JAPAN INTERNATIONAL COOPERATION AGENCY

SWAZILAND POSTS AND TELECOMMUNICATIONS CORPORATION

KINGDOM OF SWAZILAND

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR RURAL AUTOMATION MULTI-ACCESS RADIO SYSTEM IN THE KINGDOM OF SWAZILAND

MARCH 1993

JAPAN TELECOMMUNICATIONS ENGINEERING AND CONSULTING SERVICE

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PREFACE

In response to a request from the Government of the Kingdom of Swaziland, the Government of Japan decided to conduct a basic design study on the Project for Rural Automation Multi-Access Radio System in the Kingdom of Swaziland and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Swaziland a survey team headed by Mr. Minoru Takahara, Training Manager & Instructor of the Training Institute of Telecommunications Administration of the Ministry of Posts and Telecommunications and constituted by members of Japan Telecommunications Engineering and Consulting Service (JTEC), from October 25 to November 23, 1992.

The team held discussions with the officials concerned of the Government of Swaziland, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Swaziland 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 government of the Kingdom of Swaziland for their close cooperation extended to the teams.

March 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International
Cooperation Agency

Mr. Kensuke Yanagiya,
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

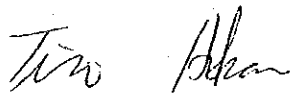
We are pleased to submit to you the basic design study report on the Project for Rural Automation Multi-Access Radio System in the Kingdom of Swaziland.

This study has been made by Japan Telecommunications Engineering and Consulting Service, based on a contract with JICA, from October 21, 1992 to March 26, 1993. Throughout the study, we have taken into full consideration of the present situation in the Kingdom of Swaziland, and have planned the most appropriate project in the scheme of Japan's grant aid.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs and the Ministry of Post and Telecommunications. We also wish to express our deep gratitude to the officials concerned of Swaziland Posts and Telecommunications Corporation, JICA Zambia office, Embassy of Japan in Zambia and in the Republic of South Africa for their close cooperation and assistance during our study.

At last, we hope that this report will be effectively used for the promotion of the project.

Very truly yours,



Jiro Kokan
Project Manager
Japan Telecommunications Engineering
and Consulting Service
Basic design study team on
The Project for Rural Automation
Multi-Access Radio System
in the Kingdom of Swaziland

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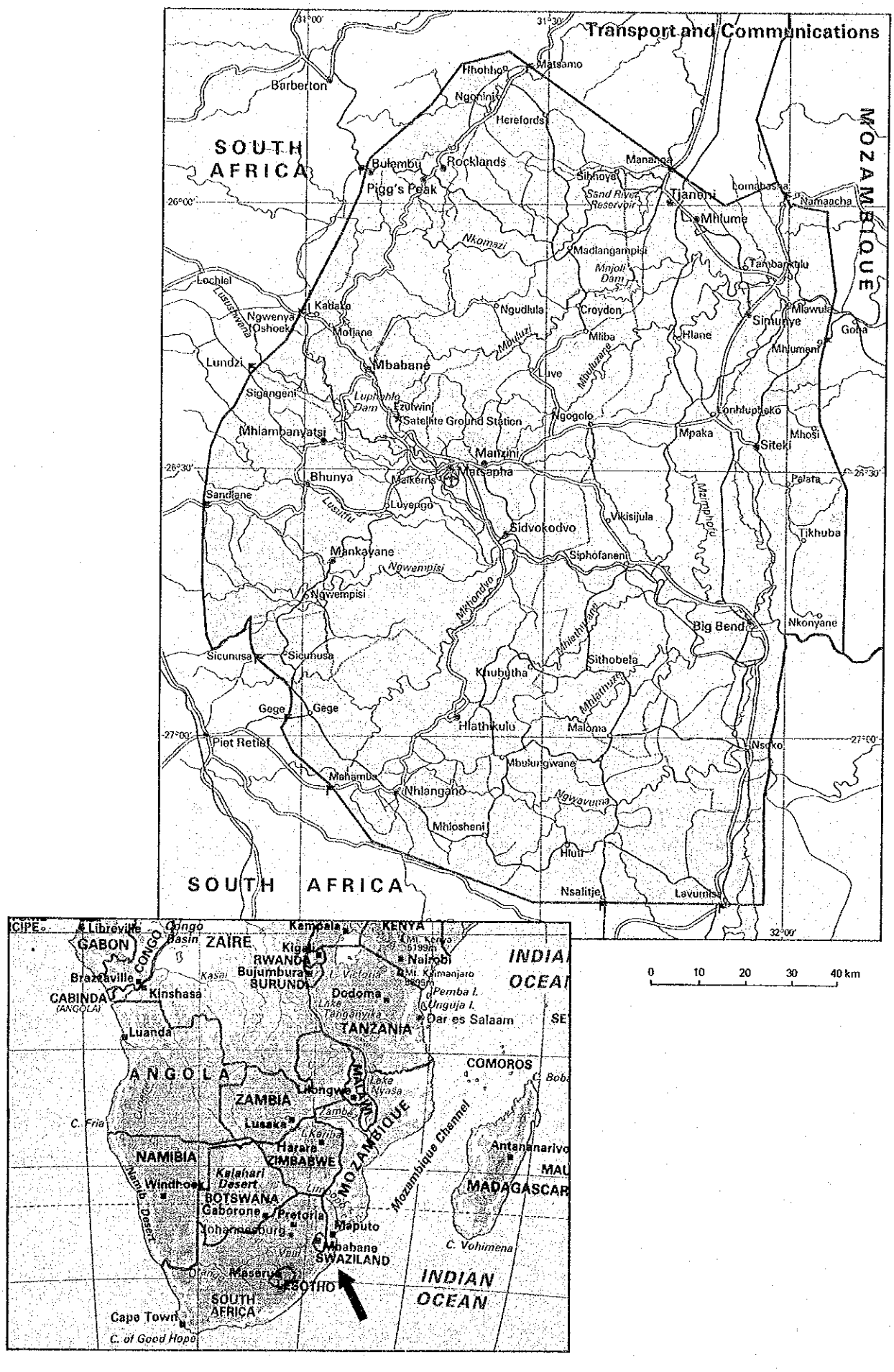

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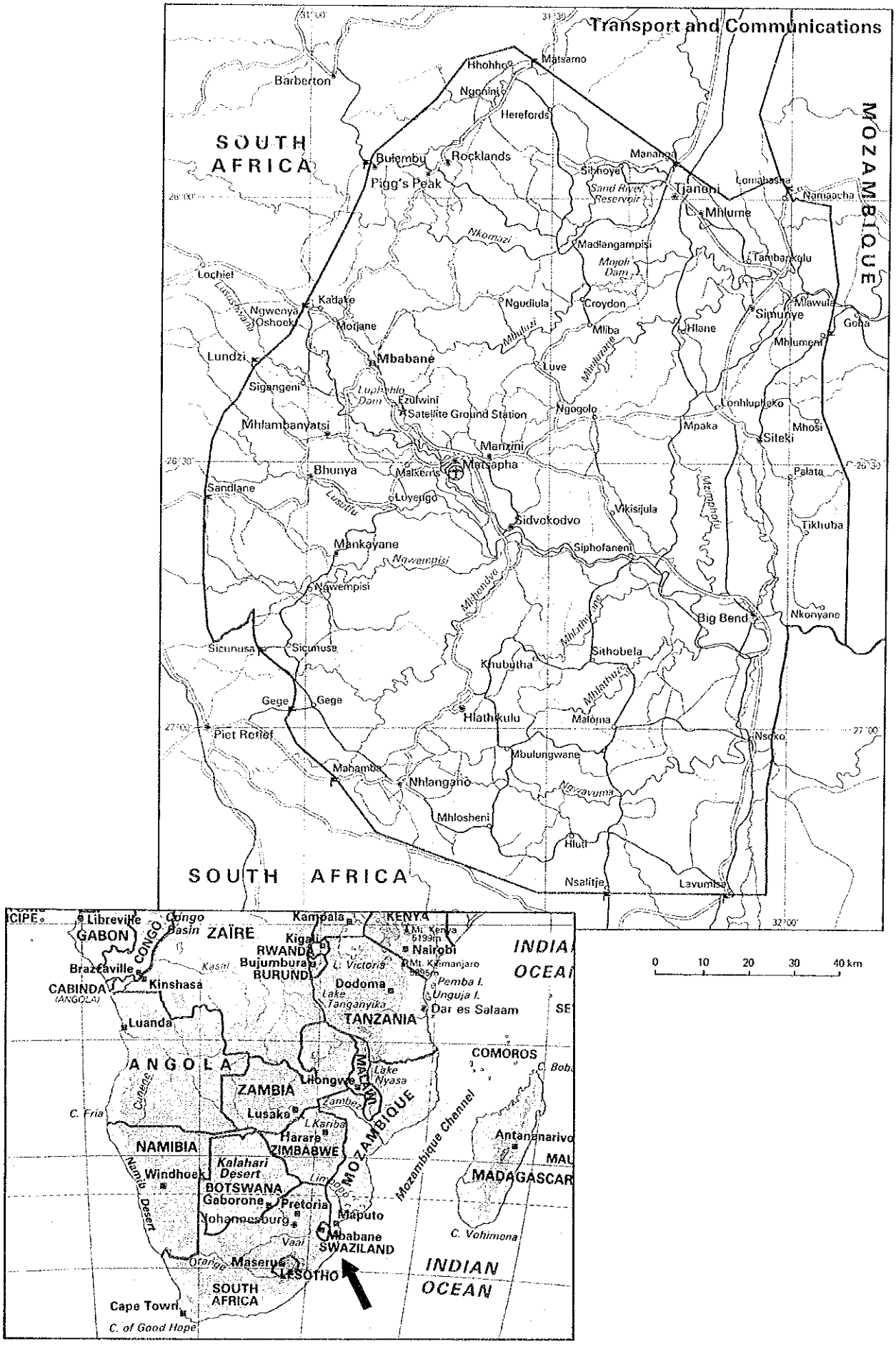

SUMMARY

SUMMARY

The Kingdom of Swaziland, independent in 1968, is a landlocked country of 17,000 square kilometers, whose population is about 760,000 people. Its economy depends on agriculture; sugar cane and wood (pulp) are the main products. The most of the population (80%) is distributed in the rural areas, where economic activities are stagnant due to lack of adequate communication media such as telephones. It causes migration from the farm areas, and generates social problems in the urban areas.

The Government of Swaziland lists the development of the domestic telecommunications network in its national development plan and hopes to achieve a communication service in which at least one telephone exists within a 10 km range throughout the nation. This is the minimum standard for development of a telecommunication network as defined by the ITU (International Telecommunications Union). The Swaziland Posts and Telecommunications Corporation (SPTC) is putting forth efforts to achieve this standard and has introduced digital switching equipment in the capital Mbabane and various provincial cities, and installed a microwave radio network to link the capital Mbabane with the provincial cities.

In rural areas, however, telephone installation costs too much for distant places, and a geographical limitation due to the mountainous nature of the country makes it technically and economically difficult to develop a telephone network in those areas. With this background, the Government of Swaziland plans to develop a telephone network using radio systems in the farm areas from now on. So, it requested to Japan a Grant Aid considering Japan's high technical level in this field and Swaziland's lack of funds.

In response to the request, the Japanese government decided to conduct a basic design study related to the project for rural automation multi-access radio system in the Kingdom of Swaziland. Hence, Japan International Cooperation Agency (JICA) was to carry out the study and sent the basic design study team to that country for 30 days from October 25 through November 23, 1992.

The study team had discussions with concerned SPTC staff members to study the adequacy as a Grant Aid project and the contents and scale of the cooperation. The team also conducted a survey of the project sites, and studied the present situation and future plans of the telecommunications facilities and services, and maintenance and

administration system. Furthermore, it realized radio wave propagation tests in planned sections. After returning to Japan, on the basis of the collected data and field survey results, a basic design relating to the necessary and optimum contents and scale of the project was worked out and a draft of the basic design study report was made.

Further, JICA sent a mission for explanation of the draft of the final report from January 31 through February 12, 1993 to explain and discuss with concerned government officials of that country.

The outline of the project based on the basic design study is shown below.

(1) The areas included in the project:

Manzini, Hlathikulu, Piggs Peak, Maphiveni

(2) Scale of the project:

* Number of base stations 4
* Number of repeater stations 11
* Number of terminal stations 87
* Number of subscriber lines 556
  (of the total, ordinary telephones 447, public telephones 87, TELEX 22)

(3) Outline of planned equipment

The main components of the Project is as follows:

Item		Contents
Transmission System		2.4 GHz band time division multiple access system (60 time slots, maximum subscriber capacity is 512)
Main equipment	Radio Facilities	* Base station equipment:4 sets (Normal/stand-by) * Repeater station equipment:10 sets (Normal/stand-by) * Combined repeater/terminal station equipment:1 set (Normal/stand-by) * Terminal station equipment:86 sets * Supervisory and control equipment * Measuring apparatus and spare panels
	Steel towers and poles	* 9 towers of 27m high * 68 poles of 10m high * 12 poles of 15m high * 5 poles of 20m high * 1 pole of 25m high
	Antennas	* 15 omni-antennas * 6 3mϕ parabolic antennas * 56 horn antennas * 1 1.8mϕ parabolic antenna * 4 4mϕ parabolic antennas * 30 1.2mϕ parabolic antennas
	Power supply systems	* 42 solar cell power supply systems * 54 charger/battery systems
	Cable	* 10 pair subscriber cable:60km

Further, the construction of which the expense is to be borne by Swaziland is shown below.

(A) Offering and securing the land and equipment rooms required for the repeater stations and terminal stations, and construction of huts for accommodation of equipment, where such accommodation facilities are not available.

(B) Construction of the foundations for antenna towers, poles and solar cell panel supporting parts in cooperation with Japanese supervisors,

(C) Wiring work between switching equipment and main distributing frame of the base station equipment,

(D) Installation work of subscriber cables between terminal radio equipment and subscriber telephones, and installation of telephone sets,

(E) Construction of access roads and fences which are required for the installation of the equipment

(F) Arrangement of commercial AC 220V power supply in project sites, where such power supply is available.

(G) Transportation of equipment and materials of tower/pole to the project sites from warehouse of SPTC.

A total of 1,233 thousand Emalangeni will be borne by the Swaziland side. The implementation period is scheduled to be five and a half months for a detailed design, tendering and contract awarding, and twelve months for equipment procurement and installation.

The SPTC shall act as the principal organization for execution and operation of this project. Its financial affairs are good enough so that the SPTC can shoulder the expenses for normal operations of granted equipment. Also the SPTC already employs microwave transmission systems using digital technology, and knowledge and skills on said technology of its maintenance personnel are deemed to be maintained at a higher level through various training programs within the country and abroad. Therefore, engineers and technicians in charge of maintenance and operations of granted equipment can be sufficiently secured by giving OJT to the existing maintenance personnel during the construction period.

It is hoped that the rural telephone network of the Kingdom of Swaziland is established and improved greatly through the execution of this project and that it will contribute greatly to the social and economic development in the rural areas as their important infrastructure. Also, it is expected that the rural telephone network will expand and develop further by adding terminal stations and installing cables by themselves, since the system to be donated by this project is capable of coping flexibly with the future telephone demand. This project will benefit about five hundred thousand people, i.e. 70% of the rural population.

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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

The Kingdom of Swaziland has set up and implemented 5 year national development plans aimed at the national land development and improvement of private sectors since their independence in 1968 and is now implementing the 4th national development plan.

As the result of a variety of business which have been done by the government, the economy has improved steadily and GNP per capita has reached US$900 in 1989 and imports of maize has been reduced to 10% of the required quantity for this nation. However, the production of the agricultural sector in the rural areas, where lives 80% of the total population, is stagnant to only 20% of GNP of the country. And, the migration from rural areas into cities due to the increased population there has caused a social problem. Therefore, it is urged to create employment and promote investment in the agricultural districts, and plans focusing on the rural development are now being implemented.

On the other hand, for the telecommunications sector, Swaziland Posts and Telecommunications Corporation (SPTC) which was established in 1986 as a public enterprise responsible for providing telecommunications services in this country set up a long term plan toward the year 2010 in 1986 and started the construction of a telecommunication network in which the demand for telephones is expected to be 85,000 subscribers in 2010, and the corporation has installed digital switching equipment in the urban area to satisfy the increasing telephone demand there. But in the rural area the number of telephones is extremely small or there are no telephones in many villages. To overcome the strained circumstances in the rural area, SPTC started to establish a rural communication network which is an urgent theme for the rural development which is emphasized in the National Development Plan but in fact nothing has been done because of the shortage of funds.

Thus, the government of the Kingdom of Swaziland requested the Japanese government a Grant Aid as help to advance the establishment of the rural telephone network which is a theme of great urgency.

In response to this request, the Japanese government decided to conduct a basic design study related to the project for rural automation multi-access radio system on the basis of the request of the Swaziland government in August 1991, that is, the Japan International Cooperation Agency (JICA) was responsible to conduct the study and sent a

study team with Mr. Minoru Takahara, training manager and instructor of the Training Institute of Telecommunications Administration of the Ministry of Posts and Telecommunications, being the leader to the country for 30 days from October 25 through November 23, 1992.

The study team had discussions with concerned SPTC staff members to study the adequacy as a Grant Aid project and the contents and scale of the cooperation. The team also conducted a survey of the project sites, and studied the present situation and future plans of the telecommunications facilities and services, and maintenance and administration system. Furthermore, it realized radio wave propagation tests in planned sections.

Further, JICA sent a mission for explanation of the draft of the final report from January 31 through February 12, 1993 to explain and discuss with concerned government officials of that country.

The members of the study team, the study process, a list of the persons interviewed, minutes of discussions and a list of collected data are attached at the end of this report.

CHAPTER 2 BACKGROUND OF THE PROJECT

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 Background of the Project

The Kingdom of Swaziland is a landlocked country surrounded by the Republic of South Africa on three sides and adjoining the Republic of Mozambique on the east. It is one of the smallest countries in Africa with an area of only 17,000 km^2. The western part of the country is a highland area with an elevation of 1,000m - 1,400m and the eastern part is a low lying grassland area, and there is a hill belt rising to a height of a few hundred meters stretching between the two areas. The annual average temperature is about 15°C in the highland area and about 22°C in the lowland area, and the annual rainfall ranges from 1,150mm to 1,900mm in the highland area and from 500mm to 700mm in the lowland area.

The census taken in July 1986 disclosed that the country has a total population of about 680,000 and a population density of about 40 persons per square kilometer, with its population growing at an annual average rate of 3.5%. Nearly half of its population is contained in the fertile hill belt zone in the central part of the country. Total urban population is about 120,000, and Mbabane, the capital city, has a population of about 40,000. Seen by tribe, the Swazis are by far the largest in number, accounting for 95% of total population, and the remaining 5% comprise Zulus and Tongas.

Since its independence in 1968, the Kingdom of Swaziland has acted out a number of 5-Year National Development Plans aimed at national land development and improvement of the people's livelihood. In 1983, the government formulated the Fourth 5-Year National Development Plan, and is expected to complete its upgraded version in 1992. The long-term development goals envisaged by the Fourth National Development Plan are as follows.

* Improvement in the capacity of the civil service,
* Development of small holder agriculture in order to achieve self sufficiency in maize by the year 2000 and decrease rural unemployment,
* Improvement in the quality of health and educational services, particular the expansion and upgrading of vocational facilities.

The Fourth National Development Plan also embodies the following macro economic development strategies.

* Greater control in use of public funds,

* Stimulation of private investment, both in existing and new activities,

* Creation of more jobs through vocational training programmes and the establishment of productive agricultural employment in the rural areas.

Swaziland is a typical farming country depending economically on South Africa that surrounds it on three sides, but it still resorts to import for the supply of maize, though at a decreasing rate (about 10% in 1989 and about 7% in 1990). Attainment of self-sufficiency in maize is therefore a keen national desire. In addition, the rural population is growing at a rapid pace and drifting to cities increasingly, making it imperative to create employment and encourage investment in rural areas. For this reason, the government is carrying out a diversity of plans focused on the development of rural areas. Table 2-1 shows the sector-wise government investments from 1987 to 1991. As seen in the table, the government investment for agricultural development in 1991 was about three times greater than it was in 1990, which indicates the unquestionable government enthusiasm for agricultural development.

