zambia or PTC in financing the required local expenditure, thereby escalating local portion costs, then the Government of the Republic of Zambia may be required to meet such additional costs by further contributions.

The local portion of the phase II project will be approximately 2,187,000. Since the PTC has declared that they have allocated the maximum funds they can generate from their own resources to Phase I, it is considered prudent for the Government of Zambia to provide this sum on the usual terms to the PTC.

Exchange Rate : US\$ 1 = 200 Japanese Yen

K1 = 236 Japanese Yen

8. Mass Media Television Link

It is desirable that Mass Media Television Link should urgently be established separately from Phase I and Phase II, because the New Mass Media Center will be completed in November, 1981.

Construction cost is estimated about one million Kwacha including necessary television link by November, 1981 which is the New Mass Media Center-Lusaka Telephone Exchange Link and its cost will be estimated about 0.3 million Kwacha and should be provided by the Government of the Republic of Zambia.

9. Economic Evaluation

As a result of the financial analysis of this project, the internal rate of return on the project is estimated at 8.78 % for the overall project and 11.28 % for Phase I Project. And the return on investment is evaluated from a national point of view. The economic internal rate of return for the overall project is estimated at 10.38 %. Zambian Economy and the price escalation considered, a rise in telephone tariff rate is recommended from the PTC management strategical point of view. The above percentages are estimated on the assumption that a rise in tariff rate would be introduced into basic benefit of the project evaluation. By the current tariffs, Internal Rate of Return which is estimated financially, is the former 6.67 %, the latter 9.11 %. Some of the essential objectives for the Third National Development Plan in Zambia is the provision of gainful employment opportunities to the local force and this is sought to be promoted through increased utilization of existing productive capacities, adoption of labour intensive technology particularly in sectors such as manufacture and construction, and by the level of productivity of small scale farmers and subsistence producers in the agriculture and through the setting up of small scale industries in both rural and urban areas to get rid of the dependence on the mining industry. This project will be promoted as part of the Development Plan. The necessity of the enhancement of the telecommunication network is fully recognized and it is necessary to carry it out urgently because it will bring general improvement in the economic and industrial development of the Zambian infrastructure.

Table 1 The Composition of Study Team

<u>NAME</u>	
MR. TOHRU HASEGAWA	Team Leader (Ministry of Posts and Telecommunications)
MR. TSUNENATSU YANO	Engineer (MPT)
MR. TAKASHI SUZUKI	Chief Engineer (The Nippon Telecommunications Consulting Co., Ltd.)
MR. MUNEO KURONO	Principal Engineer (NTC)
MR. MIKIO SOMA	Engineer (NTC)
MR. AKIO ITOH	Project Coordinator

Table 2 Project Cost for Phase - I

	Foreign Currency		Local Currency
	Thousand Japanese Yen	Equivalent Thousand US \$	Thousand Kwacha
1. Equipment Work Portion			
a. Lusaka-Copperbelt Route	1,850,000	9,250	830
b. Kasama-Mansa Route * 1	1,492,000	7,460	1,870
c. Kasama-Mbala Route * 2	598,000	2,990	700
d. Kasama-Mporokoso Route	272,000	1,360	410
e. Chipata-Lundazi Route * 3	748,000	3,740	980
f. Sub Total (a+b+c+d+e)	4,960,000	24,800	4,790
g. Survey Cost	37,000	185	-
h. Training Cost	43,000	215	-
i. Total (f+g+h)	5,040,000	25,200	4,790
2. Civil Work Portion			
j. Lusaka-Copperbelt Route	5,000	25	250
k. Kasama-Mansa Route	15,000	75	500
l. Kasama-Mbala Route	10,000	50	250
m. Kasama-Mporokoso Route	10,000	50	50
n. Chipata-Lundazi Route	15,000	75	970
o. Sub Total (j+k+l+m+n)	55,000	275	2,020
p. Survey Cost	34,000	170	-
q. Total (o+p)	89,000	445	2,020
3. Total Cost for Equipment and Civil Work Portion (i+q)	5,129,000	25,645	6,810
4. Consultancy Service	416,000	2,080	240
5. Basic Project Cost (3+4)	5,545,000	27,725	7,050
6. Contingency	388,000	1,940	500
7. Total Project Cost (5+6)	5,933,000	29,665	7,550

Exchange Rate: 1US Dollar = 200 Japanese Yen
1 Kwacha = 1.179 US Dollars

- * 1 - Except Kawambwa-Nchelenge Link
- * 2 - Except Senga Hill
- * 3 - Except Lundazi-Chama Link

Table 3 Project Cost for Phase - II

	Foreign Currency		Local Currency
	Thousand Japanese Yen	Equivalent Thousand US \$	Thousand Kwacha
1. Equipment Work Portion			
a. Chingola-Solwezi Route	549,000	2,745	810
b. Lundazi-Chama Route	419,000	2,095	600
c. Kawambwa-Nchelenge Link	303,000	1,515	400
d. Sub Total (a+b+c)	1,271,000	6,355	1,810
e. Survey Cost	30,000	150	-
f. Total (d+e)	1,301,000	6,505	1,810
2. Civil Work Portion			
g. Chingola-Solwezi	-	-	-
h. Lundazi-Chama Link	5,000	25	140
i. Kasama-Nchelenge Link	5,000	25	30
j. Sub Total (g+h+i)	10,000	50	170
k. Survey Cost	7,000	35	-
l. Total (j+k)	17,000	85	170
3. Total Cost for Equipment and Civil Work Portion (1+2)	1,318,000	6,590	1,980
4. Consultancy Service	110,000	550	64
5. Basic Project Cost (3+4)	1,428,000	7,140	2,044
6. Contingency	100,000	500	143
7. Total Project Cost (5+6)	1,528,000	7,640	2,187

Exchange Rate: 1US Dollar = 200 Japanese Yen
 1 Kwacha = 1.179 US Dollar

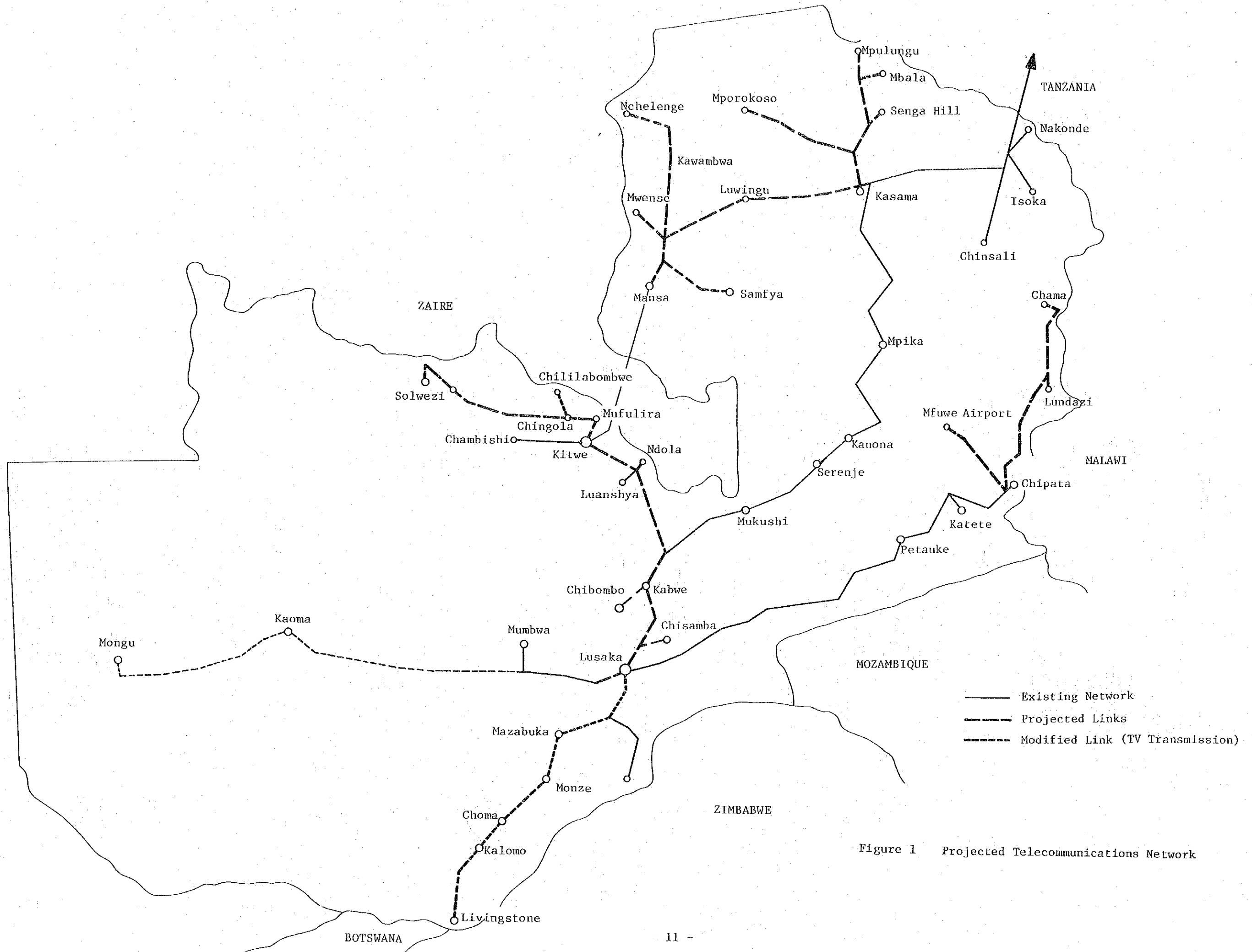
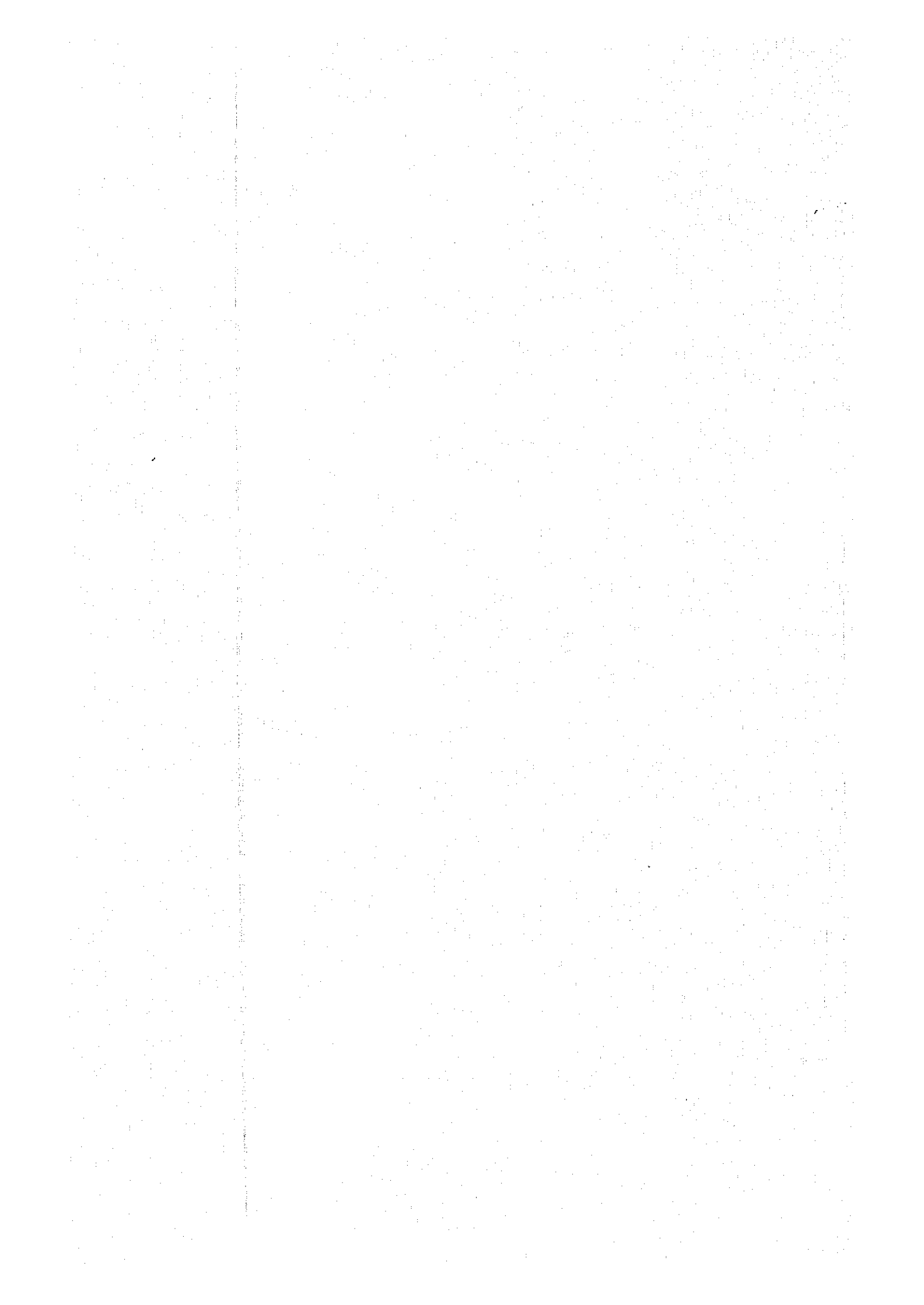