Table 2-1 Capital Expenditure by Sector (Million E)

Category	1987	1988	1989	1990	1991
General public services	5.5	12.0	27.5	33.0	39.8
– General administration	2.9	7.4	18.4	20.1	20.2
– Public order & safety	2.6	4.5	9.2	12.9	19.5
Social services	19.5	15.9	21.9	33.5	61.9
– Education	10.7	5.8	12.1	20.8	30.9
– Health	6.6	2.0	1.8	3.9	13.2
– Housing	1.1	2.1	6.6	7.2	15.1
– Other	1.1	5.9	1.4	1.6	2.7
Economic services	40.9	37.5	49.5	63.0	107.2
– Agriculture	4.0	6.1	11.0	12.0	33.6
– Manuf.,min.& Constr.	5.5	2.7	1.2	0.0	1.1
– Water & Sewerage	3.6	4.8	0.5	3.8	3.5
– Roads	12.4	15.9	17.2	22.9	46.0
– Other transport & Communication	15.2	7.9	19.1	24.3	21.9
– Other	0.2	0.0	0.5	0.0	1.1

In the area of telecommunications services, SPTC formulated a long-term plan in 1986 with a view to developing the telecommunications network in the country to accommodate the estimated increase of subscribers to 85,000 in 2010. When this plan was formulated, however, the rate of dead switching terminals was as high as 45.5% (only 8,100 of 14,869 terminals available were in use) at a national level, so that new/additional installation in the subsequent years was limited to the installation of additional terminals of existing crossbar switches in small cities. With the sharp growth of telephone demand in recent years, switches in large and medium-size cities became short of capacity. As a temporary measure to cope with situation, it was determined to introduce small-scale digital switching equipment at offices having a large number of subscriptions on waiting list, and six units of switching equipment with a maximum of 1,000 terminals were purchased from SIEMENS to put them in service by the end of 1992. Prior to this, a digital switch with 720 trunks was put in operation in May 1990 for international switching services. For the network development in the future, it is planned to install 28,000 new terminals by 1995 under a two-stage mid-term plan shown in Table 2-2.

Table 2-2 Telecommunications Network Mid-term Development Plan

	Switching system		Transmission system	
	Exchange name	Capacity	Route name	Capacity
Phase I	Mbabane	10,000	Mbabane-Ntondozi	1,920
	Manzini	5,000	Mbabane-Manzini	480
	Matsapha	3,000		
	Malkerns	1,000		
	Ngwenya	1,000		
	Bhunya	512		
	(Cost 20.5 Million E)		(Cost 1.5 Million E)	
Phase II	Lobamba	1,000	Mbabane-Nhlangano	240
	Nhlangano	2,000	Mbabane-Siteki	480
	Hlatikulu	1,000	Siteki-Lubuli	480
	Siteki	1,000		
	Matata	256		
	Hluti	128		
	Lavumisa	128		
	Tshaneni	512		
	Piggs Peak	1,000		
	(Cost 8 Million E)			

In addition to the installation of new terminals mentioned above, two network development plans will be completed in the second stage of the said mid-term plan, i.e., the construction of an optical fiber communication system linking Mbabane-Oshoek-South Africa, and the development of local cable network to be carried out in parallel with the installation work of new digital switches.

In connection with the above plan, a purchasing contract has already been concluded with ITALTEL in October 1992 for the supply of digital switches to be installed at Mbabane (10,000 terminals), Manzini (5,000 terminals), Matsapha (4,480 terminals), Lobamba (1,536 terminals), Nhlangano (1,536 terminals), and Bhunya (512 terminals).

A number of measures are taken for the telephone network development in rural areas containing about 80% of total population, but its progresses greatly delayed because of the huge construction cost per circuit (SPTC's estimated cost per subscriber is E40,000 for radio system). As described earlier, however, the government is making a considerable investment for rural development, and one of its top priority policies is to promote rural infrastructural improvement including telephone network development. The rural telephone network development is therefore positioned as one of SPTC's most important policies in the development plan (1992 - 1994) of the Ministry of Economic Planning and Development.

Telecommunication services in Swaziland are planned, operated and controlled by the Swaziland Posts and Telecommunication Corporation (SPTC) which is also responsible for postal services. SPTC was established as a category A public enterprise in April 1986 under Law No. 11 of 1983 which defines and stipulates its activities. The category A public enterprise means a public enterprise or body which is either wholly owned by the government, or in which the government has a majority interest or which is dependent upon government subvention for its financial support. SPTC has a staff of 751 persons as of July 1992, and 361 of them are engaged in telecommunications services and 256 in postal services. Figure 2-1 shows the organizational structure of SPTC.

Table 2-3 shows SPTC's profit and loss statement in the last five years, which indicates that SPTC has gained an annual profit equivalent to about 20% of total operating revenues in the five-year period. In 1990, total operating revenues amounted to E51.6 million, of which E43.9 million (85%) came from telecommu-

nications services, E5.2 million (10%) from postal services, and E2.5 million (5%) from other sources. Itemized statement of revenues and expenditures in the telecommunications services, balance sheet and main financial indicators are shown in Tables 2-4, 2-5 and 2-6, respectively, and the details of fixed liabilities as of the end of March 1992 are shown in Table 2-7.

When analysing the main financial ratios, the stockholder's equity ratio (own capital/total assets) which indicates the soundness of management, and the net income/sales ratio (net profit/gross sales) which shows the degree of making profits were found to be even better than those of NTT in its fiscal 1988 wherein the company were making better showing.

Furthermore, the fixed assets/equity ratio (fixed assets/own capital: A smaller figure stands for a stabler status) of this corporation is almost a half of that of NTT, so the corporation possesses high management stability.

These facts will lead to a conclusion that the SPTC financial and management standings are very good.

In regard to the collection of telephone charges, etc., as shown in Table 2-3, the subscriber's bad debts written off and the subscribers provision for doubtfull debts have been occupying about 0.5% to 5% of the total proceeds, although they fluctuates within the given percentage range among different fiscal years. Comparing them with the telephone charge collection rate of approximately 98% of NTT, toll collecting situation of the SPTC can be deemed as satsifactory.

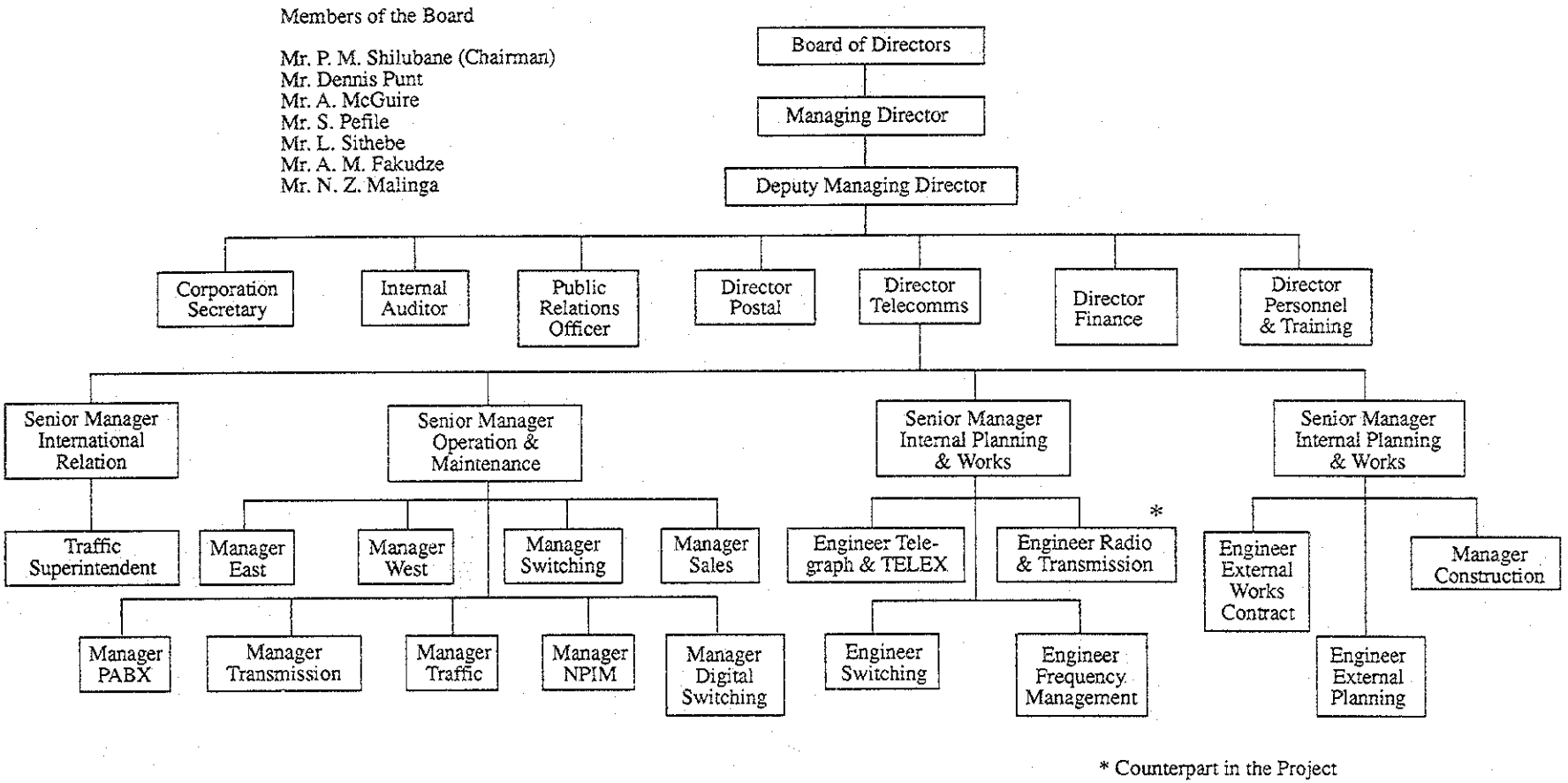

Figure 2-1 Organization Chart of SPTC

Table 2-3 Revenue and Expenditure Statement (Thousand E)

Item	1987	1988	1989	1990	1991
Turnover	30,226	37,702	42,094	48,849	56,284
Other revenue	759	1,682	2,600	2,817	3,620
Total revenue	30,984	39,384	44,694	51,666	59,904
Expenditure	24,911	29,870	36,224	46,364	48,712
Net profit	6,073	9,514	8,470	5,302	11,192
Accumulated funds - at beginning of year	5,248	11,321	21,840 (*1)	30,310	35,613
Accumulated funds - at end of year	11,321	20,835	30,310	35,613	46,805
Subscribers bad debts written off	1,756	698	745	189	–
Subscribers provision for doubtful debts	1,343	1,932	1,783	3,400	6,500

(*1): Being changed by prior year adjustment

Table 2-4 Revenues and Expenditures in the Telecommunications Services (Thousand E)

Revenue	1989	1990	1991	Expenditures	1989	1990	1991
(Telephone)							
Installation	274	225	208	Salaries & allowances	4,679	6,235	7,308
Rental	1,768	1,863	1,876	Purchases & freight	1,120	2,177	1,514
Meter calls	24,009	26,931	28,110	Maintenance	1,541	1,451	1,722
Oper. assist.	392	482	632	Vehicles	1,199	1,471	1,185
International	5,044	6,974	7,030	Services & leases	450	797	816
Others	102	205	220	Utilities	375	342	320
Net outpayment	-2,160	-806	-2,600	Insurance	258	247	339
(Total telephone)	29,429	35,904	35,476	Bad debts	0	1,807	500
(PABX)	-184	946	986	Sales taxes	232	117	230
(Telex)	1,694	1,781	2,501	Depreciation	3,065	5,031	6,490
(Miscellaneous)	335	366	473	Loan int.charge	1,644	2,348	2,022
				Exch. fluctuation	5,673	5,664	5,500
				Others	777	708	1,116
Total telecomms.	31,274	38,947	38,436	Total telecomms.	21,013	28,396	29,061
Plus.outpayments	5,522	4,956	6,070	Acctg.outpaymts	5,522	4,956	6,070
Telecomms. rev. per books	36,796	43,903	44,506	Telecom.expend. per books	26,536	33,352	35,131
				Common services	975	2,067	1,547
				Net operating telecomms.income	9,286	8,484	7,827

Table 2-5 Balance Sheet (Thousand E)

Assets	1989	1990	1991	Liabilities	1989	1990	1991
(Current assets)				(Current liabilities)			
Stores	1,999	1,708	1,022	Credit & provisions	6,106	9,194	6,942
Subscribers	8,162	11,874	16,745	Swaziland government	5,900	6,224	6,224
Cash bank & on deposit	27,207	19,709	12,998	Current portion of loan	5,730	4,428	5,023
Others	3,078	5,770	7,213	Others	3,493	1,228	5,038
Total current assets	40,446	39,061	37,978	Total current liabilities	21,229	21,074	23,227
(Fixed assets)							
Land & building	5,707	7,995	7,784	Fixed	43,026	44,225	42,280
Telecomms. equipment	37,998	44,214	55,705	liabilities			
PABX equipment	4,739	4,145	4,193	(Capital)			
Motor vehicles	1,279	1,733	2,010	Accumulated	30,310	35,613	46,805
Work-in-prog.	1,139			fund			
Others	215	346	1,242				
Total fixed assets	51,077	58,434	70,934				
Investments	3,042	3,417	3,400	Total fund &			
Total assets	94,565	100,912	112,312	liabilities	94,565	100,912	112,312

Table 2-6 Financial Analysis

Item	1989	1990	1991	NTT 1988
Net income/sales (%)	19	10	19	4.7
Stockholder's equity ratio (%)	32	35	41	33
Current ratio (%)	191	185	164	65.4
Fixed assets/equity (%)	169	164	152	274.7
Debt ratio (%)	212	183	140	178.3
Income/Total assets (%)	9	5.3	10	8.4
Return on stockholder's equity (%)	28	15	24	16.0
Total assets turnover	0.47	0.51	0.53	0.5
Fixed assets turnover	0.88	0.88	0.84	0.5

Table 2-7 Fixed Liabilities (March, 1992) (Thousand E)

Loans	Interest rate (%)	Remainder
(External loans)		
African Development Bank phase I	6	71
African Development Bank phase III	7	17,712
Italian Loan	2.5	15,451
Denmark Loan - interest free	–	11,704
(Swaziland Government Loans)		
Swaziland Government II	9	567
Swaziland Government III	9	1,324
(Amounts borrowed by the Swaziland Government for which the Corporation has accepted responsibility)		
Exchequer Annuity Loan	6.625	9
Exchequer loan - interest free	–	23
U.K.Loan 1970/71 - interest free	–	60
U.K.Loan 1970 - interest free	–	19
Denmark Loan - interest free	–	361
Total		47,302
Deduct: Current portion included in current liabilities		5,023
Fixed liabilities		42,280

At the end of 1991, there were 14,300 telephone subscribers concentrated mostly in urban areas, the number of telephones per 100 population was 1.8, and the number of subscriptions on waiting list was 7,300. Rural telephone services are offered in certain limited areas using various systems connected to the exchanges in cities, such as the open wire carrier system, single channel radio system, and magnet multiparty line system. Owing to the long distance to the exchange, the quality of these telephone services is extremely poor and has such defects as lack of clarity of the voice heard over the telephone, high noise level, and frequent line disconnection. Table 2-8 shows the telephone installation situation in Swaziland.

Table 2-8 Telephone Service Statistics (as of Dec.1991)

Items	Explanation
The number of subscribers	14,335 Business 6,663 Residence 7,177 SPTC 260 Public 235
The number of telephones per 100 population	1.8
Ratio of automatic non-delay service	99.3%
The number of waiting applicants	7,269

Table 2-9 shows the annual number of subscribers in the last six years. As seen in the table, the annual increase rate of subscribers is smaller than 10% which is SPTC's target for telephone installation except in 1988. This is due to the shortage of exchange terminals and subscriber cables.

Table 2-9 The number of Subscribers in the Last Six Years

Year	Population	Subscribers	Subs./100 Population	Increasing Ratio
1985	637,973	8,300	1.30	-
1986	677,383	9,000	1.33	8.4%
1987	698,817	9,500	1.36	5.6%
1988	724,005	11,800	1.63	24.2%
1989	749,805	12,500	1.67	5.9%
1990	779,876	13,700	1.76	9.6%

Table 2-10 shows the annual telephone traffic in the last five years, and indicates that there has been a notable growth of international telephone traffic.

Table 2-10 Telephone Traffic in Statistics

Fiscal year	Local calls (Millions of metered units)	Inter-territorial calls (Millions of paid minutes)	International calls (Thousands of paid minutes)	
			Out going	Incoming
1986	63.5	9.5	552	670
1987	72.9	9.0	665	890
1988	83.3	10.4	638	1,100
1989	90.6	11.9	863	1,150
1990	97.4	11.6	1,482	1,265

As of June 1992, Swaziland has 24 telephone exchanges shown in Table 2-11, of which one is a switching office for international and toll calls not accommodating subscriber lines. All local switches are analog switches, but a digital switch with 850 terminals was introduced at the Matsapha office in November 1992. In addition, six units of digital switch with 4,200 terminals in total are expected to be put in operation by February 1993, and step by step switches now in use are planned to be replaced by digital switches in the coming years. Magnet switchboards (120 terminals) are still used at four rural offices, but these will also be replaced by line concentrators when digital switches are installed at the master stations in the near future.

At present, the inter-office trunk lines are basically designed as a star type network as shown in Figure 2-2 with the Mbabane office as the toll office. When a digital network is introduced in the future, it will be installed to overlay the existing analog network as shown in Figure 2-3.

The transmission system in Swaziland uses analog microwave systems (7GHz/960 voice channels) and digital microwave systems (2GHz/34Mbits, 900MHz/2Mbits) for trunk lines, and a UHF (400MHz/24CH) and open wire carrier system (12CH, 18 CH) for branch lines. Figures 2-4 and 2-5 show the network of trunk transmission lines.

At present, SPTC has five digital microwave transmission routes which were installed in 1990 using the digital transmission technology of TELETTRA and GTE, and also has another four routes now under construction. According to SPTC's manager in charge of maintenance services, the routes installed in 1990 have been in smooth operation without any serious failures.

Table 2-11 Telephone Exchange Office List

Exchange Name	Exchange Type	Capacity	Subscribers	Note
Mbabane ISC	AXE-10 (SPC)	(720)*		Transit switch
Mbabane 2	SxS	1,400	1,137	To be replaced by EWSD (2,000) in Nov/1992
Mbabane 4	C-400 (XB)	5,000	4,135	
Manzini	C-400 (XB)	3,500	3,366	
Malkerns	C-23 (XB)	400	352	To be replaced by EWSD (780) in Nov/1992
Lobamba	C-23 (XB)	1,000	885	
Maphiveni	SxS	260	193	To be replaced by EWSD (1,000) in Feb/1993 and moved to Simunye
Siteki	ARF-102 (XB)	560	415	
Big Bend	ARF-102 (XB)	440	311	
Nsoko	ARF-102 (XB)	150	77	
Mhlume	ARF-102 (XB)	480	379	
Matsapha	ARF-102 (XB)	1,600	1,381	To be expanded by EDSD (850) in Nov/1992
Mankayane	ARF-102 (XB)	210	94	
Hlatikulu	ARF-102 (XB)	300	247	
Nhlangano	ARF-102 (XB)	720	659	
Mhlambanyatsi	ARF-102 (XB)	460	359	
Piggs Peak	ARF-102 (XB)	580	456	
Bulembu	ARF-102 (XB)	190	100	
Ngwenya	SxS	100	99	Sub. line concentrator, To be replaced by EDSD (160) in Nov/1992
Bhunya	SxS	50	0	Sub. line concentrator
Sidvokodvo	Manual	10	7	Manual exchanges are to be replaced by digital subscriber line concentrators.
Hulti	Manual	30	35	
Kubuta	Manual	30	20	
Lavumisa	Manual	50	31	
Total		17,520	14,738	

* ( ) shows trunk capacity and is not counted in Total

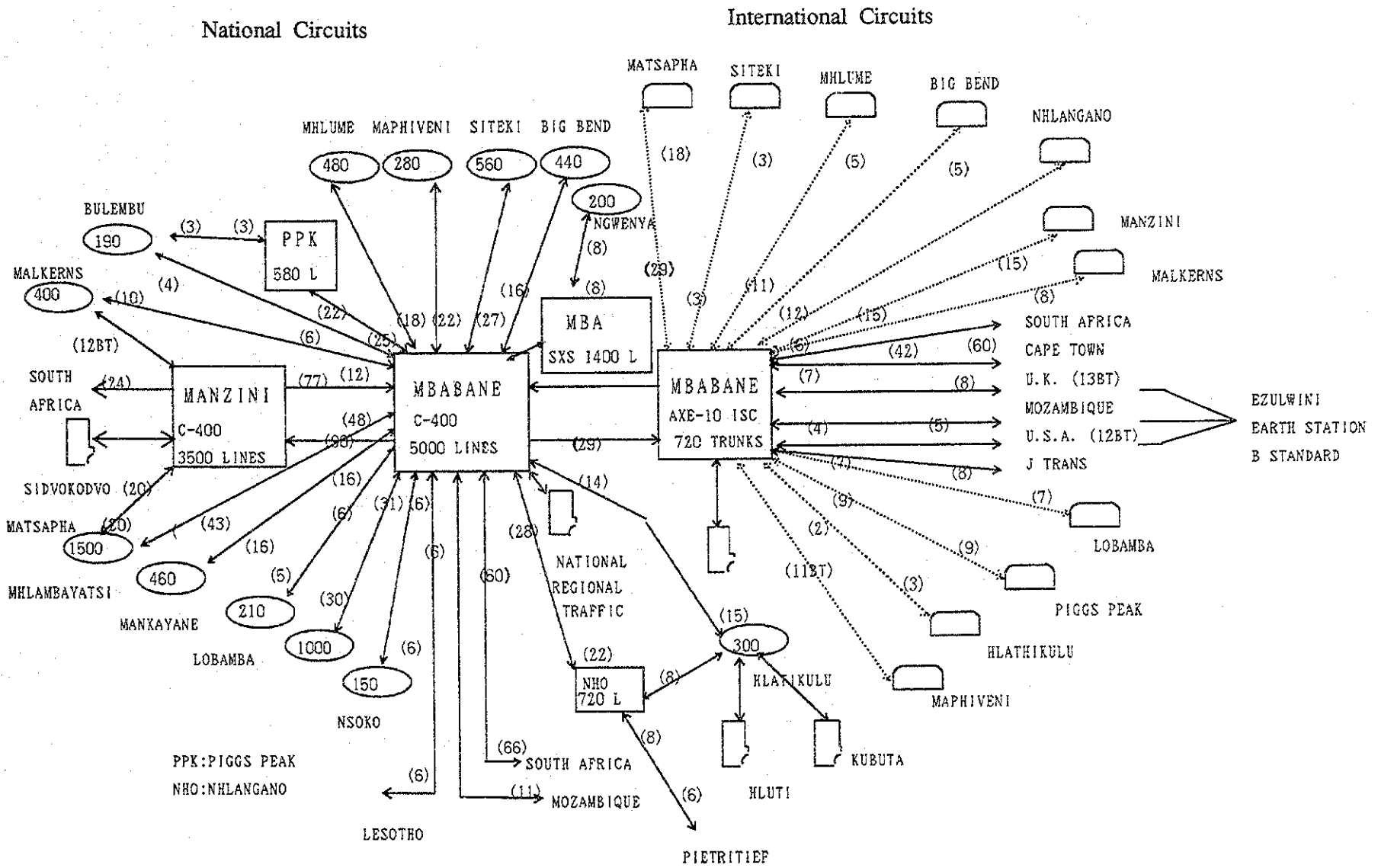

Figure 2-2 Trunking Network

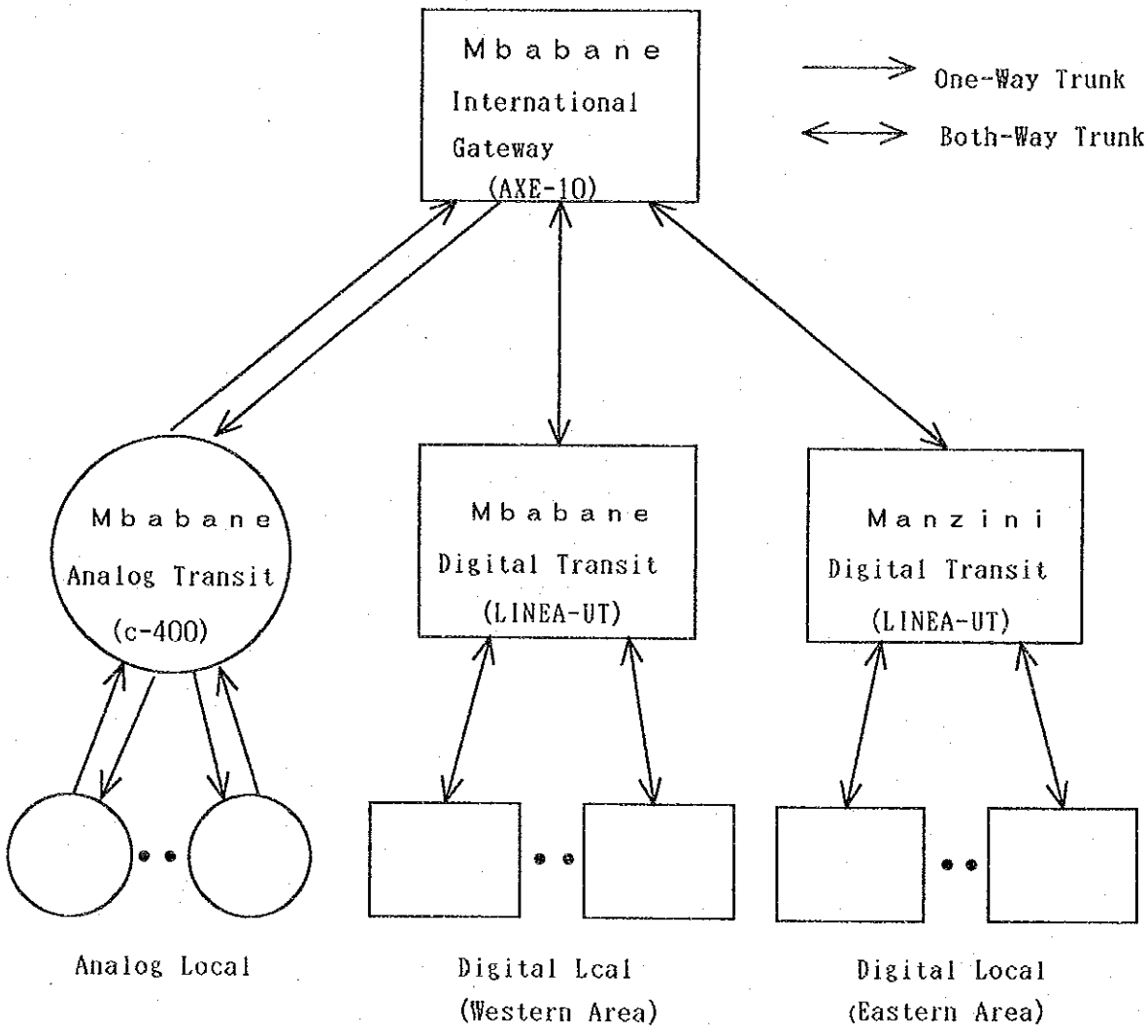

Figure 2-3 Network Configuration (Analog/Digital)

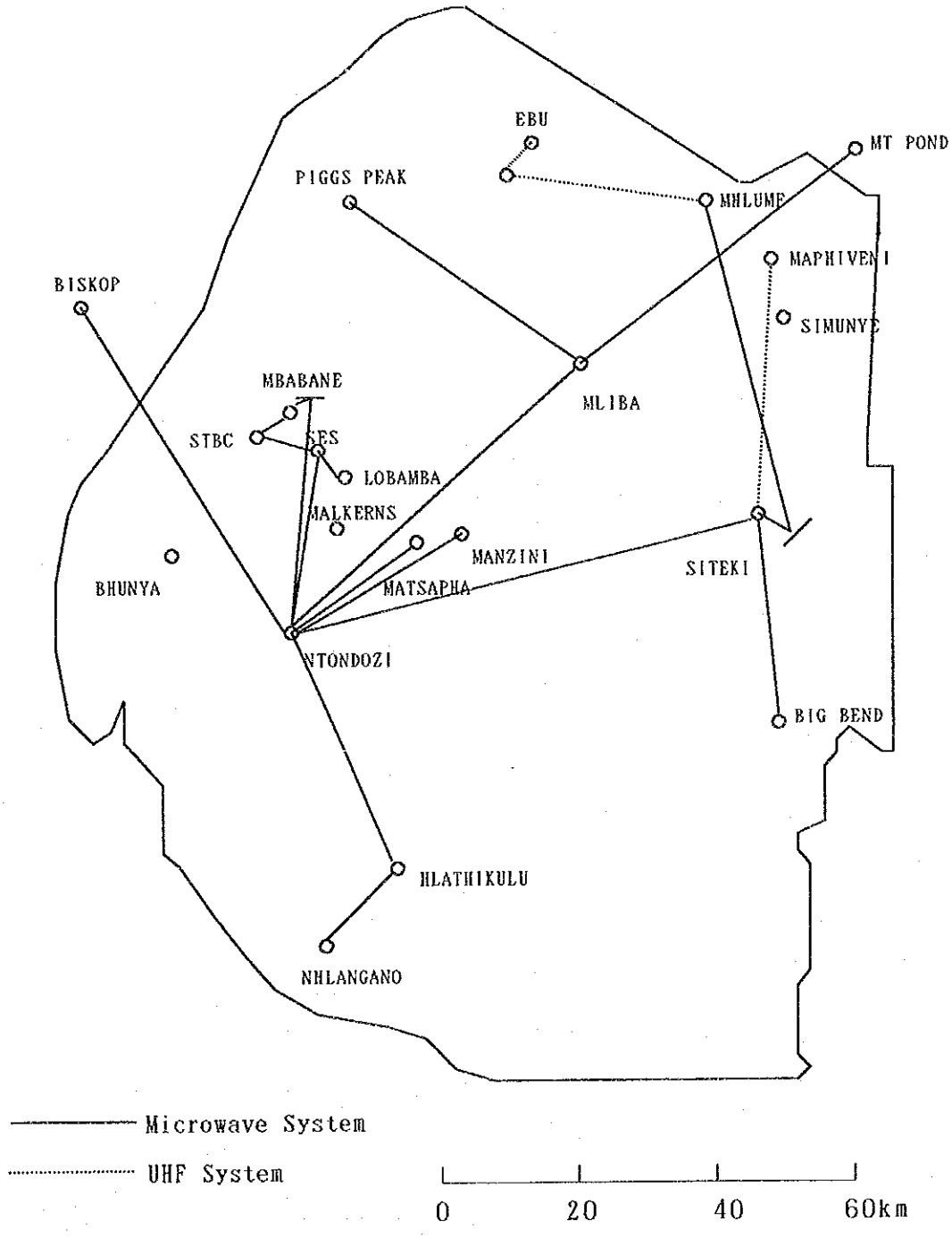

Figure 2-4 Analog Transmission Network

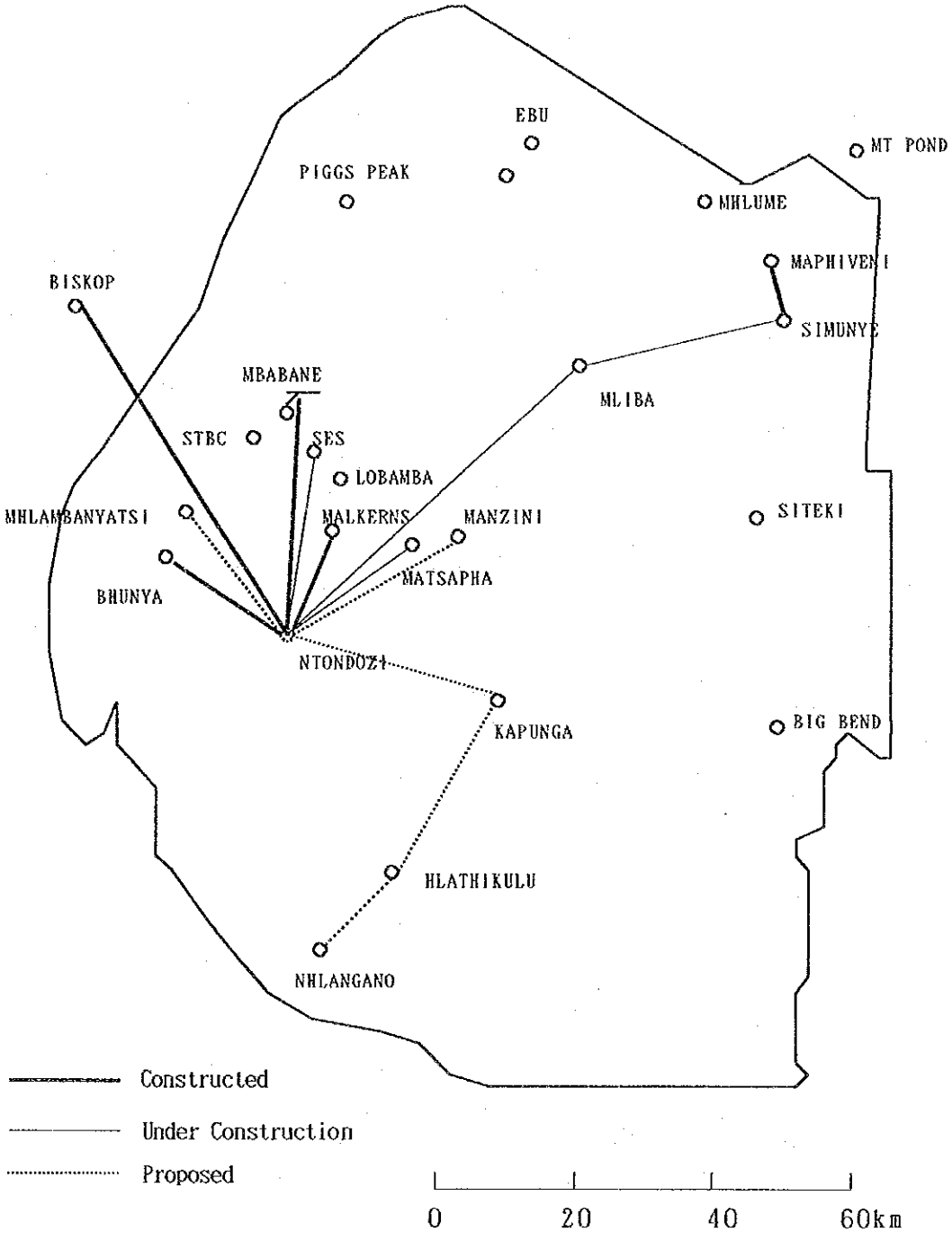

Figure 2-5 Digital Transmission Network

SPTC's staff training is conducted within and outside Swaziland. Training in Swaziland is conducted at the Telecommunication Training Center established within Swaziland College of Technology (SCOT) where basic courses in the theory and technology of telecommunications are given. The center has seven instructors from SPTC, and conducted 10 courses in 1991 for a total of 61 trainees. Training in foreign countries is intended to enable trainees to acquire professional skill and techniques. In 1991, a total of 107 trainees participated in 53 courses which were conducted in Kenya, Malawi and Britain. Some of these 53 training courses were related to digital transmission technology.

It is considered that SPTC's staff charged with telecommunications services have sufficient theoretical knowledge about digital transmission, because they have received the training courses mentioned above. As for the maintenance of the subscriber radio system to be supplied under the project, it will be possible for SPTC's staff to acquire the necessary maintenance techniques, because analog subscriber radio systems are still used in certain areas, and also because practical OJT in system construction and testing can be given when the project is brought into execution.

At present, the transmission system is given maintenance services under a form centralized in Mbabane, from which maintenance personnel are sent out as need arises for periodical testing or upon receipt of a failure report. This centralized system suffices to meet the maintenance demands, because the country is small in area and the remotest office is at an hour and half hours' car ride from SPTC. 18 personnel are currently assigned to maintenance services, as shown below.

Intra-office maintenance group - 10 personnel
(3 engineers, 2 senior technicians, 2 technicians, 2 assistant technicians, and 1 driver)

Extra-office maintenance group - 8 personnel
(1 engineer, 5 technicians, 2 assistant technicians)

It is probable that the existing system will be used continuously, perhaps with some increase in personnel, for the maintenance of the radio system to be provided under the project. Since the base station facilities will be installed at manned offices (switching offices), it will be possible to perform regular system monitor-

ing services with the control and monitoring equipment installed at such offices. Under this system, when a alarm signal is generated at any office, a man stationed in that office will call to the maintenance department of Mbabane to request the dispatch of maintenance personnel of the system. Furthermore, in the Mbabane Telephone Office where maintenance personnel is stationed a centralizing remote supervisory equipment will be introduced under the project, so it will be possible to monitor conditions of all system constituent equipment at any time. When the project is brought into execution, SPTC plans to organize a new maintenance group to be charged exclusively with the subscriber radio system.

2-2 Outline of the Request

Since the days when it was called the Posts and Telecommunications Department of the Ministry of Public Works and Communication, SPTC has made continued efforts to develop Swaziland's telecommunications network with some grant aids and loans from the African Development Bank and donor countries like Italy and Denmark, as shown in Table 2-12. However, these network development efforts were focused mainly on urban areas. Although the government had long been aware of the necessity of developing telecommunications services in rural areas which account for the greater part of population, such services were not developed or left superannuated without replacing the existing magnet multiparty line system using open wires. This was because the development of modern telecommunications services in rural areas incurred a huge cost and left no margin of profit.

Table 2-12 Recent Telecommunications Network Development

Contract	Installed system	Fund	Amount
1989	International digital switch	Italian loan	US$2.7 Million
1989	Digital microwave systems	Italian loan	US$2.2 Million
1990	Local cables	Denmark grant	Krone 8 Million
1990	PABX	Denmark grant	Krone 12 Million
1990	Coin telephone	Denmark grant	Krone 4 Million
1991	Digital switches (4,260 terminals)	Own fund and local banks	E5.7 Million
1991	Digital microwave systems	Own fund	E8 Million
1992	Digital switches (23,000 terminals)	Local banks	E16 Million
	Local cables	ditto	E5 Million
	Buildings, consultant service	ditto	E9 Million

This absence of rural telecommunications services produced adverse influences on farm management, cattle-breeding and other agro-industries and accelerated the drift of rural population to cities, thus frustrating the government in its scheme to create employment by encouraging the location of light industries in rural areas. The Swaziland government has requested Japan's grant aid to cope with this situation by developing rural telecommunication services.

In the official letter of request forward from the Swaziland government to the Japanese government, it was stated that the project was formulated to provide a total of 556 subscriber lines from 87 terminal stations by dividing the entire project (rural) area into four districts. The names of villages in the project areas were not given in the said letter of request, but they were made clear by SPTC during the field survey period of the basic design study (Table 2-13).

Table 2-13 The Name of Villages in the Project

Manzini area	Hlathikulu area	Piggs Peak area	Maphiveni area
Gebeni Royal Kr.	Mbelebeleni 1	Ndingeni	Luve 1
Gudvweni	Mbelebeleni 2	Matsamo	Luve 2
Ntondozi Vill. 1	New Haven	Ntfonjeni 1	Bekinkosi
Ntondozi Vill. 2	Nhletjeni	Ntfonjeni 2	Zindondo
Nqabaneni	Ntjanini	Mashobeni	St.Florence
Cana	Hluti 1	Mvembili	Mafutseni
Bethlehem	Hluti 2	Ntabinezimpsi	Ekukhanyeni
Mahlangatsha 1-1	Kapunga	Ndlozini	Nyakeni
Mahlangatsha 1-2	Kubuta	Herefords	Nkiliji
Mahlangatsha 2	Bethany	Nginamadolo	Ekuthokuzeni
Sigombeni	Nkungwini	Luhlangotsini	Mpaka
Kabhudla	Salitje	Malandzela	Croydon
St.Philomena	Matsanjeni	Ngonini	Nsingweni
Siphofaneni	Nkweni	Mavula	Kakhuphuka
Lushikishini	Lavumisa 1	Maphaleni	Mliba Village
Kapunga Rep.	Lavumisa 2	Bhalekane	Dvakolwako
St.Philips	Maloma	Nkabeni	Maliyaduma
Nhlambeni	Makhava		Ngomane
Embhekelweni	Mooihoek		Shewula
Ponjwane	Empateni		Hlane
Ekudzeni	Jerico		Bulandzeni
Mkhulamini	Sandleni		
Ngwane Park	Ebenezer		
	Our Lady		
	New Warm		
	Zombodze		
Total 23 stations	Total 26 stations	Total 17 stations	Total 21 stations

Figure 2-6 shows the locations of the said villages, and Table 2-14 shows the types of subscriber lines at each terminal office (ordinary telephones, coin public telephones, telex).