Figure 1 Projected Telecommunications Network



CHAPTER 1 INTRODUCTION

Chapter 1 Introduction

This document is intended to ascertain the viability of the links covered by the Project which aims at replacement, improvement and expansion of a part of the Republic of Zambia domestic microwave telecommunications trunk network for telephone and television signal transmission. The Project also aims at construction of the rural telecommunications network in the Northern and Eastern regions of Zambia. It further includes additional facilities to the existing television transmission system.

This report contains firstly the present aspects of telecommunications services in Zambia; secondly an outline of the proposed system; and thirdly the economic feasibility study of the Project.

Shown in Figure 1-1 is the existing long distance telecommunications trunk network. The sections where the existing equipment and facilities are to be replaced and the microwave radio system is to be newly constructed in this Project are illustrated in Figure 1-2.

The proposed microwave radio systems hold the transmission capacities of 1800 channels for the Copperbelt Links, 960 channels for Chingola-Solwezi and Kasama-Mansa Links and 120 channels for the Northern and Eastern rural telecommunications system.

The Copperbelt Links are to be composed of one working bearer, one TV bearer and one protection bearer. The protection bearer is designed to transmit occasionally the color television signals also. The system composition for other routes, refer to 4.3 Outline of Each Radio Route.

For the modulation system, the analog signal modulation system (FDM System) will be adopted in consideration of the interface with the existing systems and the television signal transmission.

The project cost used in the economic feasibility study is an estimate based on recent international tender prices, on condition that the aforementioned new systems be constructed on the turn-key basis.

The economic feasibility study of this Project mainly consists of the financial analysis based on the said project cost. By means of such financial analysis, the financial internal rate of return of the Project is estimated. The internal rate of return obtained by the financial analysis stands in the neighborhood of 8.8 %.

Considering the favourable financial internal rate of return and also the goals set out in the Third National Development Plan, the implementation of this Project will be complimentary to the development of the Zambian National Economy. Since the Project is viable, the project organization will be able to generate working capital and also to serve the loan.

Furthermore, the Project will create indirect benefits in the form of infrastructure improvements, and such benefits are considerable when considered from the socio-economic point of view of Zambia. The Project will therefore have a big impact on the general development of Zambia especially the rural development.