Table 2-14 Subscriber Distribution

(1) Manzini Area

No.	Service area name	Ordinary telephone	Coin telephone	Telex
1	Gebeni Royal Kraal	5	1	
2	Gudvwini	3	1	
3	Ntondozi Village-1	4	1	
4	Ntondozi Village-2	4	1	
5	Nqabaneni	5	1	
6	Cana	7	1	
7	Bethelehem	5	1	
8	Mahlangatsha 1-1	5	1	1
9	Mahlangatsha 1-2	5	1	
10	Mahlangatsha 2	5	1	
11	Sigombeni	4	1	
12	Kabhudla	4	1	
13	St. Philomena	5	1	
14	Siphofaneni	5	1	1
15	Lushikishini	5	1	
16	Kapunga Repeater	7	1	1
17	St. Philips	5	1	1
	Suburbs of Manzini	29	6	2
18	(Nhlambeni)	(5)	(1)	
19	(Embhekelweni)	(5)	(1)	(1)
20	(Ponjwane)	(5)	(1)	
21	(Ekudzeni)	(5)	(1)	
22	Mkhulamini)	(5)	(1)	
23	(Ngawane park)	(4)	(1)	(1)
	Subtotal	112	23	6

(2) Hlatikulu Area

No.	Service area name	Ordinary telephone	Coin telephone	Telex
1	Mbelebeleni-1	5	1	
2	Mbelebeleni-2	5	1	
3	New Haven	5	1	
4	Nhletjeni	5	1	1
5	Ntjanini	9	1	
6	Hluti-1	8	1	1
7	Hluti-2	7	1	
8	Kapunga	7	1	1
9	Kubuta	5	1	1
10	Bethany	5	1	
11	Nkungwini	4	1	
12	Salitje	6	1	1
13	Matsanjeni	6	1	
14	Nkweni	9	1	1
15	Lavumisa-1	7	1	
16	Lavumisa-2	6	1	
17	Maloma	6	1	
18	Makhava	6	1	
19	Mooihoek	6	1	
20	Empateni	6	1	
21	Jerico	5	1	
22	Sandleni	5	1	
23	Ebenezer	6	1	
24	Our Lady	6	1	
25	New Warm	5	1	
26	Zombodze	5	1	
	Subtotal	155	26	6

(3) Piggs Peak Area

No.	Service area name	Ordinary telephone	Coin telephone	Telex
1	Ndingeni	6	1	
2	Matsamo	7	1	1
3	Ntfonjeni-1	5	1	1
4	Ntfonjeni-2	5	1	1
5	Mashobeni	8	1	
6	Mvembili	4	1	1
7	Ntabinezimpsi	4	1	
8	Ndlozini	5	1	
9	Herefords	5	1	
10	Nginamadolo	5	1	
11	Luhlangotsini	5	1	
12	Malandzela	5	1	
13	Ngonini	5	1	1
14	Mavula	5	1	
15	Maphaleni	5	1	
16	Bhalekane	4	1	
17	Nkabeni	5	1	1
	Subtotal	88	17	6

(4) Maphiveni Area

No.	Service area name	Ordinary telephone	Coin telephone	Telex
1	Luve-1	4	1	1
2	Luve-2	4	1	
3	Bekinkosi	5	1	
4	Zindondo	5	1	
5	St. Florence	5	1	
6	Mafutseni	4	1	
7	Ekukhanyeni	4	1	
8	Nyakeni	4	1	
9	Nkiliji	4	1	
10	Ekuthokuzeni	4	1	
11	Mpaka	4	1	
12	Croydon	4	1	
13	Nsingweni	4	1	
14	Kakhuphuka	4	1	
15	Mliba Village	9	1	
16	Dvakolwako	4	1	1
17	Maliyaduma	4	1	
18	Ngomane	3	1	1
19	Shewula	4	1	
20	Hlane	4	1	1
21	Bulandzeni	5	1	
	Subtotal	92	21	4
	Total	447	87	22
	Grand Total		556	

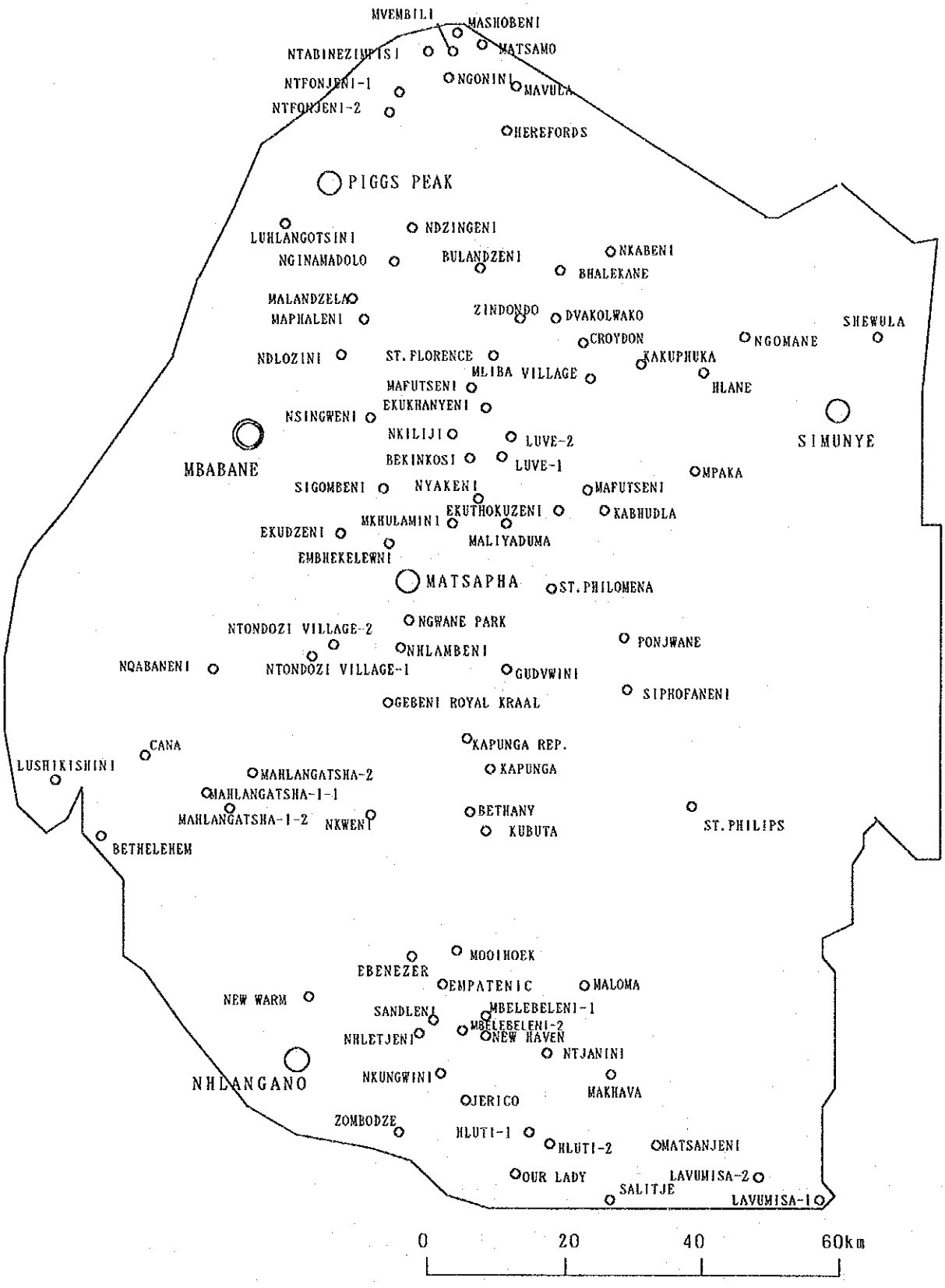

Figure 2-6 Location of Villages

2-3 Outline of Project Sites

The project sites are Swaziland's rural areas divided into four districts. The greater part of project sites are farming villages raising maize and cattle, and others are banana and orange growing areas, sugar cane factories, and border areas. Nearly all these sites are village communities situated at a distance of more than 5 km from well-developed arterial national highways and connected by unpaved roads with a width of about 6m. 100 to 300 houses are distributed sporadically in a broad expanse of grazing land found on a mild slope in each village. The maximum population of these village communities is about 3,000.

Among the communication methods in this country, namely, postal service, telegram and telephone, the postal service is only for those who pay for the post office boxes and delivery service to individual addresses is yet being offered.

Categorizing 80 post offices by their service types, 46 post offices are carrying out postal service, acceptance and delivery of telegrams and public phones service, but the remaining 34 post offices are handling mails only.

Among 87 project sites of the present project, 15 villages are provided with post offices, and among them 7 villages are provided with the public telephone service and 5 villages are provided with post office boxes, thus indicating delays in the development of public communication services.

Referring to the telephone installations at the project sites, certain villages comparatively closer to large cities are limitatively equipped with telephone facilities using an open wire carrier system or a magnet party line system connected to switching centers in the cities, but the service level is still quite low, for example, transmited voices are faint and failures occur frequently.

For organizations and bodies which are located far from urban cities but indispensable to have telephone facilities such as public organizations including armed forces, police, a part of post offices and a portion of large scale farms and stock farms, they are equipped with single/dual radio telephones (about 50 subscriptions) and analog type subscriber radio system (about 60 subscriptions) as shown in Fig. 3-1, but beneficiaries of such facilities are very limited.

The above mentioned situations prove the fact that the majority of people living in the project sites are being merely provided with poor communication services, so the development of the communication services under the present project is being earnestly desired.

Table 2-15, meanwhile, shows the outline of a part of the project sites.

Table 2-15 Outline of project sites (15 terminal stations)

Area names	Site names	Population	Number of households	Industries	Commercial electric power supply	Number of public facilities and shops	Communication services		
							Numbers of telephones	Postal service	Telegram service
Manzini	Nqabaneni	1,100	110	Agriculture and stock farming	Available	Medical clinic (1), schools (2), churches (4) and shop (1)	2	Not provided	Not provided
	Cana	2,000	250	Agriculture and stock farming	Available	Medical clinic (1), schools (5), churches (4) and shop (1)	4	Not provided	Not provided
	Mahlangatsha 1-1	2,000	300	Agriculture and stock farming	Available	Police station (1), medical clinic (1), school (1), community development association (1) and shop (1)	1	Not provided	Not provided
	Mahlangatsha 2	2,000	250	Agriculture and stock farming	Not available	Post office (1), schools (2), churches (3), community center (1) and shop (1)	0	Provided	Not provided
	St. Philomena	1,000	80	Agriculture and stock farming	Available	Medical clnic (1), schools (5), churches (4), shop (1) and stock farm (1)	1	Not provided	Not provided
Hlathikulu	Ntjanini	3,000	150	Agriculture and stock farming	Not available	Post office (1), medical clinic (1), schools (2), church (1) and shops (4)	0	Provided	Not provided
	Kubuta	650	60	Agriculture and stock farming	Not available	Post office (1), medical clinic (1) schools (3), churches (2) and shops (2)	2	Provided	Provided
	Bethany	500	50	Agriculture and stock farming	Not available	Medical clinic (1), schools (2), churches (4) and shop (2)	0	Not provided	Not provided
	Nkungwini	2,000	200	Agriculture and stock farming	Not available	School (1), church (1), shops (3) and Chinese project (1)	0	Not provided	Not provided
	Salitje	1,000	100	Cotton	Available	Government organization (2), school (1), agricultural cooperative (1) and shop (1)	2	Not provided	Not provided
Piggs Peak	Matsamo	1,250	100	Agriculture and stock farming	Available	Government organizations (2), church (1) and shops (2)	2	Not provided	Not provided
	Mvembili	2,500	200	Agriculture and stock farming	Available	Armed force (1), police station (1), medical clinic (1), school (1), church (1) and shops (2)	0	Not provided	Not provided
	Ngonini	3,000	400	Agriculture and stock farming	Available	Medical clinic (1), post office (1), schools (3), churches (1) and shop (6)	3	Provided	Provided
	Bhalekane	3,000	200	Agriculture and stock farming	Available	Police station (1), medical clinic (1), schools (3), churches (2) and shops (3)	0	Not provided	Not provided
Maphiveni	Mliba Village	3,000	150	Agriculture and stock farming	Available	Police station (1), post office (1), medical clinic (1), schools (7) and shops (4)	2	Provided	Not provided

CHAPTER 3 CONTENTS OF THE PROJECT

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3-1 Purpose of the Project

The Kingdom of Swaziland intends to promote the development of rural areas which account for 20% of its GDP and 80% of its population to realize balanced national development completely free from regional differences between urban and rural areas. For this purpose, the country is striving to increase its pubic investment to develop rural infrastructure, raise the self-sufficiency rate of food, and revitalize productive and economic activities in rural areas.

In the area of telecommunications services, Swaziland embarked upon the modernization of telecommunications network using digital technology in 1990 to meet the growing demand for telephone services in urban areas. On the other hand, rural telephone facilities are left virtually intact partly because of the shortage of funds. This has not only induced the rural people to feel more isolated than before but also built a barrier between urban and rural areas, thus causing a great impediment to the efficient performance of administrative functions, stabilization of the people's livelihood, and development of rural industries.

The project is intended to develop a rural telecommunications network in Swaziland to resolve various problems arising from the lack of reliable communication media in rural area, encourage investments in rural areas by promoting infrastructural improvement, and thereby open up the way to accelerated socio-economic development in rural areas.

3-2 Study on the Contents of the Project

The contents of the project agreed during the stay of the basic study team in Swaziland is as follows:

To provide a total of 556 subscriber lines (447 ordinary telephone lines, 87 coin public telephone lines, and 22 telex lines) locating a total of 87 terminal stations of TDMA (Time Division Multiple Access) subscriber radio system in four rural areas.

(1) Adequateness and Necessity of the Project

SPTC is a monopolistic public enterprise providing telecommunications services in Swaziland. Since its establishment in 1986 as a public corporation, it has made consistent efforts to develop the country's telecommunications network so far lagging behind other countries, and succeeded in increasing the number of subscribers from 9,000 in 1986 to 14,300 registered at the end of 1991. It also formulated a long-term telecommunications services development plan in 1986, and embarked upon a network development implementation to achieve the following three goals in 2010.

(a) Increase of the number of subscribers per 100 population to 5 (from 1.8 at the end of 1991)

(b) Supply of versatile services by digitalizing the telecommunications network

(c) Expansion of the existing star type transmission network to a mesh type network for stabilization of the national telecommunications network

To achieve these goals, SPTC determined to formulate and carry out a number of projects. In 1990, it started the operation of combined digital switch for international and toll calls to cope with increasing international and toll calls, and introduced five digital radio systems, with four additional systems now under construction. To meet the rapid growth of telephone demand resulting from the socio-economic development in recent years (number of subscriptions on waiting list totaled 7,300 at the end of 1991), it procured 6 units of small-capacity digital switch (1,000 terminals) to put them in service, and also concluded a purchasing contract for digital switches with a total of 23,000 terminals in October 1992.

On the other hand, some measures are taken for the development of the telephone network in rural areas containing 80% of total population. But the process of this rural telephone network development is greatly delayed because the construction cost per circuit is very high (SPTC's estimated cost per subscriber is E40,000 for the radio system) and leaves no margin of profit. As described earlier, however, the government is planning to make a considerable investment for rural development, with great impor-

tance attached to infrastructural improvement, including telephone services development. The rural telephone network development is therefore positioned as an important program of SPTC in the development plan (1992 - 1994) of the Ministry of Economic Planning and Development.

As described in the chapter 2, SPTC has maintained a sound financial condition, and this is because it has not made large equipment investment until recently. However, it is now planning to make a heavy investment to meet the sharp growth of telephone demand and promote the system digitalization (total fund requirement for the abovementioned digital radio systems under construction and digital switches with 23,000 terminals is estimated at about E40 million), and it also has a plan to introduce an optical fiber cable transmission system. To meet this fund requirement, SPTC plans to obtain soft loans and bank loans.

Considering the heavy equipment investment mentioned above, SPTC may be exposed to a heavy financial pressure, if it intends to cover the project cost with its own funds or loans to develop the telephone network covering more than 70% of rural areas of this country. In addition, the rural telephone network development promises to provide low rentability as compared with the required capital investment, and this is prone to endanger SPTC's financial and operational stability. Therefore, reflecting upon that the rural telephone network development is a long-standing question in Swaziland and needs to be implemented as an important infrastructural project for accelerating rural development, it can be justified to implement the project with Japan's grant aid.

Introduction of the TDMA subscriber radio system under the project was determined partly to meet the strong request expressed by SPTC, because it excels the cable system in both construction period and cost especially when a few telephones are to be installed in each of widely distributed villages in a mountainous country like Swaziland. The TDMA radio system is free from any difficulties in construction, and in view of maintenance and administration this system presents no specific technical or financial problems as mentioned below.

(2) Study on Project Implementation/Operation Plan

The project implementation and operation will be undertaken by SPTC which is exclusively responsible for providing telecommunications services in the country. The organization, staff and financial status of SPTC are as described in the Chapter 2.

The following construction works will be carried out by SPTC under the project.

(a) Construction of huts for accommodating repeater/terminal stations,

(b) Construction of foundations for antenna towers, poles and solar cell supporting parts in cooperation with Japanese supervisors,

(c) Installation of subscriber cables (cables will be supplied by Japan),

(d) Wiring work between switches and main distributing frame of base station,

(e) Construction of access roads and fences required for installation of facilities,

(f) Arrangement of commercial AC 220V power supply in project sites, where such power supply is available.

(g) Transportation of equipment and materials of tower/pole to the project sites from warehouse of SPTC.

Items (c) , (d) and (g) are included in SPTC's routine services, and the items (a) and (e) can be performed by a suitable local construction company. The item (f) will be conducted by the Swaziland Electricity Board upon request of SPTC. The item (a) was specifically thought necessary by SPTC for the assurance of safety. Access roads to repeater stations will be not necessary to be constructed because all selected sites are within 30 minutes' walk from the nearby road. The item (b) will present no specific problems because SPTC is experienced in the antenna tower construction work and a supervisor will be sent from Japan, when the project is executed by Japan's grant aid.

As for the cost of the above construction works, it is estimated the SPTC's share will amount to E1.3 million. SPTC will find no difficulty in disbursing this amount, because it has gained a net profit of E11 million in 1991. Maintenance and administration of the provided system after completion of the construction works will be satisfactorily realized by the maintenance system described in 3-3-(4), and the cost of maintenance services can be fully covered with the profit from the system operation.

(3) Relations to Similar Projects or Other Aid Projects

Construction of analog subscriber radio system to accommodate 60 subscribers in the eastern part of the country with Danish soft loan can be cited as a project similar to this project, its subscribers are plantations and ranches of big scale, and army, police and post offices. Figure 3-1 shows the configuration of this system. The sites covered by this Danish-financed project overlap only a small part of the TDMA system project sites. Swaziland received about US$2.8 million in grant aid from Denmark in 1990, which is appropriated for purchases of local cables, PABX and pay telephones.

(4) Study on the Contents of Requested System

The system requested to be supplied is the TDMA (time division multiple access) subscriber radio system. Figure 3-2 is a conceptual drawing of the TDMA system. In the requested system specifications, each base station is required to accommodate a maximum of about 500 subscribers and each terminal station several tens of subscribers, with each base station covering an area with about 100 km radius by installing repeater stations.

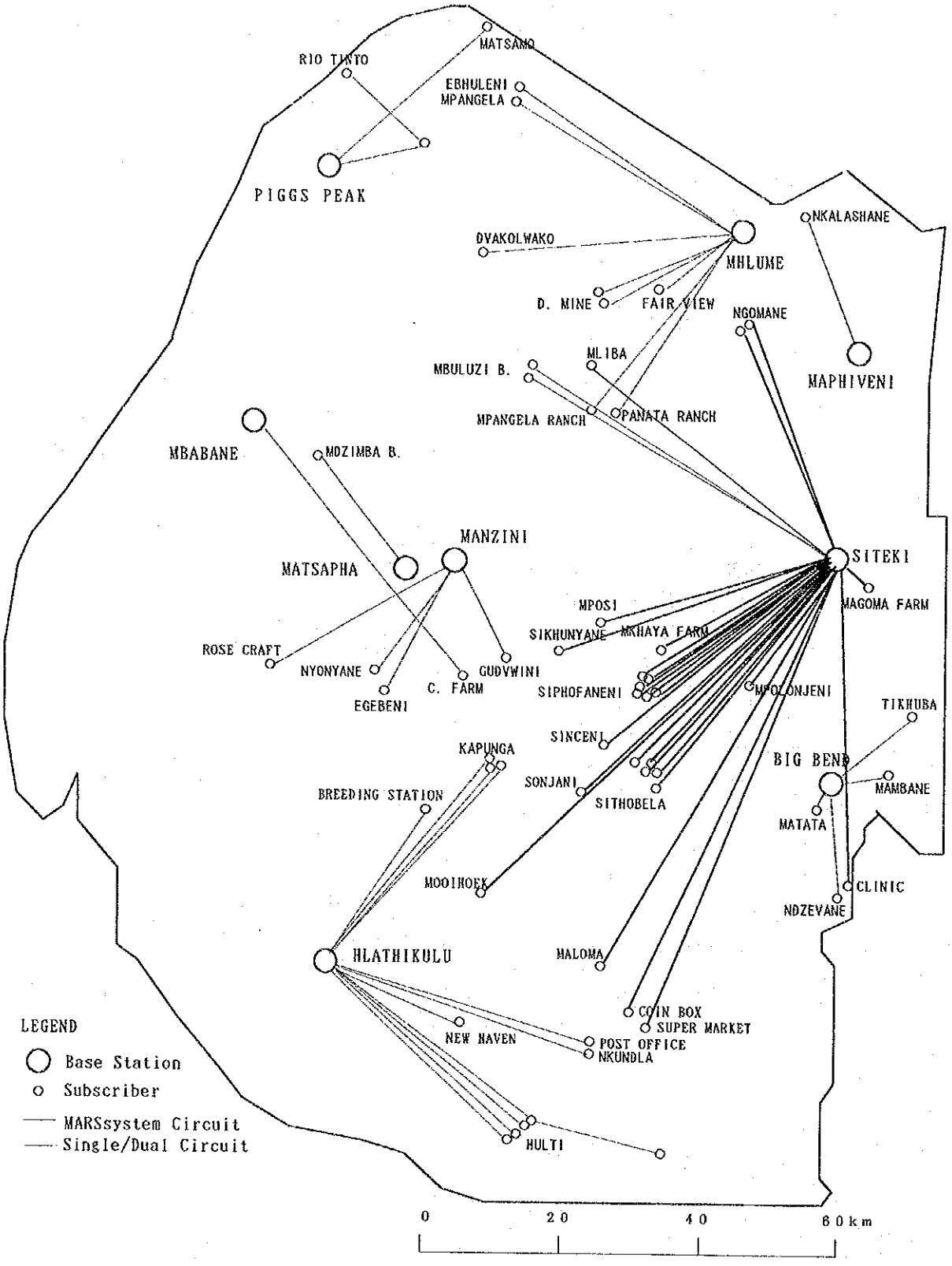


Figure 3-1 Configuration of Existing Analog Subscriber Radio System

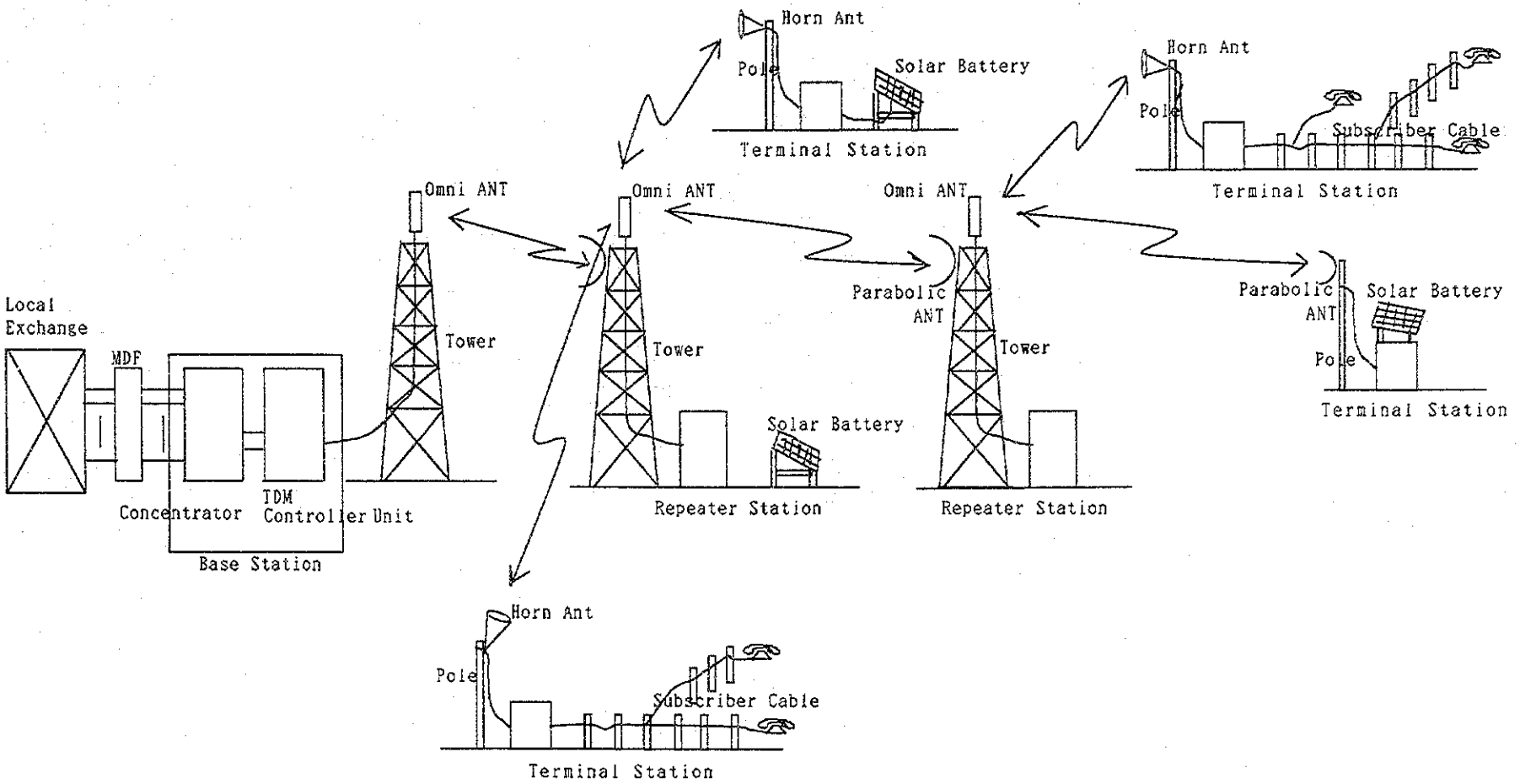


Figure 3-2 Conceptual Drawing of TDMA Subscriber Radio System

(a) Number of Base Stations

Swaziland is broadly divided into four administrative districts. Installation of one base station in each administrative district is considered essential for the purpose of billing and numbering plans.

(b) Capacity of Base Station

The maximum capacity of a requested base station equipment is 512 subscribers, but the number of subscribers requested to be accommodated under the project is 556 to be covered by the four base stations, each accommodating 111 to 187. A prospective demand survey conducted in a limited number of villages indicated the required number of subscribers will be a demand in one or two years after the system is put in service, as shown in Table 3-1. Since the system has a long life span of operation under proper maintenance works, the future demand can be satisfied adding panels to base and terminal station equipment. So, its maximum required capacity is considered appropriate to meet the growth of telephone demand in the future and to avoid double investment. Naturally, in this project the number of panels provided is one which will satisfy the requested demand (i.e. 556 subscribers).

(5) Study on Propagation Conditions

The study team conducted field survey and map-on-survey about propagation characteristics on a condition that a line-of-sight could be guaranteed for any propagation section among base, repeater and terminal stations. As a result, it can be judged that the station locations shown in Tables 3-8 to 3-11 realize a line-of-sight for any propagation section, taking into consideration the propagation obstacles such as trees around some stations. So, there will be no problem about propagation characteristics.

Table 3-1 Project Site Demand Survey Results (15 Terminal Stations)

Area name	Terminal station name	Post office	Police	Clinic	School	Mission	Govern-ment	Private company	Store	Resi-dence	Public telephone	Telex	Total Demand	Request by SPTC
Manzini	Nqabaneni			1	2	1			1		1		6	6
	Cana			2	3				1	2	1		9	8
	Mahlangatsha 1-1		1	1	1		1		1		1	1	7	7
	Mahlangatsha 2	1			2	1	1		1		1		7	6
	St. Philomena				4				1		1		6	6
Hlatikulu	Njanini				2				4	1	1		8	10
	Kubuta	1		1	1	1		1	1		1	1	8	7
	Bethany			1	2				1		1		5	6
	Nkungwini				1			1			1	1	4	5
	Salitje				1		1	1	1		1	1	6	7
Piggs Peak	Matsamo			1	2		2	1	1	1	1	1	10	9
	Mvembili		1	1	1		1				1		5	6
	Ngonini			1	2			1	1		1	1	7	7
	Bhalekene		1	1	1				1		1	1	6	5
Maphiveni	Mliba Village	1	2	1	3				2		1		10	10

(6) Study on Antenna Tower/Pole

There exist antenna towers in the Matsapha, Nhlangano, Piggs Peak and Simunye exchange offices which are expected to be base stations and in the Ntondozi and Mliba microwave stations which are expected to be repeater stations. These towers can be utilized for the project. For other repeater and terminal stations a tower or pole should be newly constructed for each station. The tower/pole height should be determined taking into consideration the height of trees around station, so it was concluded that the tower height would be 27m for all repeater stations, and the pole height would range between 10m and 25m as shown in Tables 3-8 to 3-11.

(7) Study on Power Supply Facilities

Field survey result shows that in the existing offices and microwave stations except Mliba station the DC-48V/DC-24V power source can be utilized, and in Mliba station and Hlathikulu station to be newly constructed the commercial AC 220V power source can be utilized. On the other hand, for the repeater stations to be newly constructed (Lapanda, Kapunga, Luqolweni, Nkondolo, Nkondowane, Fire Lookout, Malandela and Lukonde) and also for 34 terminal stations a solar cell power supply system should be installed for each station as shown in Table 3-8 to 3-11. In the country the sunshine time is considerably long as shown in Table 3-2. So, it was concluded that the number of solar panels necessary for a terminal station of 8 subscribers would be three, considering the power consumption of radio equipment, intensity of solar radiation, quantity of electrical power generated by a solar cell and capacity of battery. (One solar panel can generate 50W at its maximum)

Table 3-2 Sunshine Hours (monthly total) (unit:hour)

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1980	187	198	213	254	256	266	254	238	138	202	135	189
1981	175	146	188	220	201	243	229	168	138	179	148	159
1982	172	213	223	195	241	251	242	249	217	180	162	229
1983	216	192	209	216	229	224	223	239	208	138	132	205
1984	187	184	140	248	248	236	209	228	167	149	153	198
1985	237	196	211	215	217	232	253	248	120	171	231	155
1986	202	177	229	184	259	256	253	246	180	207	-	-
1987	-	-	-	-	-	-	-	201	145	-	-	146
1988	189	189	207	169	252	235	245	221	215	148	182	-
1989	180	-	-	-	-	183	228	237	-	183	-	-

(8) Study on Switch Capacity

Table 3-3 shows the capacity of switches connected to base stations as of June 1992 and terminal utilization situations. As seen in the table, all existing switches are short of capacity except at the Matsapha exchange office, but it will be possible to accommodate the required number of subscribers, when the installation work of digital switches at each station proceeds as planned.

Table 3-3 Capacity and Used Terminals of Base Station Exchanges

Base station	Exchange	Capacity	Used	Free	New * subs.	Project demand	Notes
Matsapha	ARF-102(XB)	1,600	1,381	219			
	EWSD(SPC)	1,000	852	148			
	LINEA-UT(SPC)	4,480	0	4,480	784	135	Note 1
Nhlangano	ARF-102(XB)	720	659	61			
	LINEA-UT(SPC)	1,536	0	1,536	334	181	Note 2
Piggs Pesk	ARF-102(XB)	580	456	124			
	EWSD(SPC)	850	0	850	185	105	Note 3
Maphiveni	SxS	260	193				
(Simunye)	EWSD(SPC)	500	(193)	307	137	113	Note 4

* It is assumed that by the time of service inauguration of the project a half of the number of subscriptions on waiting lists as of June 1992 is expected to be new subscribers.

Note 1. Planned to be put in service in Sep. 1993
2. Planned to be put in service in Oct. 1993
3. Planned to be put in service in Sep. 1993
4. Planned to be put in service in Mar. 1993

(9) Examination of Transmission Capacity of Existing Network

(A) Calling Rate of TDMA System Subscribers

Table 3-4 shows the calling rate (telephone traffic per subscriber) of automatic switching offices in Swaziland. The national average calling rate is 0.056 (Erlangs) for outgoing calls and 0.045 (Erlangs) for incoming calls. It is difficult to estimate the calling rate in the rural areas covered by the project on the basis of past traffic data, because there are few telephones already installed in the project areas. On the other hand, the CCITT manual (GAS 2: Local Network Planning) specifies the maximum outgoing calling rate of 0.04 (Erlangs) for the case where the number of telephones per 100

population is small such as in rural areas. This rate of 0.04 (Erlangs) will be adopted as the calling rate for both outgoing and incoming calls of TDMA system subscribers to be accommodated under the project. As for the calling rates of other general subscribers accommodated in switches to be connected to base stations, the values based on the past traffic data of each switch will be adopted.

(B) Estimation of Traffic of Switches to be Connected to Base Stations, and Calculation of Required Number of Circuits

Table 3-4 Calling Rate at Automatic Exchanges

Exchange name	Subscribers	Traffic (erl.)			Calling rate (erl./sub)		
		Origi-nating	Termi-nating	Total	Origi-nating	Termi-nating	Total
Mbabane 2	865	18.17	17.30	35.47	0.021	0.020	0.041
Mbabane 4	3,003	264.26	228.23	492.48	0.088	0.076	0.164
Matsapha	1,140	80.94	76.38	157.32	0.071	0.067	0.138
Manzini	3,325	166.25	103.08	269.33	0.050	0.031	0.081
Big Bend	280	12.32	9.80	22.12	0.044	0.035	0.079
Bulembu	105	2.84	3.15	5.99	0.027	0.030	0.057
Hlathikhulu	210	9.24	6.09	15.33	0.044	0.029	0.088
Lobamba	779	26.49	23.37	49.86	0.034	0.030	0.064
Malkerns	395	9.09	5.14	14.23	0.023	0.013	0.036
Mankayane	88	3.87	3.87	7.74	0.044	0.044	0.088
Maphiveni	185	12.58	9.25	21.83	0.068	0.050	0.118
Mhlambanyatsi	345	13.46	11.39	24.85	0.039	0.033	0.072
Mhlume	330	15.84	12.87	28.71	0.048	0.039	0.087
Nhlangano	612	23.87	21.42	45.29	0.039	0.035	0.074
Nsoko	74	3.55	2.81	6.36	0.048	0.038	0.086
Piggs Peak	378	18.52	14.36	32.88	0.049	0.038	0.087
Siteki	388	18.62	17.07	35.69	0.048	0.044	0.092
Whole country	12,502	699.90	565.57	1,265.47	0.056	0.045	0.101

The traffic estimation for each switch to be connected to base station will be made under the following conditions.

(a) The number of subscribers to be newly accommodated up to the time of system operation will be taken at half the number of subscriptions on waiting list as of June 1992, and their traffic rates will be determined according to the past traffic data of respective offices.

(b) The number of TDMA system subscribers will be the number of subscribers required to be accommodated under the project, and their traffic rates will be 0.04 (Erlangs) for both outgoing and incoming calls.

(c) The ratios of toll call traffic to total traffic will be taken at the 1990 values shown in Table 3-5.

(d) The calculation of the required number of circuits will be based on the CCITT-specified basic traffic, and the basic traffic will be 1.2 times the calculated toll traffic (average). The toll circuit loss probability will be taken at 0.01.

Table 3-5 Toll Traffic Ratio

Exchange Name	Local & toll traffic (erl.)	Toll traffic (erl.)	Toll / (local & toll)
Matsapha	157.32	99.36	63.2%
Nhlangano	45.25	33.63	74.3%
Piggs Peak	32.88	26.72	81.3%
Maphiveni	21.83	20.84	95.5%

Table 3-6 shows the required number of circuits calculated under the above conditions. The number of circuits of new transmission systems to be installed is large enough to cover the required traffic.

(10) Study on Numbering and Charging System

The local subscriber's number consists of five digits, of which the first two digits are used as a trunk call number (trunk code). As shown in Table 3-3 each telephone exchange to which the planned TDMA base station is to be connected, has a enough capacity for TDMA subscribers demand for the project. So, the trunk code being assigned for the base station exchange is also able to be assigned as a trunk code for TDMA subscribers. For easy management, specified numbers of hundredth's digit should be assigned for the TDMA subscribers. Since a TDMA base station's capacity is able to be expanded up to 512 subscribers, it is a alternative idea to assign a new trunk code which is not used now, in expectation of TDMA subscriber increase in the future.

Table 3-6 Calculation of Traffic and Required Circuits

Base station	Exchange	Category	Subscribers	Item	Calling rate	Traffic	Basic traffic	Toll ratio	Toll traffic	Required circuits	Designed circuits	Surplus
Matsapha	LINEA-UT	General	784	Orig.	0.071	55.7	66.8					
				Term.	0.067	52.5	63.0					
				Total	0.138	108.2	129.8					
		TDMA	135	Orig.	0.04	5.4	6.5					
				Term.	0.04	5.4	6.5					
				Total	0.08	10.8	13.0					
		Total	919	Orig.			73.3	0.632	46.3	59	240	181
				Term.			69.5	0.632	43.9	57	240	183
				Total			142.0	0.632	90.2	116	480	364
Nhlangano	LINEA-UT	General	334	Orig.	0.039	13.0	15.6					
				Term.	0.035	11.7	14.0					
				Total	0.074	24.7	29.7					
		TDMA	181	Orig.	0.04	7.2	8.7					
				Term.	0.04	7.2	8.7					
				Total	0.08	14.5	17.4					
		Total	515	Orig.			24.3	0.747	18.2	28	60	32
				Term.			22.7	0.747	17.0	27	60	33
				Total			47.0	0.747	35.1	55	120	65
Piggs Peak	EWSD	General	185	Orig.	0.049	9.1	10.9					
				Term.	0.038	7.0	8.4					
				Total	0.087	16.1	19.3					
		TDMA	105	Orig.	0.4	4.2	5.0					
				Term.	0.4	4.2	5.0					
				Total	0.08	8.4	10.0					
		Total	290	Orig.			15.9	0.813	12.9	22	30	8
				Term.			13.5	0.813	11.0	19	30	11
				Total			29.4	0.813	23.9	41	60	19
Simunye	EWSD	General	137	Orig.	0.068	9.3	11.2					
				Term.	0.050	6.9	8.2					
				Total	0.118	16.2	19.4					
		TDMA	113	Orig.	0.04	4.5	5.4					
				Term.	0.04	4.5	5.4					
				Total	0.08	9.0	10.8					
		Total	250	Orig.			16.6	0.955	15.9	25	26	1
				Term.			13.6	0.955	13.0	22	24	2
				Total			30.2	0.955	28.0	47	50	3

Pulse Metering, which is dependent on time-duration and distance between exchanges, is adopted for domestic call. For distance calculation between exchanges, two digits' trunk code is used. So, in the case that the same trunk code has been assigned for both exchange subscriber and TDMA subscriber, call charge will be the same. No problem will occur, if the telephone exchange area and the TDMA base station area is the same. In this project, as one base station covers several remote telephone exchange areas, we have to recognize that call charge discrepancy between exchange subscriber and TDMA subscriber will occur in some cases. For example, a call originated from a exchange subscriber to different exchange which locates in the same TDMA base station area will be charged as a toll call but a call in the same TDMA subscribers which locate in different telephone exchange areas will be charged as a local call.

(11) Necessity of Technical Cooperation

As described in the Chapter 2, the technical level of SPTC's maintenance personnel is considerably high. However, since the TDMA radio system to be introduced under the project uses technologies not so far applied in Swaziland, it is advisable to conduct OJT during the construction period and provide training services in Japan for participants invited from Swaziland for the assurance of proper maintenance and operation of the system.

3-3 Outline of the Project

(1) Project Executing Agency and Operating System

The project will be put into execution by SPTC which is within the jurisdiction of the Ministry of Transport and Communications. Figure 2-1 in the article 2-1 shows SPTC's organizational chart.

The Telecommunications Department will assume direct responsibility for the project implementation, and the Internal Planning and Works Division, which is one of its subordinate office, will assign a number of staff members to technical liaison services for the project. These staff members and transmission system maintenance engineers and technicians stationed mainly at the Mbabane exchange office will participate in the equipment installation/ erection work under the project, and will also be given OJT by dispatched

Japanese engineers to acquire the knowledge and techniques for system maintenance after the project completion. Equipment maintenance and inspection services will be undertaken by radio transmission system maintenance personnel of the Mbabane office, and the system operation will be performed by subscriber service staff at exchange offices (base stations) or Mbabane staff using a centralizing remote supervisory equipment to be installed at the Mbabane office. Each base station will have a supervisory display terminal and the Mbabane office will have the said centralizing remote supervisory equipment, so that when any failure occurs, it will be detected by the said equipment and SPTC's maintenance personnel rush to the scene of failure. The maximum time required for the maintenance personnel to arrive at the scene of failure is about one hour and a half.

(2) Project Scale/Offices

The project will have the following scale.

* Number of base stations 4
* Number of repeater stations 11
* Number of terminal stations 87
* Number of subscriber lines 556 (447 ordinary telephone lines, 87 coin public telephone lines, 22 telex lines)

The following stations will be used for the project.

(a) Base stations

All will be installed at the following existing offices.

Matsapha exchange office, Nhlangano exchange office, Piggs Peak exchange office, Simunye exchange office

(b) Repeater stations

Two stations will be installed at the existing facilities, and other repeater equipment will be installed in simple huts constructed by SPTC.

Ntondozi, Mliba (installed in the existing facilities), Lapanda, Kapunga, Hlathikulu, Luqolweni, Nkondolo, Nkondwane, Fire lookout, Lukonde, Malandela

(c) Terminal stations

Terminal stations will be installed at post offices and other facilities of SPTC. In places where no such facilities are available, terminal equipment will be installed in simple huts constructed by SPTC. If arrangements are made between SPTC and public facilities near the station site, terminal equipment will be installed at such facilities. The terminal station names are listed in table 2-13.

The actual state of each station is shown in Tables 3-8 to 3-11.

(3) Outline of System Facilities

Table 3-7 shows the outline of TDMA subscriber radio system to be provided under the project.

Table 3-7 TDMA Subscriber Radio System

Item		Contents
Transmission system		2.4 GHz band time division multiple access system (60 time slots, maximum subscriber capacity is 512)
Project areas		4 areas (Manzini, Hlathikulu, Piggs Peak, Maphiveni)
Radio	Base station	4 exchange offices (Matsapha, Nhlangano, Piggs Peak, Simunye)
	Repeater station	11 stations (Ntondozi, Lapanda, Kapunga, Hlathikulu, Luqolweni, Nkondolo, Nkondwane, Fire Lookout, Lukonde, Malandela, Mliba)
	Terminal station	87 stations as shown in Table 2-13 (One station is located in a repeater station (Kapunga Rep.)
Tower	Base station	The existing towers are to be used.
	Repeater station	The existing towers are to be used in the Ntondozi and Mliba stations. As for other stations a new steel tower of 27m high will be constructed for each station.
	Terminal station	A steel pole will be constructed for terminal station. (68 poles of 10m high, 12 poles of 15m high, 5 poles of 20m high, 1 pole of 25m high)
Building	Base station	The existing buildings are to be used.
	Repeater station	The existing buildings are to be used for Ntondozi and Mliba stations. As for other stations a brick hut will be constructed by SPTC for each station.
	Terminal station	Station equipment will be installed in the existing SPTC facilities, if available. If not available, a brick hut will be constructed by SPTC for each station.
Power	Base station	The existing power supply facilities will be used.
	Repeater station	Commercial AC power source will be used for Ntondozi, Hlathikulu and Mliba (charger/battery set will be installed). As for other stations a solar cell power supply system will be installed for each station.
	Terminal station	Commercial AC power source will be used, if available (charger and battery set will be installed: 52 stations) If not available, a solar cell power supply system will be installed for each station: 34 stations.