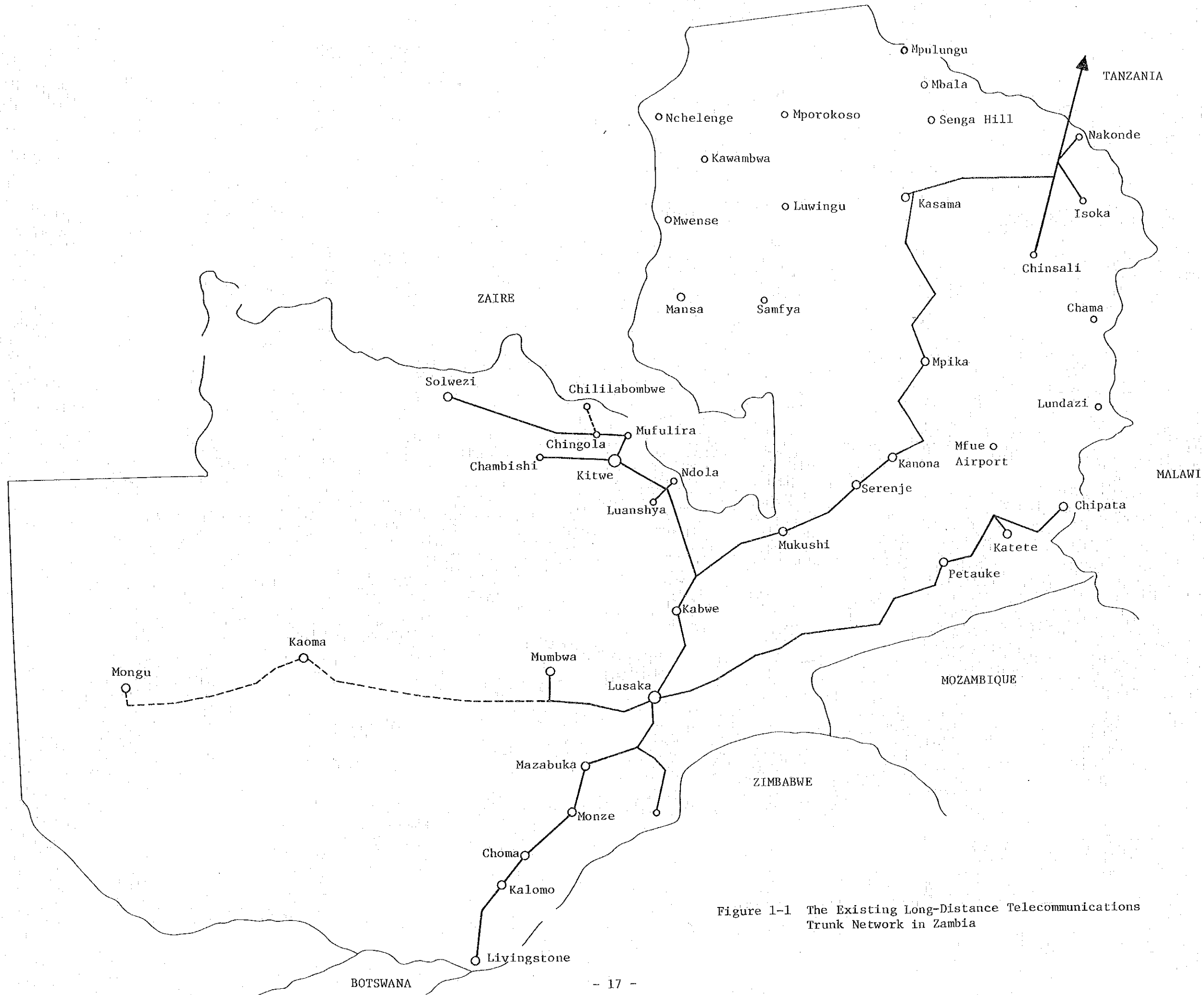


Figure 1-1 The Existing Long-Distance Telecommunications Trunk Network in Zambia

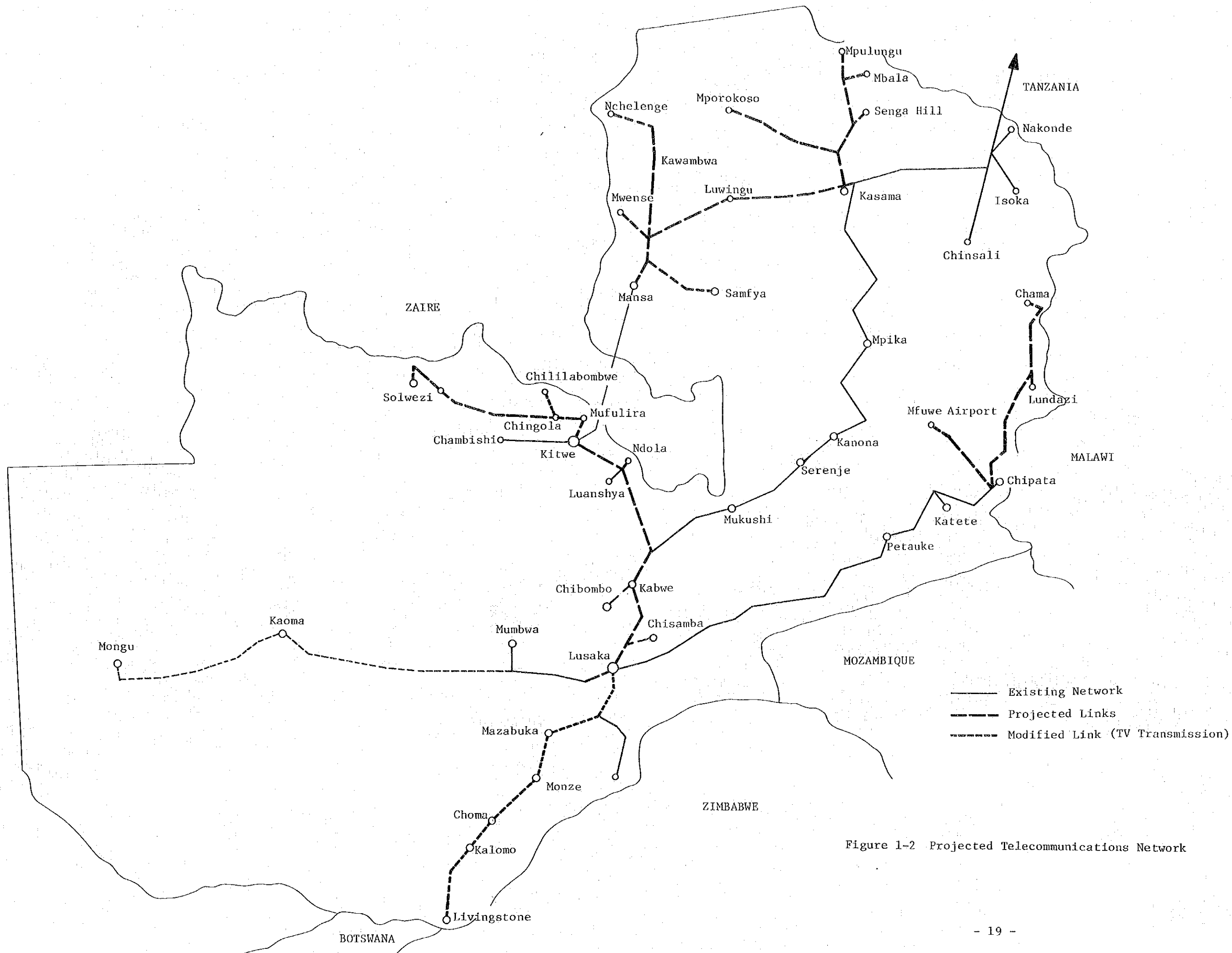


Figure 1-2 Projected Telecommunications Network

CHAPTER 2 OUTLINE OF THE PROJECT

Chapter 2 Outline of the Project

2.1 Aim and Purpose of the Project

The Project is to replace, and improve the performance of, the obsolete sections out of the existing national microwave communication network of Zambia, and to relieve the outstanding demand in the areas now served by the overage system. The Project is also to construct the microwave radio system in the areas where the toll telephone network is to be established in conjunction with the new switching plan for toll calls and the television transmission network is to be established as part of the Third National Development Plan (TNDP). In other words, the improvement and expansion of the existing system and the establishment of the rural telecommunications system in the Zambian national telecommunications networks are the aim and purpose of the Project.

2.2 Projected Microwave Routes

The routes where the Project is to be implemented are as follows. The feasibility study was made on all the projected routes.

- a) Mass Media Television Link
- b) Lusaka - Copperbelt Route (1800 channels + TV)
- c) Kasama - Mansa Route (960 and 120 channels + TV)
- d) Chingola - Solwezi Route (960 channels + TV)
- e) Kasama - Mporokoso Route (120 channels)
- f) Chipata - Lundazi Route (120 channels)

2.3 Intended Effects on National and Regional Economies

The realization of this Project will exert the following effects on the national economy of Zambia, as well as on the local economies of the regions concerned:

- 1) The improvement and expansion of national telecommunications services uphold expectations for infrastructural development instrumental to national and regional socio-economic development;

- 2) The improvement, expansion and construction of sound broadcasting and television signal transmission system lead to the development of mass communication media and, through it, contribute to the national socio-economic stability and advancement and to the up-grading of welfare and standard of living among the local inhabitants of the regions concerned.

2.4 Outline of the Current Telecommunications Services

The present status of telecommunications facilities and agency-wise policies and objectives to be attained in the Third National Development Plan (TNDP) for the telecommunications and information sectors are described below.

2.4.1 Local Exchange Service

As of December, 1977, Zambia had approximately 60,000 telephone stations connected to 32,000 direct exchange lines. There is a large unsatisfied demand for telephone service.

According to information obtained from the PTC, total telephone exchanges in Zambia number 49 offices as shown in Table 2-1, and the Table also contains the existing radio telephone public offices. Among them, the automatic exchanges number 31 and the remainder are manual. The types and capacities are listed in Table 2-2.

The majority of the automatic exchanges operate with the step-by-step type equipment, and these are currently being replaced with up-to-date exchanges. It is expected that a total of 53 new automatic exchanges will be in operation by the end of 1981. On-going telephone exchange projects are listed in Table 2-3.

Table 2-4 shows the present number of telephone sets in the major cities and towns of Zambia.

2.4.2 Long Distance Telecommunications Service

At present, long distance trunk systems exist in the following sections:

1) Microwave System

- Lusaka - Livingstone (6 GHz, upper, 960 CH + TV)
- Lusaka - Nakonde (6 GHz, upper, 960 CH + TV)
- Lusaka - Kitwe (2 GHz, 960 CH + TV)
- Kitwe - Ndola (2 GHz, 960 CH)
- Kitwe - Chingola (2 GHz, 960 CH)
- Kitwe - Luanshya (6 GHz, upper, 960 CH)
- Lusaka - Chipata (2 GHz, 960 CH + TV)
- Lusaka - Mumbwa (6 GHz, upper, 960 CH + TV)

The above Lusaka-Kitwe Link, referred to as "Copperbelt Microwave System" was commissioned in 1966. It carries 90% of all traffic and generates approximately 95% of the total PTC income. Due to the ever-increasing traffic, this link is now saturated, leaving no spare capacity.

2) UHF and VHF System

- Chingola - Solwezi (120 CH)
- Kitwe - Mansa (120 CH)
- Kitwe - Chambishi (120 CH)
- Kitwe - Kalulushi (12 CH)
- Chingola - Chililabombwe (120 CH)
- Ilonda - Isoka (120 CH)
- Ilonda - Nakonde (120 CH)
- Chipata - Malawi (36 CH)
- Monze - Gwembe (12 CH)
- Choma - Pemba (120 CH)
- Chililabombwe - Zaire (1 CH)
- Mkushi Rep - Mkushi T.E (120 CH)
- Serenje Rep - Serenje T.E (120 CH)
- Kululu - Chindari (120 CH)
- Kabwe - Kapiri Mposhi (120 CH)

The existing UHF links, including Chigola-Solwezi and Kitwe-Mansa links, each with the transmission capacity of 120 channels, are in the poor operating condition.

Other trunk lines are served by HF and open wire carrier systems which interconnect the majority of district centers. The existing HF networks in each province are listed in Table 2-5.

2.4.3 Automatic Trunk Switching Service

At present, the Subscriber trunk dialling (STD) Service Network comprises 21 cities and towns as illustrated in Figure 2-1.

To improve and expand the STD Service in the whole area of Zambia, the new development plan is now being implemented. The group switching centers (GSC) (10 in total) will be located at Lusaka, Kitwe, Livingstone, Kasama, Chipata, Choma, Solwezi, Mongu, Mansa and Kabwe. The subordinate centers to each group switching center are shown, together with their respective existing and new exchange capacities, in Table 2-6.

2.5 Third National Development Plan (TNDP)

An outline of Third National Development Plan (1979-1984) for the Telecommunications, Information and Broadcasting Sectors is described below.

2.5.1 Telecommunications Division

The plan envisages further expansion of telecommunications services to provide efficient external and internal communications. The programs are:

- 1) The programs are divided into 3 categories: on-going Government programs, World Bank programs and bilateral aid programs. These programs will involve a total investment outlay of K 79.8 million (US\$ 102.5 million).

- 2) On-going programs include the new telephone exchanges in Copperbelt, Eastern provinces, improvement of Lusaka and Copperbelt Cable Network, and a combined national and international telex exchange at Lusaka.

World Bank projects are scheduled to be implemented over a five-year period and include installation of equipment at local exchanges, expansion of equipment at local exchanges, expansion of cable networks for subscribers' equipment and long distance network. The World Bank assistance to these projects amounts to K 26.6 million.

Under bilateral arrangement, the Swedish International Development Agency (SIDA) has provided trunk switching centers for Lusaka and Kitwe with an international switching center at Lusaka. Under this agreement, telecommunications equipment valued at K 1.6 million provided by SIDA. The commitments on the part of PTC were met from its resources, supplemented by a loan arrangement with the Government.

Investment breakdown for Telecommunications Division in the Third National Development Plan is as follows:

(K in thousand)

Project	Location	Investment cost	Source of Finance	
			GRZ	Other Sources
Telecommunications Division				
International telex exchange extension	Central	1,490	590	900
Inter-territorial communications	National	2,900	-	2,900
National trunk network	Various locatiton	20,819	5,072	15,747
Automatic telephone exchange and local distribution network	Various locations	29,276	10,840	18,436
Telephone exchanges and bearer systems	Various locations	13,000	-	13,000
Maintenance and support services	Various locations	11,750	-	11,750
Satellite earth station	Lusaka	600	498	102
Total		79,835	17,000	62,835

Together with the aforementioned on-going projects, the telephone exchanges, radio bearers and outside plants will be further constructed within the period of the Third National Development Plan. Table 2-7 gives the new projects.

2.5.2 Information and Broadcasting Sector

The Second National Development Plan (SNDP) for the information and broadcasting sector aimed at providing improved television and radio services and also extending existing facilities over a wider area of the country. An investment outlay of K 8 million was budgeted covering the five-year period.

1) Objectives

Objectives of the Third National Development Plan (TNDP) are:

- (a) To continue to strengthen all means of mass media and extend these to all corners of the country;
- (b) To extend the coverage and improve the content and presentation of radio and television programs, in support of rural reconstruction and other national development programs;
- (c) To increase the capacity for locally produced radio and television programs in order to facilitate the development of local talent;
- (d) To improve radio reception throughout the country and coordinate radio and television development with other aspects of the social and economic life of the people;
- (e) To set up an effective external service in order to project the true and correct image of Zambia abroad;
- (f) To improve the standard of locally produced newspapers, magazines and other publications and also improve their circulation and effectiveness, in support of national programs of social and economic development; and
- (g) To strengthen ZANA as a news clearing body with a view to ensuring speedy flow of news to all parts of the country and exchanging news with outside agencies.

The mass media complex project, being implemented with Japanese assistance, will be vital link in the development of radio, television and other information services. Its full implementation will go a long way toward bridging the present communications gap that exists between various parts of the country. Regional radio transmission stations will be set up to improve reception in all parts of the country. Studio facilities both for radio and television broadcasts will be strengthened.

Equipment, transport and other facilities will be provided to all mass media. Training of local personnel will be emphasized, and Information Centers will be set up and strengthened all over the country to improve coverage.