Table 3-8 Actual Status of Each Station (Manzini Area)

Name of Station	Type of Station	Building	Equip. Space	Power Supply	Tower	Path Condition	Location Latitude	Location Longitude
Matsapa	Base	Existing	Existing	Existing(DC-48V)	Existing	Good	S26:30:14	E31:18:30
Ntondozi	Rep.	Existing	Existing	Existing(DC-24V)	Existing	Good	S26:37:25	E31:10:07
Lapanda	Rep.	Hut necessary	—	Solar power	27m tower necessary	Good	S26:48:30	E31:04:04
Kapunga	Rep.	ditto	—	Solar power	27m tower necessary	Good	S26:46:14	E31:31:00
Gebeni Royal Kraal	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:38:09	E31:20:49
Gudvwini	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:33:49	E31:27:20
Ntondozi Village-1	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:37:05	E31:12:04
Ntondozi Village-2	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:36:28	E31:13:37
Nqabaneni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:37:06	E31:07:44
Cana	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:45:24	E30:59:58
Bethelehem	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:50:34	E30:56:33
Mahlangatsha 1-	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:49:15	E31:04:19
Mahlangatsha 1-2	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:49:31	E31:05:35
Mahlangatsha 2	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:48:51	E31:09:12
Sigombeni	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:22:01	E31:20:25
Kabhudla	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:27:38	E31:35:38
St.Philomena	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:30:20	E31:30:13
Siphofaneni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:40:34	E31:40:30
Lushikishini	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:47:42	E30:52:07
Kapunga Repeater	Term.	ditto	—	(as same as Kapunga repeater station)			S26:46:23	E31:30:59
St.Philips	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S26:51:12	E31:46:09
Nhlambeni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:34:27	E31:24:45
Embhekelweni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:26:12	E31:19:37
Ponjwane	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:36:38	E31:37:27
Ekudzeni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:26:00	E31:18:00
Mkhulamini	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:25:43	E31:23:05
Ngwane Park	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:32:31	E31:23:18

Path condition is good in the mode of connection shown in the Figure 4-2.
* There are trees ahead of the terminal station.

Table 3-9 Actual Status of Each Station (Hlathikulu Area)

Name of Station	Type of Station	Building	Equip. Space	Power Supply	Tower	Path Condition	Location Latitude	Location Longitude
Nhlangano	Base	Existing	Existing	Existing(DC-48V)	Existing	Good	S27:06:41	E31:11:47
Hlathikulu	Rep.	Hut necessary	Existing	Existing(AC220V)	27m tower necessary	Good	S26:57:35	E31:19:46
Luqolweni	Rep.	ditto	—	Solar power	27m tower necessary	Good	S27:03:37	E31:30:04
Nkondolo	Rep.	ditto	—	Solar power	27m tower necessary	Good	S27:11:01	E31:45:48
Nkondwane	Rep.	ditto	—	Solar power	27m tower necessary	Good	S26:49:57	E31:22:54
Mbelebeleni-1	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S27:01:44	E31:27:27
Mbelebeleni-2	Term.	Existing	Existing	Existing(AC220V)	20m pole necessary	Good*	S27:00:53	E31:28:58
New Haven	Term.	Hut necessary	—	Existing(AC220V)	10m pole necessary	Good	S27:02:58	E31:29:35
Nhletjeni	Term.	ditto	—	Solar power	10m pole necessary	Good	S27:02:53	E31:22:50
Ntjanini	Term.	ditto	—	Solar power	10m pole necessary	Good	S27:04:34	E31:33:50
Hluti-1	Term.	Existing	Existing	Existing(AC220V)	20m pole necessary	Good*	S27:12:08	E31:33:29
Hluti-2	Term.	Hut necessary	—	Solar power	10m pole necessary	Good	S27:12:50	E31:35:43
Kapunga	Term.	ditto	—	Solar power	15m pole necessary	Good*	S26:47:49	E31:28:57
Kubuta	Term.	Existing	Existing	Existing(AC220V)	25m pole necessary	Good*	S26:52:51	E31:28:57
Bethany	Term.	Hut necessary	—	Solar power	20m pole necessary	Good*	S26:51:36	E31:27:53
Nkungwini	Term.	ditto	—	Solar power	10m pole necessary	Good	S27:07:33	E31:24:12
Salitje	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S27:19:01	E31:38:39
Matsanjeni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S27:15:09	E31:45:00
Nkweni	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:52:01	E31:18:27
Lavumisa-1	Term.	Existing	Existing	Existing(AC220V)	15m pole necessary	Good*	S27:18:49	E31:53:18
Lavumisa-2	Term.	Hut necessary	—	Existing(AC220V)	15m pole necessary	Good*	S27:16:21	E31:48:23
Maloma	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S27:00:08	E31:39:12
Makhava	Term.	ditto	—	Solar power	10m pole necessary	Good	S27:09:43	E31:40:03
Mooihoek	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:58:12	E31:27:20
Empateni	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:59:11	E31:24:07
Jerico	Term.	ditto	—	Solar power	10m pole necessary	Good	S27:09:38	E31:26:25
Sandleni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S27:43:24	E31:25:42
Ebenezer	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:57:08	E31:22:39
Our Lady	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S26:15:40	E31:31:27
New Warm	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:58:05	E31:17:15
Zombodze	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S27:13:09	E31:17:31

Path condition is good in the mode of connection shown in the Figure 4-3.
* There are trees ahead of the terminal station.

Table 3-10 Actual Status of Each Station (Piggs Peak Area)

Name of Station	Type of Station	Building	Equip. Space	Power Supply	Tower	Path Condition	Location Latitude	Location Longitude
Piggs Peak	Base	Existing	Existing	Existing(DC-48V)	Existing	Good	S25:58:06	E31:14:58
Fire Lookout	Rep.	Hut necessary	—	Solar power	27m tower necessary	Good	S25:57:06	E31:11:22
Lukonde	Rep.	ditto	—	Solar power	27m tower necessary	Good	S25:51:32	E31:25:06
Malandela	Rep.	ditto	—	Solar power	27m tower necessary	Good	S26:12:49	E31:19:58
Ndingeni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:00:52	E31:22:09
Matsamo	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S25:44:56	E31:28:02
Ntfonjeni-1	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S25:50:29	E31:20:30
Ntfonjeni-2	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S25:52:16	E31:20:11
Mashobeni	Term.	ditto	—	Solar power	10m pole necessary	Good	S25:44:31	E31:26:13
Mvembili	Term.	Existing	Existing	Existing(AC220V)	10m pole necessary	Good	S25:45:21	E31:25:25
Ntabinezimpsi	Term.	Hut necessary	—	Existing(AC220V)	10m pole necessary	Good	S25:56:18	E31:33:50
Ndlozini	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:13:40	E31:15:41
Herefords	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S25:55:13	E31:28:39
Nginamadolo	Term.	ditto	—	Solar power	20m pole necessary	Good*	S26:01:21	E31:17:27
Luhlangotsini	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:01:38	E31:13:44
Malandzela	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:07:43	E31:17:34
Ngonini	Term.	Existing	Existing	Existing(AC220V)	10m pole necessary	Good	S25:47:22	E31:24:00
Mavula	Term.	Hut necessary	—	Existing(AC220V)	10m pole necessary	Good	S25:49:13	E31:30:29
Maphaleni	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:09:53	E31:17:51
Bhalekane	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:05:25	E31:33:02
Nkabeni	Term.	ditto	—	Existing(AC220V)	15m pole necessary	Good*	S26:02:14	E31:36:22

Path condition is good in the mode of connection shown in the Figure 4-4.
* There are trees ahead of the terminal station.

Table 3-11 Actual Status of Each Station (Maphiveni Area)

Name of Station	Type of Station	Building	Equip. Space	Power Supply	Tower	Path Condition	Location Latitude	Location Longitude
Simunye	Base	Existing	Existing	Existing(DC-48V)	Existing	Good	S26:13:04	E31:55:09
Mliba	Rep.	Existing	Existing	Existing(AC220V)	Existing	Good	S26:15:00	E31:34:14
Luve-1	Rep.	Existing	Existing	Existing(AC220V)	10m pole necessary	Good	S26:19:10	E31:28:27
Luve-2	Rep.	Hut necessary	—	Solar power	10m pole necessary	Good	S26:17:34	E31:29:36
Bekinkosi	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:20:13	E31:25:34
Zindondo	Term.	ditto	—	Solar power	20m pole necessary	Good*	S26:09:41	E31:31:09
St.Florence	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:15:19	E31:26:19
Mafutseni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:26:25	E31:33:05
Ekukhanyeni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:20:51	E31:24:17
Nyakeni	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:23:53	E31:25:03
Nkiliji	Term.	ditto	—	Solar power	15m pole necessary	Good*	S26:19:25	E31:24:15
Ekuthokuzeni	Term.	ditto	—	Solar power	15m pole necessary	Good*	S26:27:22	E31:31:01
Mpaka	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:24:05	E31:46:30
Croydon	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:12:16	E31:33:28
Nsingweni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:14:20	E31:22:30
Kakhuphuka	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:16:06	E31:38:41
Mliba Village	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:14:22	E31:35:15
Dvakolwako	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:09:49	E31:34:49
Maliyaduma	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:26:48	E31:24:28
Ngomane	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:11:42	E31:48:53
Shewula	Term.	ditto	—	Solar power	10m pole necessary	Good	S26:06:46	E32:02:39
Hlane	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:15:20	E31:46:56
Bulandzeni	Term.	ditto	—	Existing(AC220V)	10m pole necessary	Good	S26:03:45	E31:28:04

Path condition is good in the mode of connection shown in the Figure 4-5.
* There are trees ahead of the terminal station.

(4) System Maintenance System

The TDMA subscriber radio system to be introduced under the project will be given maintenance service under the present centralized form established at the Mbabane office. This centralized form will serve to meet all maintenance requirements when the centralizing remote supervisory equipment shown in Figure 3-3 is installed at the Mbabane office.

The number of maintenance personnel newly required for the project will be six, two for subscriber services such as service order and complaint reception, four for equipment maintenance services such as routine tests of radio facilities, failure recovery, etc.. Installation work of telephone sets and failure recovery work in subscriber cables will be performed by outside plant personnel stationed in the Mbabane office and Manzini office.

Table 3-12 Maintenace System

Station type		Maintenance equipment to be installed	Maintenace mode
Mbabane	Attended	Centralizing remote supervisory equipment	
Base stations	Attended	Supervisory and control equipment (Master)	Routine visits
Repeater stations	Not attended	Supervisory and control equipment (Slave)	Routine visits
Terminal stations	Not attended	Supervisory and control equipment (Slave)	Routine visits

For the purpose of maintenance personnel training, OJT will be conducted by making SPTC's staff take part in the system construction during the project period. This OJT will suffice to acquire the maintenance and operation techniques for individual system units, but comprehensive training in Japan is desirable to meet the demand for system expansion in the future.

The maintenance work can be roughly categorized into periodical equipment checking work and defective panel identification and change at time of failure. The periodical check should be carried out twice or so in a year to measure the frequency and the output power level and to check and record the voltages of various monitor units.

The digital type subscriber radio system to be provided under this project will have smaller rate of failure than the analog type system already introduced in the country, and the main facilities (base station equipment and repeater station equipment) are of normal/emergency redundant configuration, so the reliability of the system is very high. Furthermore, spare panels are to be supplied in quantities shown in Item 4-1 (6) in Chapter 4. These facts show that the donated system will operate normally without specific problems.

However, in case of failure, it is recommendable to send back the defective panel to Japan for repairing, because panels are of very complicated electronic circuits.

Furthermore, the consumable parts such as fuses, lamps and arresters necessary for maintenance work will be supplied in sufficient quantities for two-year maintenance services of the system to be introduced under the project.

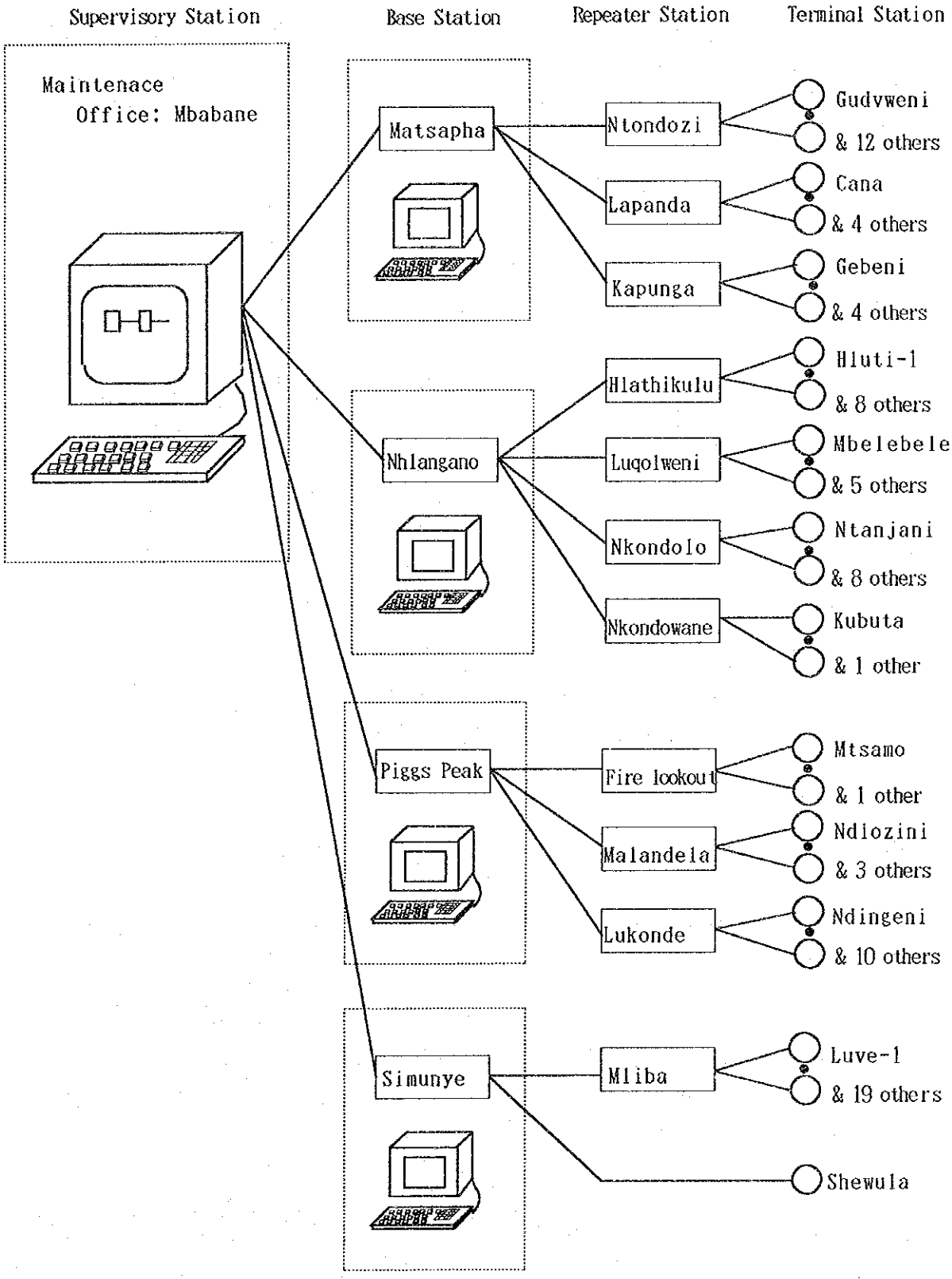


Figure 3-3 System Configuration for Maintenance and Supervision

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Basic Design Policy

The project is intended to build a new TDMA subscriber radio system to develop the telecommunication network in the four rural districts of Manzini, Hlathikulu, Piggs Peak and Maphiveni, and the system design policy is as described below.

(1) System Scale

Since the project will be implemented to build a new rural telecommunications network, the system will have a scale large enough to meet the service demand at the completion of its construction work.

(2) TDMA Subscriber Radio System

In principle, the TDMA subscriber radio system will be designed to have a scale filling the demand in 1995 when the system will be put in operation. Telephones will be installed mainly at public facilities, stores and factories, and coin telephones for public use will be installed at each terminal station. Since telex services are widely used in Swaziland, telex interfaces will be installed in areas where the telex demand is expected to exist. Subscriber cable installation from terminal stations to subscribers and telephone installation will be undertaken by SPTC (subscriber cables and accessories will be furnished by Japan).

(3) Power Facilities

Existing power facilities will be utilized, if available. New power facilities will not be installed, if DC -48 V can be obtained as shown in Tables 3-8 to 3-11, and a charger and storage battery set will be newly installed, if AC 220V is obtainable from the commercial power source. If existing power facilities are not available and stabilized commercial power is not guaranteed, a solar system will be installed with consideration given to the economic efficiency and reliability of power supply.

In this case, the number of solar cell panels will be determined to make the peak generated energy about ten times the average power consumption at

the relevant station, and the storage battery will have a capacity for operating the station on five consecutive days without power supply from the solar system.

(4) Station Buildings

Existing office buildings will be utilized, if available. In places where no existing building is found, the system equipment will be installed in simple brick huts to be newly built by SPTC.

(5) Towers

In principle, existing towers will be utilized. If no existing tower is available, a steel tower will be constructed at repeater stations where a large diameter antenna is to be installed or a steel pole will be erected at terminal stations where a small-diameter antenna is to be installed.

(6) Maintenance Parts and Measuring Apparatuses

One spare per type of packages will be provided for a group of base stations and repeater stations, and four (4) spares per type of packages will be provided for a group of terminal stations. As for power supply, ten (10) solar cell panels, one charger for each type and one solar control device for each type will be provided. Consumables will be supplied in quantities sufficient for two years' normal use. As for measuring apparatuses, two sets will be provided at the Mbabane station where the maintenance services will be controlled.

(7) Construction Period

As for the planned construction period, five and a half months will be spent for detailed design, bidding procedures and contract awarding, and twelve months for procurement and installation of equipment as shown in Figure 5-1.

4-2 Design Criteria

(1) Conditions for System Scale Determination

(a) Base Station

One base station capable of accommodating a maximum of 512 subscribers will be installed in each rural district in consideration of the future demand growth, billing plan and numbering plan.

(b) Repeater Station

Repeater stations will be installed at the selected sites in such a way as will secure stable propagation paths.

(c) Terminal Station

One terminal station will be installed at each site, if the selected sites are more than 5 km apart from each other owing to line resistance or the cable installation is difficult or economically undesirable because of the site topography.

(d) Subscriber Line Interface

Subscriber line interfaces of each terminal station will be supplied in the required quantity.

(e) Subscriber Cable

A ten (10) pair subscriber cable with a length of 700 m will be provided for each terminal station according to the pattern of demand distribution at project sites covered by the field survey (see the reference data given at the end of this report).

(2) System Configuration

Figure 4-1 shows the locations of base/repeater/terminal stations, and Figures 4-2 to 4-5 show connection mode among them based on the radio propagation characteristics examined in the field survey and on maps under the conditions mentioned above. Figure 4-6 shows a system configuration of a repeating section in Manzini area.

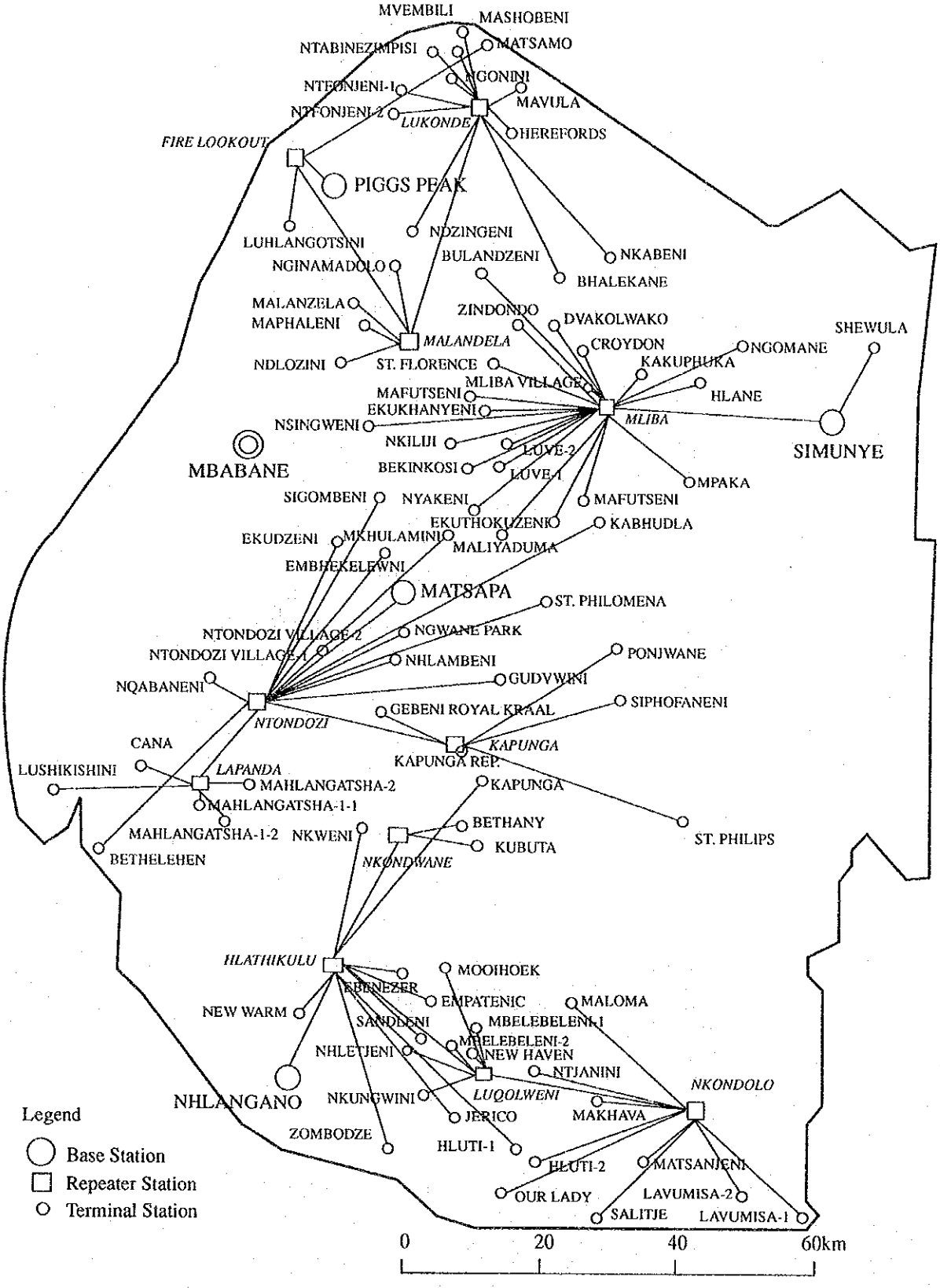


Figure 4-1 Location of Base/Repeater/Terminal Stations

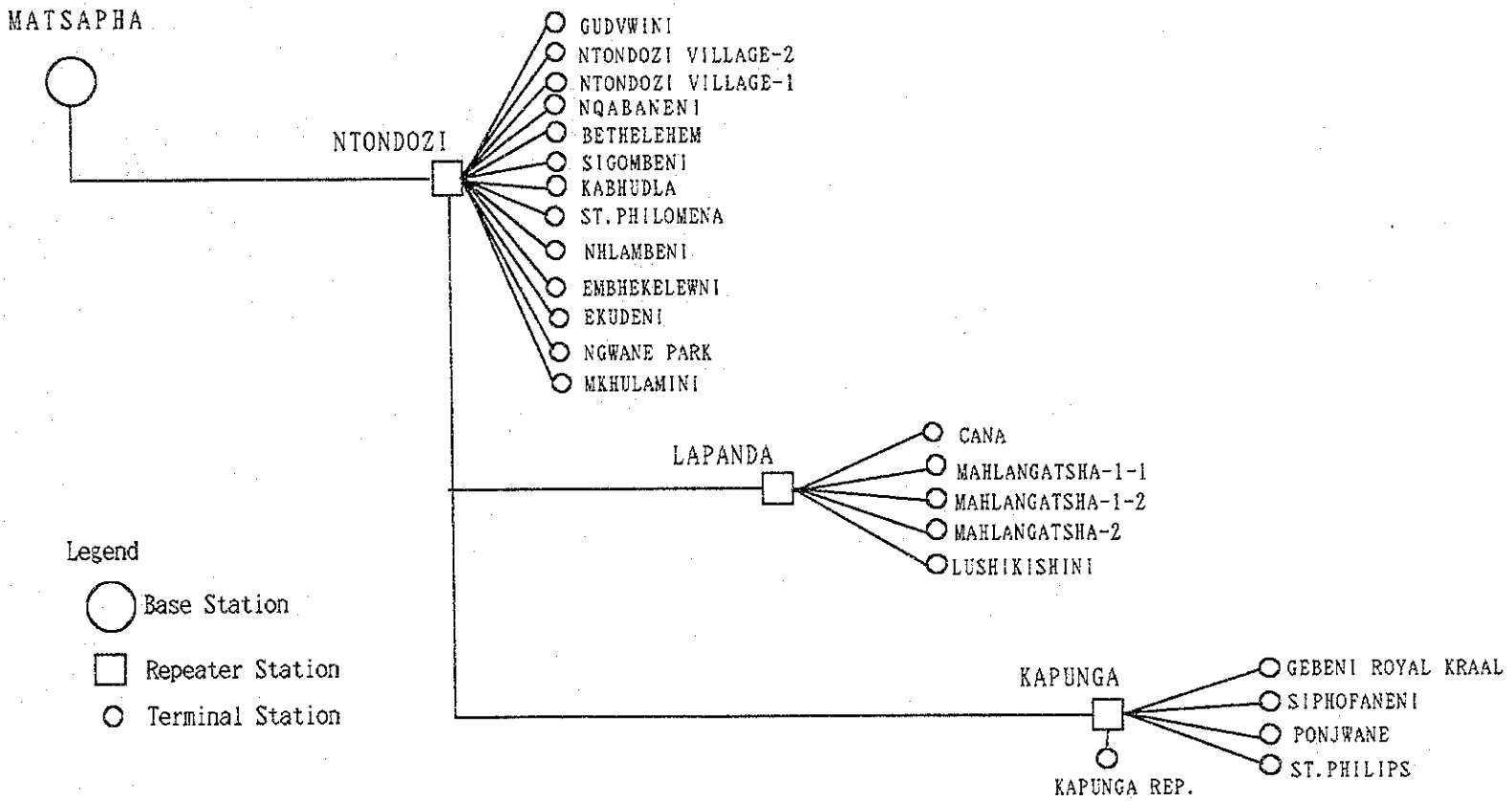


Figure 4-2 Mode of Connection (MANZINI Area)

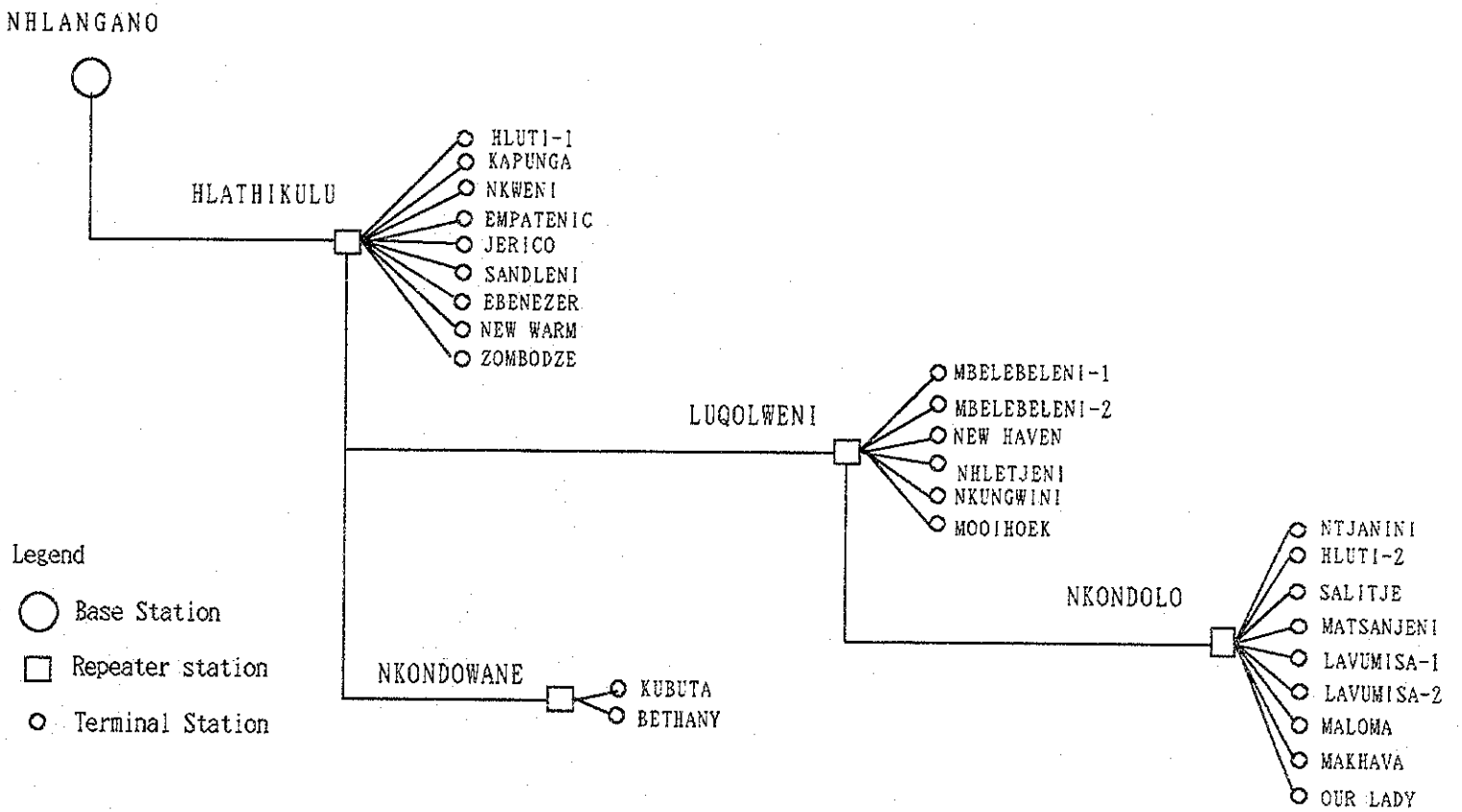


Figure 4-3 Mode of Connection (HLATHIKULU Area)

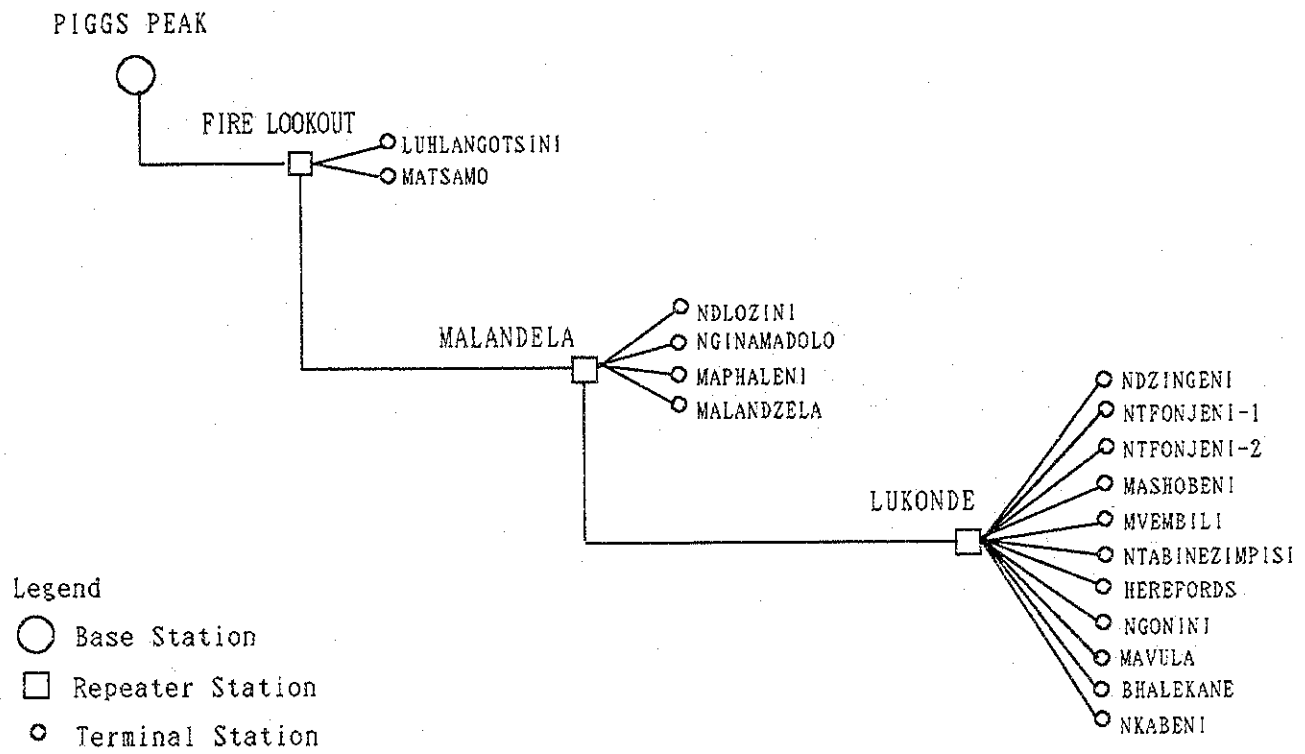


Figure 4-4 Mode of Connection (PIGGS PEAK Area)

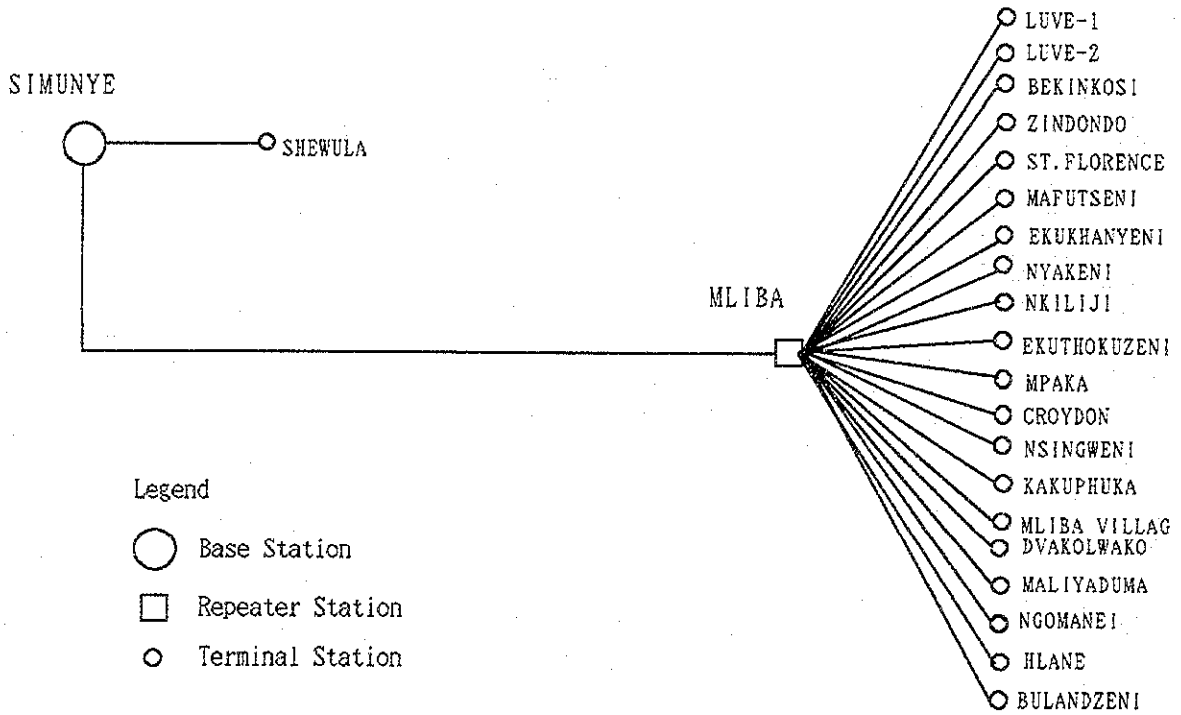
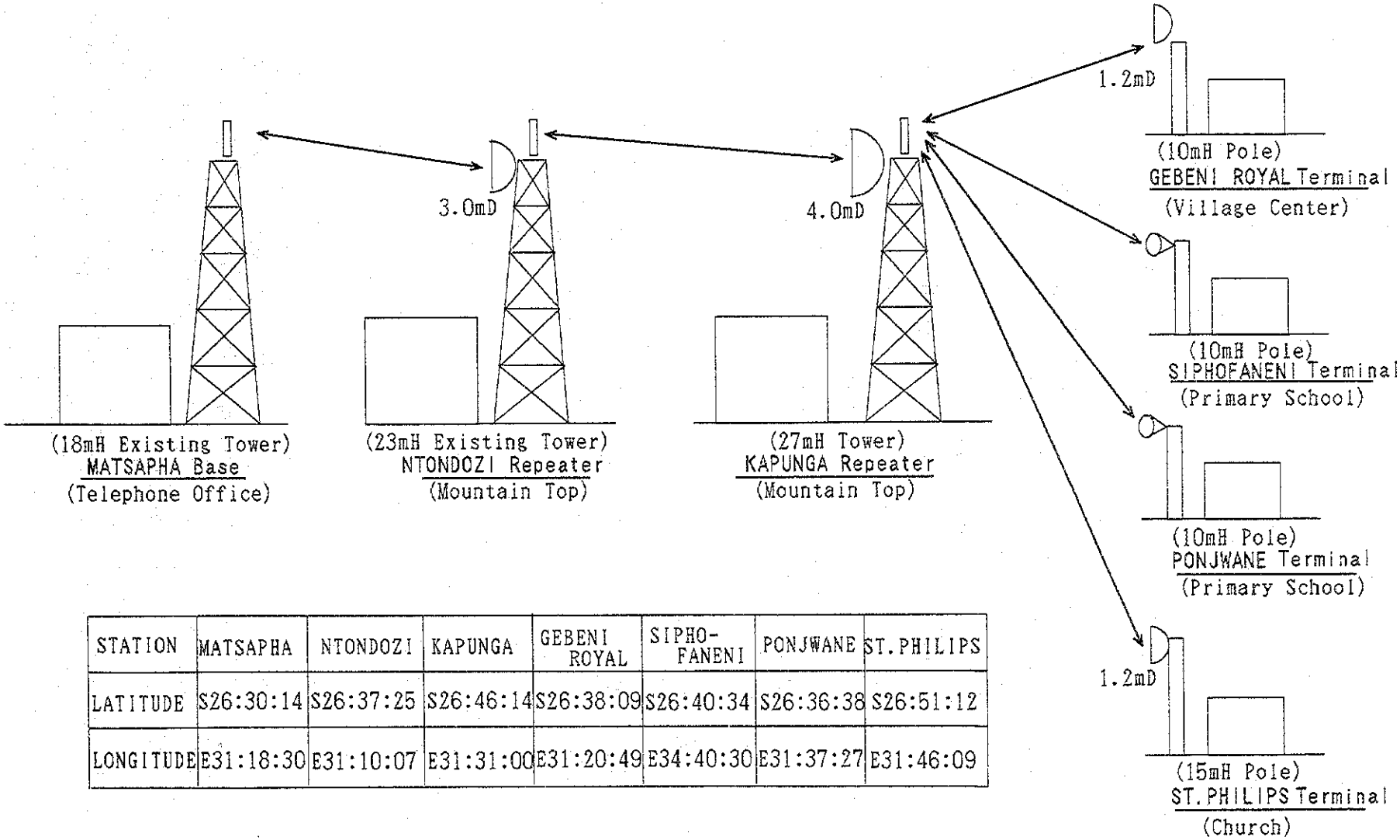


Figure 4-5 Mode of Connection (MAPHIVENI Area)



STATION	MATSAPHA	NTONDOZI	KAPUNGA	GEBENI ROYAL	SIPHO-FANENI	PONJWANE	ST. PHILIPS
LATITUDE	S26:30:14	S26:37:25	S26:46:14	S26:38:09	S26:40:34	S26:36:38	S26:51:12
LONGITUDE	E31:18:30	E31:10:07	E31:31:00	E31:20:49	E34:40:30	E31:37:27	E31:46:09

Figure 4-6 System Configuration of TDMA Subscriber Radio System (An Example)

4-3 Basic Plan

(1) Radio Transmission Facilities for TDMA Subscriber Radio System

One TDMA subscriber radio system will be installed in each admini strative district by considering the geographical and administrative conditions and billing and numbering plans, and also to cope with the future growth of telephone demand. The path between base station and repeater station, which comprises the trunk transmission route of this system, will be provided with stand-by facilities, with a large diameter antenna installed at a repeater station to maintain a stable propagation condition. For a path between repeater station and terminal station with a long propagation distance, a parabolic antenna will be installed at terminal station side to secure the transmission quality specified by CCITT. In addition, a centralizing remote supervisory equipment for facilitating maintenance services will be installed at the Mbabane office which has the radio transmission system maintenance department.

(2) Power Supply Facilities

The power supply facilities shown in Tables 4-2 to 4-6 will be installed by considering the availability of existing power facilities.