2) Programs and Projects

The Third National Development Plan (TNDP) request for this sector an investment allocation of K30 million from the Government budget. The programs and projects proposed to be undertaken by the Ministry of Information and Broadcasting are as follows:

- (a) Ministry Headquarters
 - i) Mass Media Complex
 - ii) Zambia Institute of Mass Communications

- (b) Zambia Information Services
 - i) Specialist vehicles
 - ii) Film boats and speedboats
 - iii) Campaign vans and boat equipment
 - iv) Film on the history of Zambia
 - v) Training of personnel
 - vi) Publicity overseas
 - vii) Utility vehicles
 - viii) Provincial information centers

- (c) Zambia Broadcasting Services
 - i) Improvement of radio reception
 - ii) Installation of regional radio transmitters and standby facilities at Chipata, Mongu, Kasama and Solwezi
 - iii) Completion of on-going minor projects
 - iv) Improvement of television reception at regional transmitting stations-- Kasama, Mpika, Serenje, Chipata, Mansa, Mumbwa, Kalomo, Mongu and Solwezi
 - v) Radio facilities, Lusaka and Kitwe
 - vi) Television facilities, Lusaka and Kitwe
 - vii) Staff housing at various regional stations
 - viii) Staff training
 - xi) Transport

- (d) Zambia News Agency
 - i) Training
 - ii) Staff housing
 - iii) Transport
 - iv) Telecommunications
 - v) Monitoring system
 - vi) Photo-wire services
 - vii) Office equipment

Table 2-1 Present Telephone Exchange in Zambia

1. Automatic Exchange

Chambishi
 Chilanga
 Chililabombwe
 Chingola
 Chipata
 Choma
 Gwembe
 Itimpi
 Kabwe
 Kafue
 Kalomo
 Kalulushi
 Kasama
 Kitwe
 Livingstone
 Luanshya
 Lusaka
 Ridgeway
 Mansa
 Mazabuka
 Mbala
 Mongu
 Monze
 Mpulung
 Mufulira
 Mumbwa
 Namulundu Gorge
 Ndola
 Pemba
 Siavonga
 Solwezi

2. Manual Exchange

Chalata
 Chirundu
 Chisamba
 Kanona
 Kapiri Mposhi
 Katete
 Kazimule
 Limulunga
 Luwingu
 Mkushi
 Mpika
 Mungwi
 Nakonde
 Namwala
 Petauke
 Sesheke
 Serenje
 Zimba

3. Radio Telephone Public Office

Chadiza	Kazembe	Namwala
Chama	Kaoma	
Chavuma	Luampa	Nyimba
Chilubi	Luangwa	Puta
Island	Lukulu	Samfya
Chitokoloki	Lundazi	Senanga
Chizera	Mporokoso	Sesheke
Ikelenge	Msofo	Shiwangandu
Kabompo	Mulundu	Sinda
Kalabo	Mununga	Zambezi
Kaputa	Mwanjawanthu	
Kasempa	Mwewa	
Kawambwa	Mwense	
	Mwinilunga	

Table 2-2 Type and Capacity of Existing Telephone Exchange

Name of Exchange	Type of Exchange	Capacity	Existing Subscriber Line
Chilanga	Semi Electronic	135	88
Chipata	Sxs	400	380
Choma	Crossbar	800	342
Gwembe	Crossbar	200	10
Kafue	Sxs	200	189
Kalomo	Crossbar	300	103
Livingstone	Sxs	1,400	1,160
Lusaka Main	Electronic	10,000	4,670
Mazebuka	Crossbar	800	254
Mongu	Crossbar	190	180
Monze	Crossbar	600	80
Pemba	Crossbar	300	37
Namalundu Gorge	PABX	100	45
Ridgeway	Crossbar	5,000	3,205
Siavonga	Crossbar	70	66
Mumbwa	Crossbar	200	88
Chirundu	Manual	20	8
Chisamba	Manual	60	29
Katete	Manual	50	47
Kazimule	Manual	20	3
Limulunga	Manual	20	11
Namwala	Manual	100	49
Petauke	Manual	100	88
Sesheke	Manual	2	2
Zimba	Manual	20	18
Chambishi	Crossbar	300	44
Chililabombwe	Crossbar	1,000	612
Chingola	Crossbar	1,900	1,682
Itimpi	Crossbar	300	207
Kabwe	Crossbar	1,900	1,409
Kalulushi	Crossbar	1,000	402
Kasama	Crossbar	1,000	417
Kitwe	Crossbar	9,000	4,905
Luanshya	Crossbar	3,000	1,340
Mansa	RAX	400	368
Mbala	RAX	150	141
Mpulungu	RAX	50	35
Mufulira	Crossbar	3,000	1,323
Ndola	Sxs	5,800	4,711
Solwezi	Crossbar	300	221
Chalata	Manual	20	7
Kanona	Manual	6	6
Kapiri Mposhi	Manual	100	78
Luwingu	Manual	100	86
Mkushi	Manual	100	85
Mungwi	Manual	30	28
Mpika	Manual	200	142
Nakonde	Manual	50	35
Serenje	Manual	100	63

Automatic Exchange	Expected Year of Completion	Capacity	Remarks
Chelston	1981	3000	
Chilanga	1980	768	Expansion
Chililabombwe	1981	2000	Expansion
Chinsali	1981	192	
Chambishi	1981	200	
Chadiza	1981	200	
Chipata	1981	800	
Choma	1981	800	
Chisamba	1984		
Gwembe	1980	256	
Isoka	1981	256	
Itimpi	1978	200	
Kabompo	1982	128	
Kabwe	1981	4000	
Kafue	1981	2000	
Kalabo	1981	128	
Kalomo	1979	200	
Kalulushi	1982	1000	
Kaoma	1981	128	
Kapiri Mposhi	1981	512	
Kasama	1981	1500	
Kasempa	1982	128	
Katete	1981	300	
Kawambwa	1983	256	
	1978		
Livingstone			Replacement
Luangwa	1982/84	200	Man/Auto
Luanshya	1978	3000	
Lukulu	1981	64	
Lusaka Airport	1980	512	
Lusaka Main	1980/1981	8000/7000	
Luwingu	1983	256	
Mansa	1981	800	
Mazabuka	1980	800	
Mbala	1981	640	
Mkushi	1981	256	
Mongu	1981	500	
Monze	1980	600	
Mpika	1981	896	
Mporokoso	1983	256	
Mplungu	1981	192	
Mufulira	1980	3000	
Mumbwa	1980	200	
Mungwi	1981	192	
Mwense	1983	128	
Mwinilunga	1981	128	
Nakonde	1981	128	
Ndola	1983	10000	
Nymba	1981	200	
Nchelenge	1981	128	
Pemba	1980	300	
Petauke	1981	300	

Automatic Exchange	Expected Year of Completion	Capacity	Remarks
Ridgeway Samfya Senga Hill Selenje Sinda Solwezi Zambezi	1978 1981 1981 1981 1981 1981 1981	500 256 256 384 200 600 128	
Radio Links			
Lusaka-Mongu North West Rural Radio Link Chililabombwe- Chingola Kalulushi-Kitwe	1981 1982 1981 1981	960 ch 960 ch 120 ch	Microwave Microwave

Table 2-4 Present Number of Telephone sets in Major Cities and Towns

City/Town	Number of Telephone Subscribers	Population (1979 mid-year estimates)	Telephone Penetration Per 100 Residents
Chililabombwe	1,006	74,000	1.3
Chingola	2,811	183,000	1.5
Kabwe	2,688	284,000	0.9
Kalulushi	797	57,000	1.3
Kasama	1,104	129,000	0.9
Kitwe	8,968	325,000	2.6
Luanshya	2,024	156,000	1.2
Mansa	958	89,000	1.0
Mbala	421	114,000	0.3
Mufulira	2,074	178,000	1.2
Ndola	8,229	394,000	2.0
Solwezi	636	68,000	0.9
Luwingu	138	92,000	0.1
Mkushi	394	67,000	0.2
Mpika	238	69,000	0.3
Serenje	129	62,000	0.2
Chipata	1,320	196,000	0.6
Choma	893	119,000	0.7
Kalomo	332	88,000	0.3
Livingstone	2,864	80,000	3.5
Lusaka	19,939	714,000	2.5
Mazabuka	823	94,000	0.8
Mongu	613	119,000	0.5
Monze	507	92,000	0.4
Katete	99	101,000	0.09
Mumbwa	135	71,000	0.2
Namwala	120	42,000	0.3
Petauke	187	157,000	0.1
Sesheke	15	64,000	0.02

Table 2-5 HF Network in Zambia

Province and Name of Station	Number of CHs	Mode	Province and Name of Station	Number of CHs	Mode
<u>North Western</u>			<u>Central</u>		
Chavuma	2	R/T and CW	Kacholola	1	R/T
Chitokoloki	2	R/T and CW	Keembe	1	R/T
Chizera	2	R/T and CW	Liteta	1	R/T
Ikelenge	2	R/T and CW	Luangwa	2	R/T and CW
Kabompo	2	R/T and CW	Namwala	2	R/T and CW
Kasempa	2	R/T and CW	Ngoma	1	R/T
Kipushi	1	R/T	Nyimba	2	R/T and CW
Mwinilunga	2	R/T and CW			
Zambezi	2	R/T and CW			
<u>Kasama</u>			<u>Western</u>		
Chilubi Island	2	R/T and CW	Kalobo	1	CW
Chinsali	1	CW	Kaoma	1	CW
Isoka	1	CW	Mongu	1	CW
Kaputa	2	R/T and CW	Senanga	1	CW
Mporokoso	2	R/T and CW	Senanga/Livingstone	2	R/T and CW
Ndole Bay	1	R/T			
Shiwangandu	2	R/T and CW			
<u>Mansa</u>			<u>International</u>		
Kawambwa	1	R/T	Tanzania	1	ISB
Samfya	1	CW	Mozambique	1	ISB
<u>Eastern</u>					
Chadiza	2	R/T and CW			
Chama	2	R/T and CW			
Katete	1	CW			
Lundazi	2	R/T and CW			
Msoro	2	R/T and CW			
Mwanjwanthu	2	R/T and CW			
Petauke	1	CW			
Sinda	2	R/T and CW			
<u>Southern</u>					
Machili	1	R/T			
Masese	1	R/T			
Sesheke	1	R/T			
Sesheke (P.O)	1	CW			
Senanga (P.O)	1	R/T			

Note: Lemba Farm (Chisamba) operates direct to Shiwa Estate (Shiwangandu) on R/T only.

* R/T: Radio Telephone System

P.O: Post Office

ISB: Independent Sideband

Table 2-6 Group Switching Centres and Subordinate Centres Sheet 1/2

Exchange	Existing Capacity	Expanded Capacity
<u>Lusaka Group SW Centre</u>		
Lusaka Main	4,000 lines	15,000 lines
Chelston	-	3,000
Kafue	200	2,000
Chilanga	135	500
Ridgeway	5,000	5,000 retained
Airport	-	500
Mumbwa	50 manual	200
Chisamba	60 manual	
Luangwa	-	
<u>Kitwe Group SW Centre</u>		
Kitwe	4,500	9,000
Mufulira	1,500	3,000
Chingola	1,500	3,000
Luanshya	1,500	3,000
Chambeshi	-	200
Chililabombwe	1,000	2,000
Itimpi	-	200
Kalulushi	1,000	1,000
Ndola	4,000	10,000 planned
Mpongwe	-	50 planned
<u>Choma Group SW Centre</u>		
Choma	300	800
Gwembe	manual	
Kalomo	100	200
Mazabuka	300	800
Monze	100	600
Pemba	50 manual	100
Namwala	-	100 planned
<u>Chipata Group SW Centre</u>		
Chipata	300	800
Chadiza	-	50
Katete	50 manual	150
Nyimba	-	50
Petauke	100 manual	200
Sinda	-	50
Chama	-	50 planned
Lundazi	-	150 planned
Kakumbi	-	50 planned
<u>Kasama Group SW Centre</u>		
Kasama	1,000	1,500
Chinsali	50 manual	150
Isoka	-	200
Mpika	100 manual	800
Nakonde	-	50
Luwingu	100 manual	200
Mporokoso	-	200
Mbala	150	500
Mpulungu	-	150
Mungwi	30 manual	150
Kaputa	-	50 planned
<u>Solwezi Group SW Centre</u>		
Solwezi	192	600
Kabompo	-	100
Zambezi	-	100
Mwinilunga	-	100
Chizera	-	50

Table 2-6 Group Switching Centres and Subordinate Centers Sheet 2/2

Exchange	Existing Capacity	Expanded Capacity
<u>Mongu Group SW Centre</u>		
Mongu	192 lines	500 lines
Lukulu	-	100
Kalabo	-	100
Senanga	-	100
Kaoma	-	100
Mulobezi	-	100
<u>Mansa Group SW Centre</u>		
Mansa	200	800
Samfya	-	250
Kawambwa	-	250
Nchelenge	-	100
Mwense	-	100
<u>Kabwe Group SW Centre</u>		
Kabwe	1,900	4,000
Mkushi	100 manual	200
Kapiri Mposhi	500 manual	500
Serenje	50 manual	300
Chibombo	-	50
<u>Livingstone Group SW Centre</u>		
Livingstone	1,400	
Sesheke	2 manual	200 planned
Zimba	20 manual	2,000 planned

Table 2-7

New Projects*

Automatic Exchange	Expected Year of Completion	Capacity	
Chama	1983/1984		Man/Auto
Chavuma	1984		
Chibombo	1980		
Chienge	1984		
Chirundu	1984		
Chizera	1983/1984		Man/Auto
Chozí	1984		
Ikelenge	1984		
Kakumbi	1983/1984		Man/Auto
Kaputa	1983/1984		Man/Auto
Lundazi	1983/1984		Man/Auto
Maamba	1984		
Mpongwe	1982		
Mwandi	1984		
Namalundu Gorge	1981		
Namwala	1984		
Rufunsa	1984		
Sesheke	1984		
Siavonga	1981		
Sinazongwe	1984		
Zimba	1984		
Radio Links			
Chavuma-Zambezi	1984	24 ch	
Chibombo-Kabwe	1984	24 ch	
Chingola-Lusaka	1983	1800 ch	
Chingola-Solwezi	1983	960 ch	
Chisamba-Lusaka	1983	120 ch	
Choma-Sinazongwe	1984	120 ch	
Chozí-Kasama	1984	24 ch	
Eastern Rural	1983	120 ch	
Ikelenge-Mwinilunga	1984	24 ch	
Kitwe-Mansa	1983	960 ch	
Livingstone-Mwandi-Sesheke	1984	120 ch	
Luanshya-Mpongwe	1981	120 ch	
Luapula Rural	1983	120 ch	
Lusaka-Livingstone MUX Expansion	1982		
Lusaka-Luangwa	1983	120 ch	
Lusaka-Mass Media Complex	1981	TV	
Mazabuka-Mazabuka T.E	1981		
Northern Rural	1983	120 ch	
Outside Plant			
Chelston-Lusaka Exp.			
Chilanga-Lusaka			
Chirundu-Lusaka OWL			

* International Links are excluded.

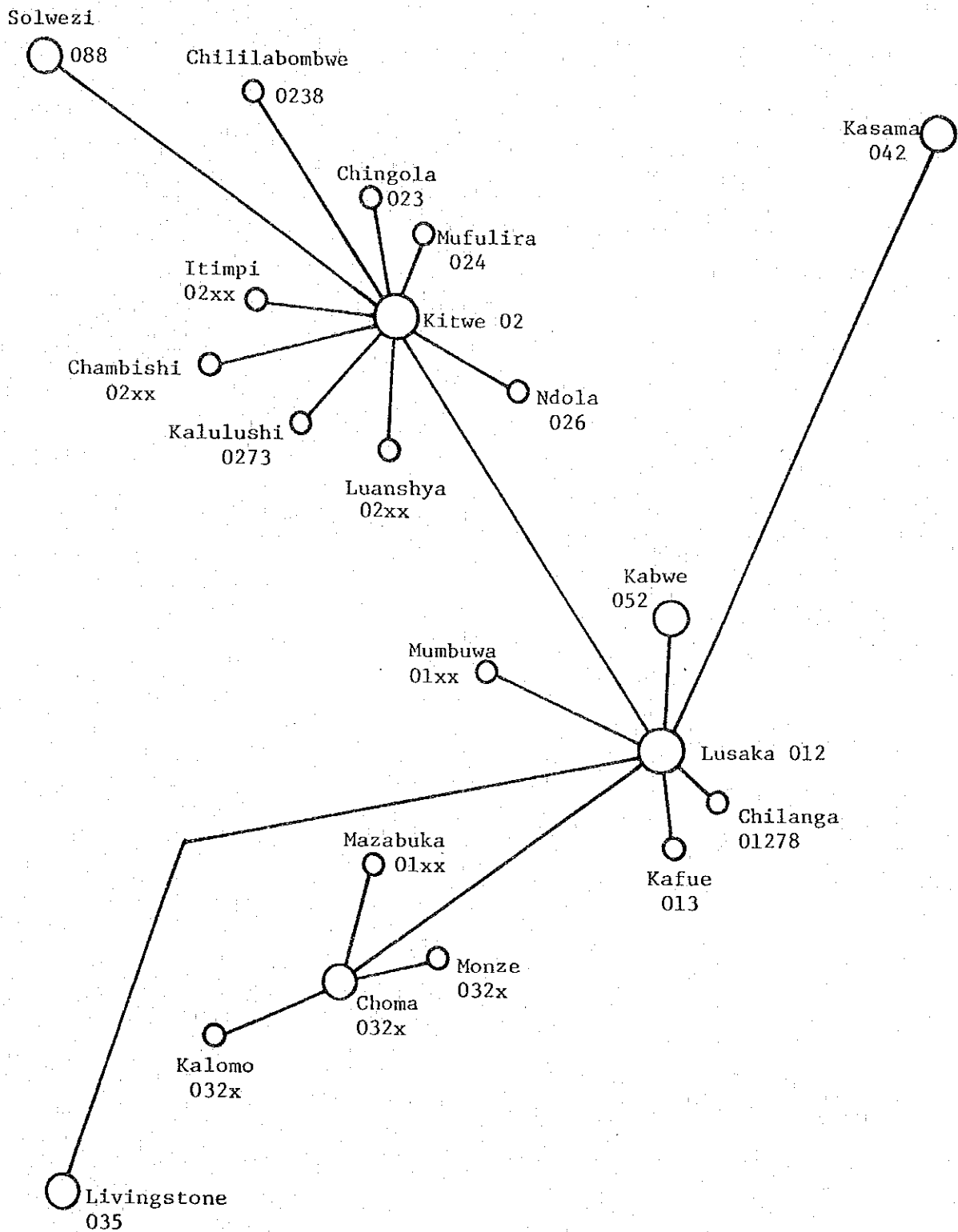


Figure 2-1 Present STD Service Network in Zambia

CHAPTER 3 TELECOMMUNICATION DEMAND
AND
TRAFFIC FORECAST

Chapter 3 Telecommunications Demand and Traffic Forecast

3.1 General

- 1) This section deals with the telecommunications demand and traffic forecast with respect to the microwave radio relay and presents the study of system capacities, including initial capacities, required.
- 2) In the future, as at present, the telecommunications demand in Zambia will mainly center upon the demand for telephones. The present telex subscribers number approximately 1,000 and this figure occupies nearly 3.3% of the number of telephone subscribers. The world trends indicate that the telex demand growth in the future will not be sharp and extensive. Therefore, the project feasibility study will be based on the telephone demand.
- 3) The microwave radio relay system as the project target is mainly to carry the long distance telephone traffic. Needless to say, the system will carry other kinds of traffic also, including telex, telegraph and leased line traffic; however, the overwhelming majority of 80-90% of the traffic to be carried by the system is considered to be the telephone traffic.

Long distance telephone traffic comprises, besides the automatic/semiautomatic connection traffic, such as subscriber trunk dialling (STD) and operator trunk dialling (OTD) traffic, the manual connection (operator-to-operator) traffic also. Judging from the implementation progress of the on-going PTC projects and the implementation plans for new projects now in the making - though the on-going projects are now lagging 2-3 years behind schedule, the automatic/semiautomatic connection system of local exchanges in Zambia as of the end of 1983 will have been considerably improved.

When it is assumed that the microwave radio relay system to be constructed by this Project will be commissioned toward the middle of 1984, the long distance telephone traffic will mainly consist of STD calls. The STD traffic forecast will be made for the years 1984, 1989 and 2000.

- 4) The initial provision (i.e., the number of initial telephone channels) will be studied so as to meet the forecasted traffic as of 1989. The next target year of provision study will be toward the end of 2003 when the service life of the system is set at 20 years as commonly admitted. However, by reason of the present-day rapid technological innovation, the period of system utilization tends to become short, so that the final provision study will be made in the year 2000.

3.2 STD Traffic Forecast

- 1) The STD traffic forecasts as of 1984 and 1989 will be made from the estimated total number of telephones in Zambia in each of the two years and the similar estimated number of telephones in each exchange area, as well as from the community of interest factor (CIF) between exchanges as of 1980. For the year 2000, the rate of traffic growth will be used, based on the forecasted number of telephones in that year.
- 2) Forecast of the Number of Telephones in Whole Zambia
The number of telephones as of the end of 1980 is 60,700. Compared with the International Agency forecast of 1975, the increase in the number of lines lags approximately 3 years behind schedule. Assuming that this lag can be reduced to 2 years by the efforts of the PTC, the number of lines as of 1984 will be 70,000 and the number of telephones will increase to approximately 94,500. (The telephone/line ratio in 1978 was 1.4, but in 1984 this ratio is assumed to be 1.35. Hence, $70,000 \times 1.35 = 94,500$.)

Further assume that, from 1984 through 1989, the number of lines will continue to increase in accordance with telephone demand incentive from 1984 through 1989. Then at the end of the period mentioned, the number of telephones will reach 145,000.

The number of telephones as of 2000 in the whole of Zambia, when considered from the estimated population and per capita GNP of the country and the world average in relationship between the per capita GNP and the number of telephones per 100 persons, is forecasted to be 242,000.

The population of Zambia in 2000 is estimated at 11 million. This estimate is based on the rate of increase used in the UN statistics (3.18% increase between 1973 and 1979).

In 2000, the per capita GNP of Zambia will be US\$ 680 assuming that the per capita growth rate in the future is 2% per year also considering that the per capita GNP of Zambia in 1978 was US\$ 440. Analysis by CCITT shows that, at GNP per capita of US\$ 680, the world average of telephone density per 100 persons is nearly 2.2. This telephone density estimate is not in the least excessive but is considered to be rather conservative. Hence, the number of telephones in Zambia as of 2000 is estimated at

$$2.2/100 \times 11,000,000 \text{ (population)} = 242,000$$

3) Number of Telephones Forecasts by Exchange Areas

Given in Table 3-1 are the forecasts based on the number of telephones in 1980, and this number of telephones is, in turn, based on the PTC data/information. The exchange areas not intimately related to this feasibility study are excluded from the forecasts.

4) Community of Interest Factor

From the number of telephones in each town and the telephone traffic intensity between towns used in the PTC data/information, the community of interest factor (CIF) in 1980 can be calculated as follows:

$$CIF_o = \frac{A_{ij}}{N_i \cdot N_j}$$

where

A_{ij} : Traffic between exchange area i and exchange area j

N_i, N_j : Number of telephones in exchange areas i and j, respectively

CIF in 1984 and 1989 can be calculated as follows:

$$1984 : CIF_x = CIF_o \times \frac{M_o}{M_x}$$

$$1989 : CIF_y = CIF_o \times \frac{M_o}{M_y}$$

where

M_o : Number of telephones in 1980

M_x : Estimated number of telephones in 1984

M_y : Estimated number of telephones in 1989

5) Traffic Forecast

Based on the CIF calculation in the preceding paragraph, the inter-exchange traffic A_{ij} is estimated as follows:

$$1984 : A_{ij} = N_i \cdot N_j \cdot CIF_o \cdot \frac{M_o}{M_x}$$

$$1989 : A_{ij} = N_i \cdot N_j \cdot CIF_o \cdot \frac{M_o}{M_y}$$

For the inter-exchange sections whereto the PTC data/information do not apply (i.e., the sections where the traffic is relatively limited), as well as the inter-exchange sections not covered by the microwave routes to be established by this Project, the traffic estimate is made from the average value of originating and terminating traffic per telephone and from the percentage of STD traffic out of such originating and terminating traffic.

The community of interest factor is bound to change according to the economic interflow between towns in the future. Therefore, the traffic estimate for 2000 by the same method of estimate as for 1984 and 1989 (i.e., on the assumption that the present trend of CIF will continue without change in the future), is not pertinent. If no change in CIF is assumed, the inter-exchange traffic in 2000 estimated from the previously mentioned number of telephones forecasts becomes 1.66 times the estimate value for 1989 on the average. The inter-exchange traffic as of 2000 is forecasted between 1.3 times and 1.5 times the traffic as of 1989. This traffic forecast is in consideration of Paragraphs 1) through 3) and the purport of this report to make a conservative forecast. The forecasted traffic is given in Table 3-2.

3.3 Number of Telephone Channels and System Capacities

1) STD Telephone Network

The number of telephone channels to be provided in 1984 and the system capacities will be calculated on the assumption that the STD network be constituted as in Figure 3-1.

Depending upon how the exchange hierarchy and the homing arrangement are determined and how the high-usage route is established, the traffic routing varies. The effect of traffic routing on the switching capacity for transit traffic and the function of exchange facilities is especially great. Such extreme details will be studied

at the implementation stages of individual projects and the optimum traffic routing will be determined. Even in the event the traffic routing is modified, the effect on the cost of transmission path construction is considered to be negligibly small.

2) Number of Channels

For the STD traffic of 1984 and 1989, the number of channels equivalent to the grade of service of 1% is required.

The microwave radio relay system to be established by this Project will carry the telex, telegraph and leased line traffic besides the STD traffic. Furthermore, from the viewpoint of system maintenance and operation, a few spare channels will have to be provided. To take care of such minor traffic, channels equivalent to 20% of the number of STD channels will be prepared in 1984 and 10% equivalent in 1989.

The number of channels required in 2000 will be in the range of 1.2 times to 1.5 times the number of channels in 1989. This range of increase is the same as the range of growth in the traffic forecast.

The number of channels required to meet the STD traffic in 1984 and 1989 appears in Table 3-2.

Figures 3-2 and 3-3 present the number of channels to be provided in 1989 and the number of channels required in 2000 inclusive of the channels to cater for the aforementioned minor traffic. This number of channels is calculated on the assumption that the channels be established according to the multiplex equipment group unit (12 channels).

3) System Capacities

The system capacities shall commensurate with the number of channels required in the year 2000.

There is need for VF channel expansion once during 1989 through 2000. In this case, the number of channels to be provided must be determined, based on the actual circuit requirements at that time. A typical example of Channel expansion plan is given in Table 3-4.

In due consideration of the required number of channels in 2000 referred to above, the microwave transmission system capacities according to radio routes are determined as follows:

Lusaka - Copperbelt	1,800-channel system
Chingola - Solwezi	960-channel system
Kasama - Mansa	960-channel system
Kasama - Mbala - Mpulungu	120-channel system
Mansa - Kawambwa - Mwense - Nchelenge	120-channel system
Mansa - Samfya	120-channel system
Chipata - Lundazi - Chama	120-channel system
Chipata - Mfuwe Airport	120-channel system

The Chingola-Solwezi and Kasama-Mansa sections will have transmission capacity of 960 channels because of the need for TV signal transmission.

Table 3-1 Forecasts of Number of Telephone

City/Town \ Year	1980	1984	1989	2000
Lusaka	20,000	34,000	51,000	
Kitwe	8,970	15,300	24,500	
Ndola	8,230	14,100	22,600	
Chingola	2,810	4,800	7,700	
Chililabombwe	1,100	1,700	2,700	
Mufulira	2,070	3,500	5,600	
Kalulushi	800	1,400	2,200	
Solwezi	640	760	1,100	
Kabwe	2,690	3,200	4,700	
Kasama	1,100	1,300	1,900	
Mansa	960	1,100	1,600	
Chipata	1,320	1,500	2,200	
Livingstone	2,860	3,300	4,800	
Chisamba	170	200	400	
Nchelenge		50	150	
Kawambwa		50	150	
Mwense		50	200	
Samfya		50	200	
Luwingu	140	160	230	
Mporokoso		50	150	
Mpulungu	60	150	200	
Mbala	420	540	800	
Kakumbi		50	150	
Lundazi		50	150	
Chama		50	150	
Other Towns	6,450	7,090	9,470	
Total	60,700	94,500	145,000	242,000

Table 3-2 STD Traffic and Number of Telephone Channels

Sheet 1/3

Exchange A	Number of Telephones 1984	Exchange B	Number of Telephones 1984	C.I.F 1980	Traffic in Erl. 1984	Number of CHs 1984	Traffic in Erl. 1989	Number of CHs 1989	Circuit Requirements 1989	Circuit Requirements 2000
Solwezi	x1000 x 1000 0.76 1.10	Kitwe	x 1000 x 1000 15.3 24.5	0.98	7.3	23x2	11.0	31x2	72	120
North West Region Chililabombwe	1.7 2.7	Ndola	14.1 22.6	0.01	0.1		0.1			
		Lusaka	34.0 51.0	0.06	1.0		1.4			
		Others	30.14 45.48	0.78	11.4		16.4			
		Other Tandems			7.6		12.0			
Chingola	1.7 2.7	Chingola	4.8 7.7	12.75	66.6		111.3			
		Kitwe	15.3 24.5	1.94	32.3	28x2	53.9	42x2	96	132
		Others	72.7 110.1	0.06	4.7		7.5			
Chingola	4.8 7.7	Kitwe	15.3 24.5	0.88	41.4	50x2	69.7	77x2	180	240
		Others	58.6 87.5	0.19	34.2		53.8			
		Ndola	14.1 22.6	1.69	73.2	49x2	123.5	77x2	180	240
Mufulira	3.5 5.6	Kitwe	15.3 24.5	3.56	122.0	84x2	205.1	133x2	300	372
		Others	61.6 92.3	0.11	15.2		23.9			
		Ndola	14.1 22.6	1.46	46.1	34x2	77.6	51x2	120	156
Kitwe	15.3 24.5	Ndola	14.1 22.6	1.79	247.1	142x2	416.3	232x2	516	612
		Lusaka	34.0 51.0	.7	246.4	183x2	388.3	287x2	636	756
		Livingstone	3.3 4.8	0.06	1.9		3.0			
Ndola	14.1 22.6	Kasama	1.3 1.9	0.15	1.9		2.9			
		Kabwe	3.2 4.7	1.26	39.5		60.9			
		Mansa	1.1 1.6	0.31	3.3		5.1			
Ndola	14.1 22.6	Others	11.44 16.8	0.32	35.8		55.3			
		Lusaka	34.0 51.0	0.57	174.9	143x2	276.0	218x2	480	576
		Mansa	1.1 1.6	0.17	1.7		2.6			
Cont'd		Livingstone	3.3 4.8	0.09	2.7		4.1			

Table 3-2 STD Traffic and Number of Telephone Channels

Sheet 2/3

Exchange A	Number of Telephones 1984	Number of Telephones 1989	Exchange B	Number of Telephones 1984	Number of Telephones 1989	C.I.F 1980	Traffic in Erl. 1984	Number of CHS 1984	Traffic in Erl. 1989	Number of CHS 1989	Circuit Requirements 1989	Circuit Requirements 2000
Cont'd	x 1000 x 1000			x 1000 x 1000								
Ndola	14.1	22.6	Kasama	1.3	1.9	0.22	2.6		4.0			
			Chipata	1.5	2.2	0.12	1.6		2.5			
			Kabwe	3.2	4.7	1.47	42.4		65.6			
			Others	11.64	17.3	0.22	23.1		36.1			
Kabwe	3.2	4.7	Lusaka	34.0	51.0	1.37	95.4	109x2	138.0	155x2	348	444
			Kitwe	15.3	24.5	1.26	39.5		60.9			
			Ndola	14.1	22.6	1.47	42.4		65.6			
			Others	27.8	42.2	0.09	5.1		7.5			
Mansa	1.1	1.6	Kasama	1.3	1.9		20.0	27x2	30.0	42x2	96	132
			Ndola	14.1	22.6	0.17	1.7		2.6			
			Kitwe	15.3	24.5	0.31	3.3		5.1			
			Lusaka	34.0	51.0	0.21	5.0		7.2			
Nchelenge	0.5	0.15	Other tandems	93.35	143.2		0.7		2.2			
Kawambwa	0.5	0.15	Other tandems	93.35	143.2		0.7		2.2			
Mwense	0.5	0.15	Other tandems	93.35	143.2		0.7		2.9			
Samfya	0.5	0.15	Other tandems	93.35	143.2		0.7		0.9			
Mansa	1.1	1.6	Others	28.5	42.06		3.4		4.9			
Nchelenge	0.05	0.15	Mansa	1.1	1.6		1.8		5.6	9x2	24	36
			Others	93.35	143.25		0.7		2.2			
Kawambwa	0.05	0.15	Mansa	1.1	1.6		1.8	5x2	5.6	9x2	24	36
			Others	93.35	143.25		0.7		2.2			
Mwense	0.05	0.2	Mansa	1.1	1.6		1.8	5x2	2.9	11x2	24	36
			Others	93.35	143.25		0.7		7.0			
Cont'd												

Table 3-2 STD Traffic and Number of Telephone Channels

Sheet 3/3

Exchange A	Number of Telephones 1984 1989	Exchange B	Number of Telephones 1984 1989	C.I.F. 1980	Traffic in Erl. 1984	Number of CHs 1984	Traffic in Erl. 1989	Number of CHs 1989	Circuit Requirements 1989 2000
Samfya	x 1000 x 1000	Mansa	x 1000 x 1000		1.8	5x2	2.9	11x2	24
	0.05 0.20		1.1 1.6						
Luwingu	0.16 0.23	Kasama	1.3 1.9		5.1	10x2	7.4	12x2	36
Mpulungu	0.15 0.2	Mbala	0.50 0.8		2.2	9x2	2.9	11x2	24
Mbala	0.54 0.8	Kasama	1.3 1.9		2.2	19x2	16.8	25x2	60
Mpulungu	0.05 0.15	Others	92.66 142.3		7.6	5x2	11.2	9x2	24
Mporokoso	0.05 0.15	Other tandems	1.3 1.9		1.8	5x2	5.6	9x2	24
Chama	0.05 0.15	Kasama	1.5 2.2		1.8	5x2	5.6	9x2	24
Lundazi	0.05 0.15	Chipata	1.3 1.9		1.8	5x2	5.6	9x2	24
Kakumbi	0.05 0.15	Others	1.3 1.9		1.8	5x2	5.6	9x2	24
Kakumbi	0.05 0.15	Chipata	1.3 1.9		1.8	5x2	5.6	9x2	24

Note:

1. The traffic between each route is divided into two parts, i.e.

Outgoing traffic: 50 % of the traffic

Incoming traffic: 50 % of the traffic

2. Grade of service: 1%

Table 3-3 Typical Channel Expansion Plan (1984/89 - 2000)

Circuit		Initial Number of CKT for 1989	Expansion for 1994		Expansion for 2000	
			No. of Expansion	Sub-TTL	No. of Expansion	Sub-TTL
Lusaka	Kabwe	384	24	408	36	444
	Kitwe	636	60	696	60	756
	Ndola	480	48	528	48	576
	Chisamba	12	12	24	12	36
Kitwe	Mufulira	300	36	336	36	372
	Ndola	516	48	564	48	612
	Chingola	180	24	204	36	240
	Solwezi	72	24	96	24	120
	Chililabombwe	96	24	120	12	132
Mufulira	Ndola	120	24	144	12	156
Chingola	Ndola	180	24	204	36	240
Kasama	Mporokoso	24	-	24	12	36
	Mbala	60	24	84	12	96
	Senga Hill	24	-	24	12	36
	Luwingu	36	-	36	12	48
	Mansa	96	24	120	12	132
Mansa	Samfya	24	-	24	12	36
	Mwense	24	-	24	12	36
	Kawambwa	24	-	24	12	36
	Nchelenge	24	-	24	12	36
Mbala	Mpulungu	24	-	24	12	36
Chipata	Lundazi	24	-	24	12	36
	Mfuwe Airport	24	-	24	12	36
Lundazi	Chama	24	-	24	12	36
Kabwe	Chibombo	12	12	24	12	36
<u>Total</u>		3,420	408	3,828	528	4,356

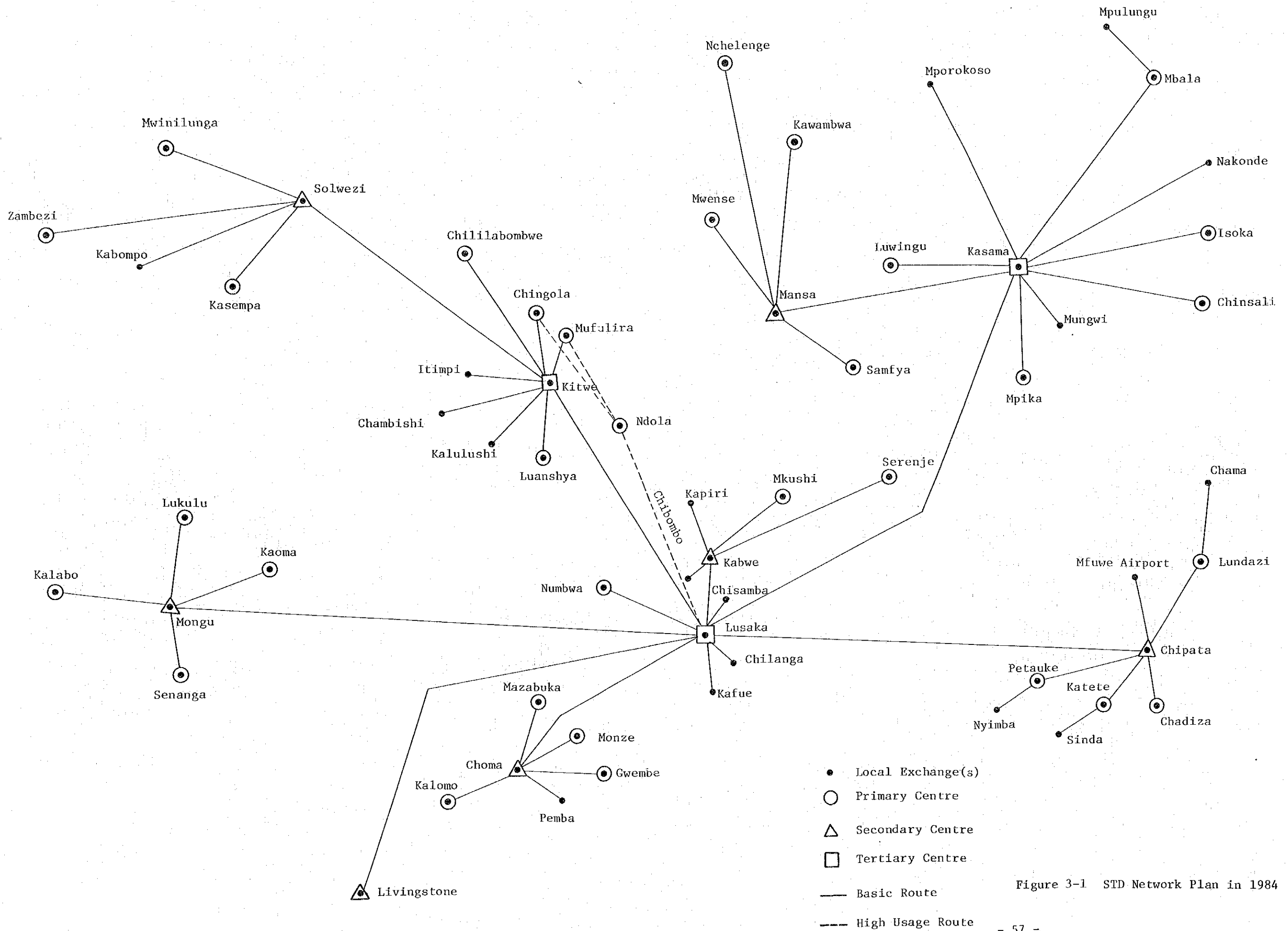


Figure 3-1 STD Network Plan in 1984

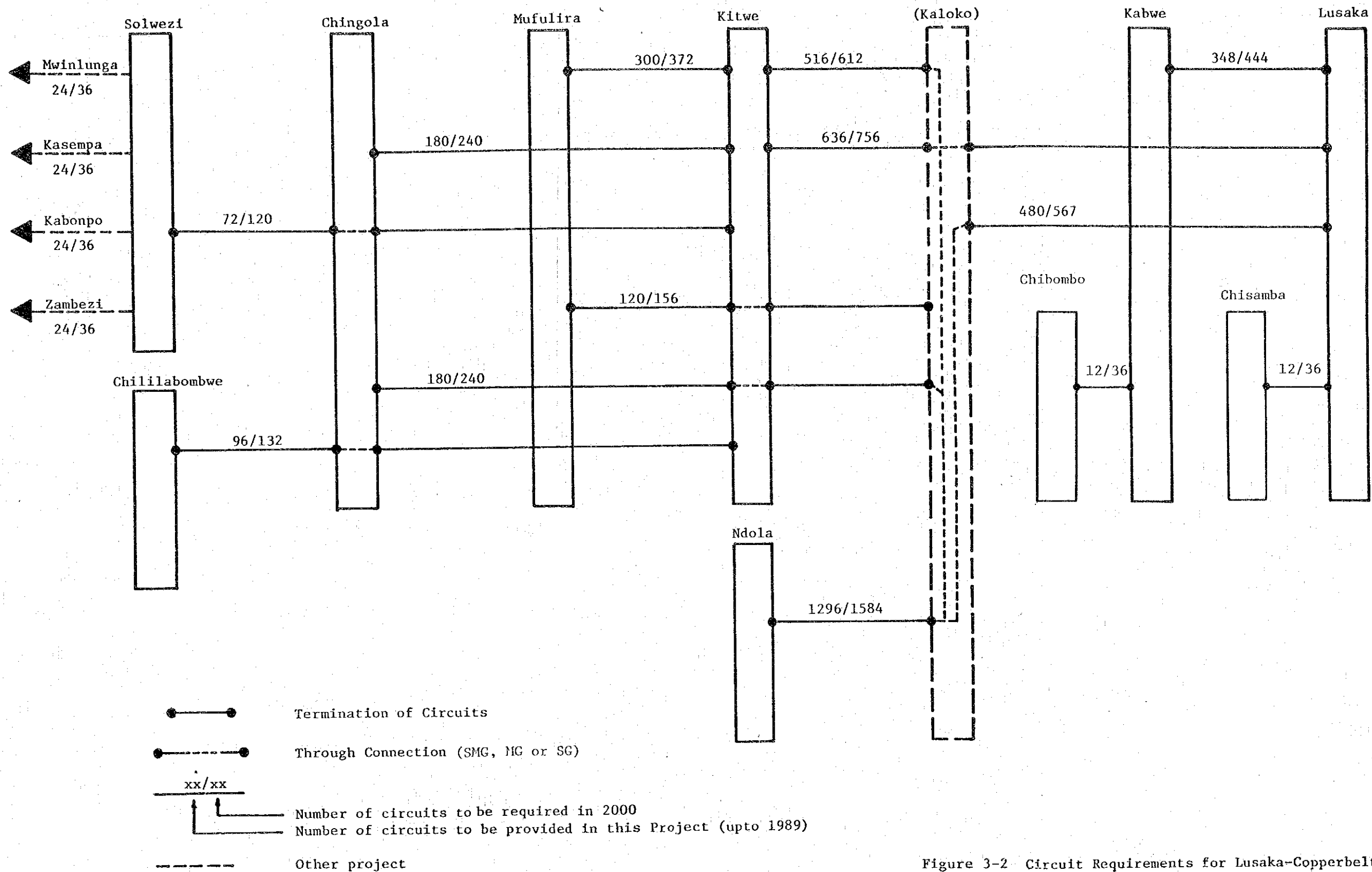


Figure 3-2 Circuit Requirements for Lusaka-Copperbelt and Chingola-Solwezi Routes

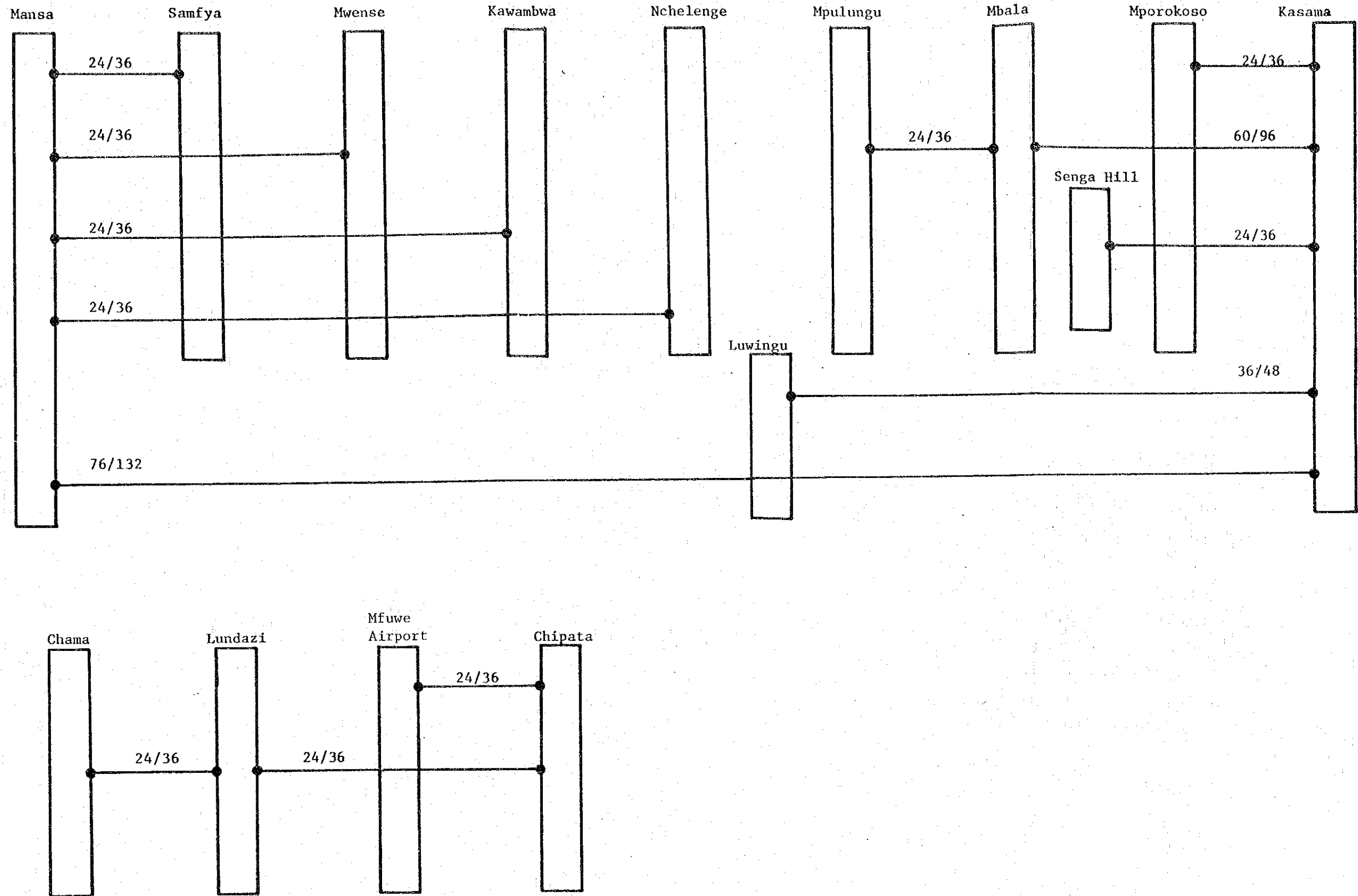


Figure 3-3 Circuit Requirements for Kasama - Mansa, Kasama - Mbala, Kasama - Mporokoso and Chipata - Lundazi Routes

CHAPTER 4 TRANSMISSION ROUTE PLAN
AND
SYSTEM DESIGN

Chapter 4 Transmission Route Plan and System Design

4.1 Overview

The existing long distance microwave and UHF radio routes are as shown in Figure 1-1.

This section deals with the technical studies of the undermentioned microwave radio routes:

- 1) Mass Media Television Link
- 2) Lusaka - Copperbelt Route
- 3) Kasama - Mansa Route
- 4) Chingola - Solwezi Route
- 5) Kasama - Mbala Route
- 6) Kasama - Mporokoso Route
- 7) Chipata - Lundazi - Chama Route

The principal objectives of the plan to construct these microwave radio routes are threefold:

- i) To up-grade the backbone telephone circuit between Lusaka and Copperbelt;
- ii) To initiate television signal transmission to the provincial capitals;
- iii) To newly establish the rural telephone network in Luapula, Northern and Eastern Provinces.

On the Lusaka-Copperbelt section of the microwave link where the main cities are concentrated, the aging transmission facilities are saturated thus increasing the need for urgent system replacement. In addition, the existing rural telephone networks in the Provinces, served by HF and open wire systems, are giving very poor service.

In view of the growth of the agricultural and industrial activities in these Provinces, the upgrading of such rural telephone networks is both imperative and indispensable.

An outline of each radio route is introduced in Paragraph 4.3

4.2 System Trunking Plan

The system trunking plan introduced in Figure 3-2 is based on the channel requirement between exchanges described in the preceding Section 3. This system trunking plan aims at satisfying the communication demand to be considered up to the year 2000. And, based on this trunking plan, the channel accommodation plan will be prepared, and the carrier multiplex equipment installation complying with the channel requirement for 1984-1989, i.e., the first stage of this Project, will be carried out.

The additional installation of carrier multiplex equipment in accordance with the channel requirement for the second stage, i.e., 1989-2000, will be accomplished at an appropriate period during the second stage.

4.3 Outline of Each Radio Route

4.3.1 Mass Media Television Link

The outline of the construction plan is as follows:

1) Television Link between Existing TV Studio and New TV Studio

Between the existing and new TV Studios, the bothway working TV radio bearer and protection radio bearer will be constructed.

2) Up-grade of the protection bearer for TV signal transmission from Livingstone to Lusaka microwave Link.

3) The protection radio bearer between Lusaka Telephone Exchange (Lusaka T.E.) and Mwembeshi Earth Station will be newly established. This telephone/television protection radio bearer is to improve the system performance and reliability. Meanwhile, at present, no protection radio bearer exists in the section mentioned.

4) Addition of the remote control and switchover functions for TV signal transmission at Lusaka T.E.

4.3.2 Lusaka-Copperbelt Route

As per the attached channel plan, the 1,800 channel system by 6 GHz upper band will be constructed between Lusaka and Copperbelt with spurs to Chisamba and Chibombo.

For TV signal transmission, the bothway route will be established between Lusaka and Kitwe and the one-way route (down direction) will be established between Kitwe and Chingola. For TV signal transmission from Chingola to Kitwe, the protection radio bearer will be used.

The system configuration and the route map appear in Figures 4-1 and 4-2.

4.3.3 Kasama-Mansa Route

1) Kasama-Mansa Link

As per the attached channel plan, the 960 CH system by 2 GHz band and the TV transmission route (one-way) will be established between Kasama and Mansa.

On this route, the IF leaking system as shown in Figure 4-3 will be adopted. The purpose is to reduce the project cost.

For TV signal transmission from Mansa to Kasama, the protection radio bearer will be used.

The route map appears in Figure 4-4.

2) Mansa-Mwense-Kawambwa-Nchelenge Link and Mansa-Samfya Link

As per the attached channel plan, the 2 GHz, 120 CH system will be established in each section. As shown in Figure 4-3, each link will undergo the IF leaking from the Kasama-Mansa route.

In this case, the Yambayamba and Bululu Stations will become the IF leaking stations where the establishment of carrier multiplex equipment, such as SG Modems, is not required. This contributes to the saving of power consumption and the reduction of equipment cost, as well as the ease of maintenance. Although the radio equipment requires transmission capacity of 300 CH, the cost increase is negligible.

The route map appears in Figure 4-4.

4.3.5 Chingola-Solwezi Route

As per the attached channel plan, the 960 CH system by 6 GHz upper band and the TV transmission route (one-way) will be established between Chingola and Solwezi. For TV signal transmission from Solwezi to Chingola, the protection radio bearer will be used.

The route map appears in Figure 4-5.

4.3.6 Kasama-Mbala Route and Kasama-Mporokoso Route

As per the attached channel plan, the 2 GHz, 120 CH system will be established in each section. On both routes, the IF leaking system will be adopted.

The system configuration and the route map appear in Figures 4-6 and 4-7.

4.3.7 Chipata-Lundazi Route

In this route Lundazi-Chama and Chipata-Mfume Airport Links are included.

As per the attached channel plan, the 2 GHz, 120 CH system will be established in each section. On both routes, the IF leaking system will be adopted.

The system configuration and the route map appear in Figures 4-8 and 4-9.