(3) Steel Tower

The steel towers or poles shown in Tables 4-2 to 4-6 will be installed at repeater station or terminal stations where no existing towers can be utilized.

(4) Station Building

As a rule, the system equipment will be installed in the existing office buildings of SPTC. In places where no such existing office buildings are available, simple brick huts will be newly constructed by SPTC. The Annex-9 shows equipment layout plans in the existing buildings.

Table 4-1 shows a list of main equipment, their technical specifications and mode of applications. A list of equipment and materials required at base

stations and repeater stations is shown in Table 4-2, and lists of equipment and materials required at terminal stations in each rural district are shown in Tables 4-3 to 4-6.

Furthermore, Figure 4-7 depicts an equipment configuration which realizes the system shown in Figure 4-6.

Table 4-1 List of Main Equipment (1/2)

Names of Equipment	Main Specifications	Applications
Exchange connection equipment (Base station)	Maximum number of subscribers: 512 Number of time slots: 60 Binary digit strings: 2Mbits x 2 2 wire interface	The equipment is for connecting interface with a subscriber switching unit at local telephone exchange
TDMA control radio equipment (Base station)	Frequency: 2.4 GHz band Output power: Approximately 1W Noise figure: 3dB Minimum permissible reception level: -94dBm Number of telephone lines: 60	To transmit signals equivalent to 60 telephone lines by radio wave after multiplexing by the TDMA method (time-division multiple access).
Centralizing remote supervisory equipment (Maintenance office)	Maximum number of base station put under control by the equipment: 4 Maximum number of repeater stations and terminal stations put under control by the equipment: 1,010 Software scale: 10MB Memory capacity: 100MB Graphic indications	It monitors the conditions of the system under remote operation in company with subordinate in base equipment stations, when necessary, it performs switching-over to emergency system. Inputting and modifying subscribers' data will be carried out by this equipment under remote operation.
Repeater station radio equipment	Frequency: 2.4 GHz band Output power: Approximately 1W Noise figure: 3dB Minimum permissible reception level: -94dBm	Usually, it is installed at a mountain top. It receives and amplify radio waves coming from base stations or preceding repeater station and transmit them after necessary amplification. It also performs regeneration and reshaping of deformed telephone signals.
Subscriber interface for repeater	Maximum number of subscribers: 64 (9 under this project)	Having subscribers connected to a repeater station, it provides function of a terminal station.
Terminal station radio equipment	Maximum number of subscribers: 64 Frequency: 2.4GHz band Output power: Approximately 1W Noise figure: 3dB Minimum permissible reception level: -94dBm	This is a radio equipment to which the subscriber terminals (such as ordinary telephones, public telephones and telex equipment) are connected.
Parabolic antenna (4mD)	Gain: 37dB Grid type	A high gain antenna for application at a location where a receiving radio wave is very weak.

Table 4-1 List of Main Equipment (2/2)

Names of Equipment	Main Specifications	Applications
Rectifier and storage battery (48V for use at repeater station)	AC input: 220V DC output: -48V/7A Full-wave rectification Ripple voltage: 100mV Battery capacity: 30Ah	A rectifier for conversion of AC220V of the commercial power supply into power suitable for a repeater equipment (DC: -48V) and a storage battery for use when the commercial power supply is interrupted.
Solar cell system (For use at repeater station)	Maximum generation capacity: Approximately 1,400W Occupying area: Approximately 13m^2 Conversion efficiency: 14% Battery capacity: Capable to maintain the equipment for 5 continuous days without sunshine.	A fuel-free power generator applicable at a location where commercial power supply is not available. It consists of solar cell panels, a charger and lead acid batteries.
Portable rectifier (48V/12V)	AC input: 220V DC output: -12V/-48V 7A Output voltage fluctuation: ±2%	It is used, when the commercial power supply or power supply from the solar cell system is interrupted, to supply necessary power to the repeater station equipment or terminal station equipment in combination with a portable power generator. This is a maintenance equipment.
Steel tower	Height: 27m Antenna load: Approximately 60 kgs Equipped with ladders	It is used to maintain the repeater station antenna at needed height so that it can face to corresponding antenna of terminal stations free from obstacles. To be procured in a third country.
Subscriber cable (Including accessories)	Number of pairs: 10 Calibre: 0.6mm Length: 60km	For connection between the radio equipment at the terminal station and terminal devices of remote subscribers (telephones and telex equipment). To be procured in a third country.

Table 4-2 Equipment List for TDMA Subscriber radio System (Base Station, Repeater Station)

Item \ Site		Base Station				Repeater Station										Sum
	Mbabane	Matsapha	Nhlangano	Piggs Peak	Simunye	Ntondozi	Lapanda	Kapunga	Hlathikulu	Luqolweni	Nkondolo	Nkondwene	Fire Lookout	Lukonde	Malandela	Mliba	
Exchange connection Equipment*		1	1	1	1												4
TDMA Control Radio Equipment*		1	1	1	1												4
Subscriber Module		2	3	2	2												9
Ordinary Tel. Interface (8ch)		14	20	11	12												57
Coin Telephone Interface (4ch)		6	7	5	6												24
TELEX Interface (1ch)		6	6	6	4												22
Concentrated Supervisory Equip	1																1
Visual Desplay Unit		1	1	1	1												4
Repeater Station Radio Equip.						1	1	1	1	1	1	1	1	1	1	1	11
Subscriber Interface for Rep.								1									1
Antenna 1.2mD													1				1
Antenna 3.0mD						1	1		1	1	1	1					6
Antenna 4.0mD								1						1	1	1	4
Omni-Antenna		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
27m Self Supporting Tower							1	1	1	1	1	1	1	1	1		9
Feeder Line (20mmD) (m)		35	45	35	35	80	70	70	70	70	70	70	70	70	70	60	920
Feeder Connector (20mmD)		1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	26
Charger/Battery (48V)									1							1	2
Solar Cell Sytem (24V)							1	1		1	1	1	1	1	1		8
Frequency Counter	2																2
Power Meter	2																2
Portable Power Generator	2																2
Portable Rectifier (48V)	2																2
Portable Rectifier (12V)	2																2
Maintenance Manuals (set)	2	1	1	1	1												6
Construction Materials (set)	1																1
Cables and Accessories (set)	1																1
Spare Parts, Consumables (set)	1																1

* Indicates a normal/stand-by configuration

Table 4-3 Equipment List for TDMA Subscriber Radio System (Manzini Area)

Item \ Site	Gebeni Royal	Gudweni	Ntondozi 1	Ntondozi 2	Nqabaneni	Cana	Bethelehem	Malangatsha 11	Malangatsha 12	Malangatsha 2	Sigombeni	Kabhudla	St Philomena	Siphofaneni	Lushikishini	Kapunga Rep.	St Philips	Nhlanbeni	Embnekelweni	Ponjweni	Ngwane Park	Mkhulamini	Ekudzeni		Sum
Terminal Station Radio equipment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		22
Subscriber Interface	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		22
Additional Subscriber Interface						1																			1
TELEX Interface								1						1			1		1			1			5
Addditional Interface Mounting Unit																									0
Horn Antenna			1	1	1	1		1	1	1				1	1					1					10
Parabolic Antenna 1.2mD	1	1					1				1		1				1	1	1		1	1	1		11
Parabolic Antenna 1.8mD												1													1
Feeder Line (10mmD) (m)	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15		20	15	15	15	15	15	15		335
Feeder Connector (10mmD)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		22
Pole 10m	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1		21
Pole 15m																	1								1
Pole 20m																									0
Pole 25m																									0
Charger/Battery Unit	1				1	1	1	1					1	1	1		1	1	1	1	1		1		14
Solar Cell System (3 panels)		1	1	1					1	1	1	1										1			8
Solar Cell System (4 panels)																									0

Table 4-4 Equipment List for TDMA Subscriber Radio System (Hlathikulu Area)

Item \ Site	Mbelebeleni 1	Mbelebeleni 2	New Haven	Nhletjeni	Ntjaniini	Hluti 1	Hluti 2	Kapunga	Kubuta	Bethay	Nkungwini	Salitje	Matsanjeni	Nkweni	Lavumisa 1	Lavumisa 2	Maloma	Makhava	Mooihoek	Empateni	Jerico	Sandleni	Ebenezer	Our Lady	New Warm	Zombodze	Sum
Terminal Station Radio equipment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	26
Subscriber Interface	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	26
Additional Subscriber Interface					1	1	1	1						1	1												6
TELEX Interface				1		1		1	1				1		1												6
Addditional Interface Mounting Unit						1		1							1												3
Horn Antenna	1	1		1			1		1	1	1	1	1	1	1	1		1	1	1			1		1		17
Parabolic Antenna 1.2mD			1		1	1		1									1				1	1		1		1	9
Parabolic Antenna 1.8mD																											0
Feeder Line (10mmD) (m)	15	25	15	15	15	25	15	20	30	25	15	15	15	15	20	20	20	15	15	15	15	15	15	20	15	15	460
Feeder Connector (10mmD)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	26
Pole 10m	1		1	1	1		1				1	1	1	1				1	1	1	1	1	1		1	1	17
Pole 15m								1							1	1	1							1			5
Pole 20m		1				1				1																	3
Pole 25m									1																		1
Charger/Battery Unit	1	1	1			1			1			1	1		1	1	1					1	1	1		1	14
Solar Cell System (3 panels)										1	1							1	1	1	1				1		7
Solar Cell System (4 panels)				1	1		1	1						1													5

Table 4-5 Equipment List for TDMA Subscriber Radio System (Piggs Peak Area)

Item \ Site	Ndingeni	Matsamo	Ntfonjeni 1	Ntfonjeni 2	Mashbeni	Mvembili	Ntabinezimpsi	Ndlozini	Hereford s	Nginamadolo	Luhlangotsini	Malandzela	Ngonini	Mavula	Maphalen i	Bhalekane	Nkabeni		Sum
Terminal Station Radio equipment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		17
Subscriber Interface	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		17
Additional Subscriber Interface		1			1														2
TELEX Interface		1	1	1		1							1				1		6
Addditional Interface Mounting Unit		1																	1
Horn Antenna	1		1	1	1	1	1	1	1		1	1	1	1	1				13
Parabolic Antenna 1.2mD		1								1						1	1		4
Parabolic Antenna 1.8mD																			0
Feeder Line (10mmD) (m)	15	20	15	20	15	15	15	15	20	25	15	15	15	15	15	15	20		285
Feeder Connector (10mmD)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		17
Pole 10m	1		1		1	1	1	1			1	1	1	1	1	1			12
Pole 15m		1		1					1								1		4
Pole 20m										1									1
Pole 25m																			0
Charger/Battery Unit	1	1	1	1		1	1		1				1	1		1	1		11
Solar Cell System (3 panels)								1		1	1	1			1				5
Solar Cell System (4 panels)					1														1

Table 4-6 Equipment List for TDMA Subscriber Radio System (Maphiveni Area)

Item \ Site	Luve 1	Luve 2	Bekinkosi	Zindondo	St Florence	Mafutseni	Ekukhanyeni	Nyakeni	Nkiliji	Ekuthokuzeni	Mapka	Croydon	Nsingweni	Kakhuphuka	Mliba Billage	Dvakolwako	Maliyaduma	Ngomane	Shewula	Hlane	Bulandzeni	Sum	Grand Sum
Terminal Station Radio equipment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	86
Subscriber Interface	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	86
Additional Subscriber Interface															1							1	10
TELEX Interface	1															1		1		1		4	21
Addditional Interface Mounting Unit																						0	4
Horn Antenna	1	1	1	1	1	1	1	1	1			1	1	1	1	1			1	1		16	56
Parabolic Antenna 1.2mD										1	1						1	1			1	5	29
Parabolic Antenna 1.8mD																						0	1
Feeder Line (10mmD) (m)	15	15	15	25	15	15	15	15	20	20	15	15	15	15	15	15	15	15	15	15	15	320	1400
Feeder Connector (10mmD)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21	86
Pole 10m	1	1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	18	68
Pole 15m									1	1												2	12
Pole 20m				1																		1	5
Pole 25m1																						0	1
Charger/Battery Unit	1		1		1	1	1				1	1	1		1	1		1		1	1	13	52
Solar Cell System (3 panels)		1		1				1	1	1				1			1		1			8	28
Solar Cell System (4 panels)																						0	6

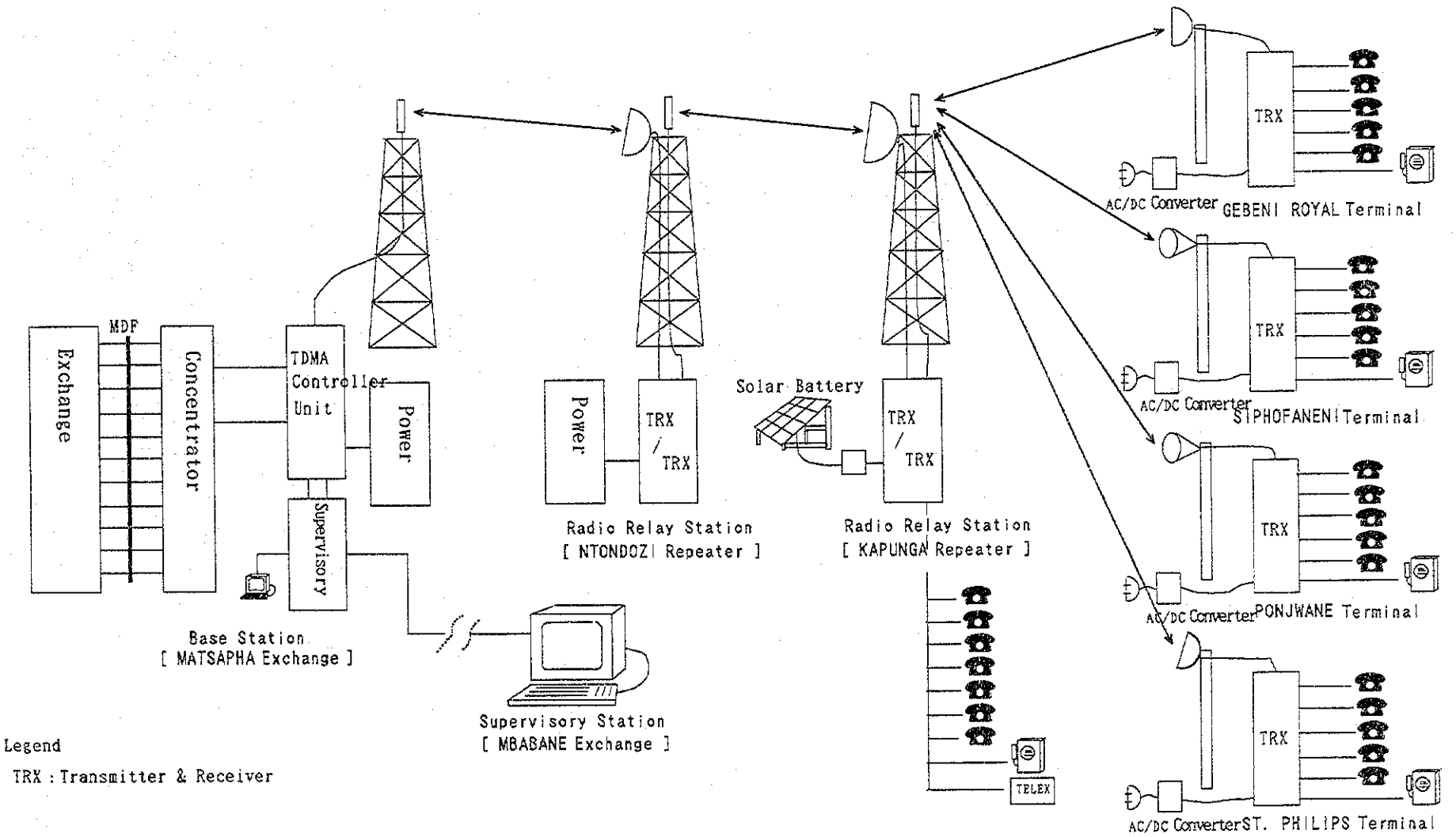


Figure 4-7 Equipment Configuration of TDMA Subscriber Radio System (An Example)

CHAPTER 5 IMPLEMENTATION PLAN

CHAPTER 5 IMPLEMENTATION PLAN

5-1 Implementation Policy

(1) Since the installation, adjustment, characteristics check testing, etc. of the equipment in this project require high technical knowledge and experience, the main project contractor of Japan will send engineer(s) for each technical field, and they will proceed with each process while giving guidance to local engineers, technicians and workers.

(2) SPTC is responsible for the construction for the tower foundation from the viewpoint of the funding status of SPTC or the technical level of the local contractor. However, the mountain areas that make construction difficult are involved in many cases, so special engineer(s) for the tower construction will be sent for giving guidance to the local contractor or workers. The foundation drawing and anchor bolts will be supplied by the main contractor in Japan.

(3) In the actual implementation, some appropriate teams will be formed from the local engineers/technicians and Japanese engineers/technicians to proceed with the construction smoothly, because the construction sites spread across wide areas.

(4) The engineers/technicians sent from Japan will transfer the knowledge required for the maintenance and the construction of terminal stations to the engineers/technicians of SPTC through OJT.

5-2 Scope of Installation Work

The basic design study team had discussions with the persons concerned including the president of SPTC on how the installation should be shared by two countries in case that the grant aid project is carried out. The results of the discussions were recorded and confirmed by making the minutes of discussion. (Data: Minutes of discussion of the basic design study team and the draft explanation team)

The scope of work to be borne by Japan's grant aid and the scope to be borne by the Swaziland side are shown below.

(1) Scope of Work of Japanese Side

(A) To install subscriber radio system equipment,

(B) To install power supply units and solar cell systems,

(C) To construct antenna towers and poles and to install antennas and feeder lines,

(D) To adjust, test, inspect and commission the system.

(2) Scope of Work of Swaziland side

(A) To provide and secure land and equipment rooms necessary for execution of the project, and to construct huts for accommodation of equipment, where such accommodation facilities are not available.

(B) To construct foundations for antenna towers/poles and solar panel supporting parts in cooperation with Japanese supervisors,

(C) To install connection cables between MDF and existing switching equipment,

(D) To install cables to connect terminal equipment to subscriber premises, and the installation of telephone apparatus (subscriber cables and accessories will be provided by Japan),

(E) To arrange fences and access roads necessary for construction of the facilities.

(F) To arrange commercial AC 220 V power supply in project sites, where such power supply is available.

(G) To transport equipment and materials of tower/pole to the project sites from warehouse of SPTC.

5-3 Implementation Management Plan

For the management of the construction work for the project, a japanese consultant in contract with SPTC will perform the following management works in relation to the project implementation.

(A) Detailed Design

The detailed design will be made to decide the general conditions, special conditions and detailed technical specifications which are required for the project implementation under the cooperation with SPTC on the basis of the results of the field survey for the basic design. Also, the consultant will make the document required for tendering on the basis of the results of the detailed design in consultation with SPTC.

(B) Management of Construction Work

(a) Works related to tendering for selecting contractor

Call for tender, receive and evaluate the tender documents and adjust for reaching agreement between SPTC and Japanese applicant for the contract.

(b) Plant inspection

The consultant will perform plant inspection of the supplier and make sure the equipment conforms to the contract specifications prior to starting the shipment of the equipment.

(c) Supervision of the construction work

In accordance with the contract agreement between SPTC and the consultant, the consultant will examine the construction method and schedule which will be submitted by the contractor and give instructions to the contractor. Also, the consultant will make sure that a engineer stay at the project sites during the construction period, visit the sites periodically to make sure the construction works conform to the contract specifications and manage the construction schedule.

(d) Witnessing for acceptance test

The consultant will witness for the acceptance test when the construction is completed to make sure the inspection result conforms to the contract specifications, then recommend the Swaziland government to accept the system.

5-4 Equipment and Materials Procurement Plan

The equipment and materials except for those for the construction to be borne by the Swaziland side will be procured in Japan. However, subscriber cables and steel materials of antenna tower and pole which do not give any specific influence to the system quality will be procured from neighboring countries.

And, also, personal computers for supervisory and control system, sealed batteries for power supply units and portable engine generators for maintenance use will be procured in Swaziland, if their characteristics meet the requirements of the whole system.

5-5 Project Implementation Process

In this project, the Japanese government and the government of the Kingdom of Swaziland will sign the exchange notes. Immediately upon signing, the consultant business contract will be made, and the consultant will perform detailed design and tender documents will be prepared. Then, after a competitive tendering, a contract on the equipment and materials procurement and construction works will be made. The project implementation schedule is shown in Figure 5-1.

5-6 Estimation of Project Cost Borne by Swaziland

The cost to be borne by the Kingdom of Swaziland is as follows according to the estimate conditions shown below.

(A) Cost to be Borne by the Swaziland Side (excluding expense for getting land and payment for its staffs)

E1,233,000 (The cost breakdown is shown in Annex 8.)

(B) Estimate conditions

(a) Time of estimate

November, 1992 (the month when the field survey for the basic design study was completed)

(b) Implementation period

The implementation period is as shown in the project implementation schedule shown in Figure 5-1.

(c) Others

The project will be carried out in the system of the grant aid of the Japanese government.

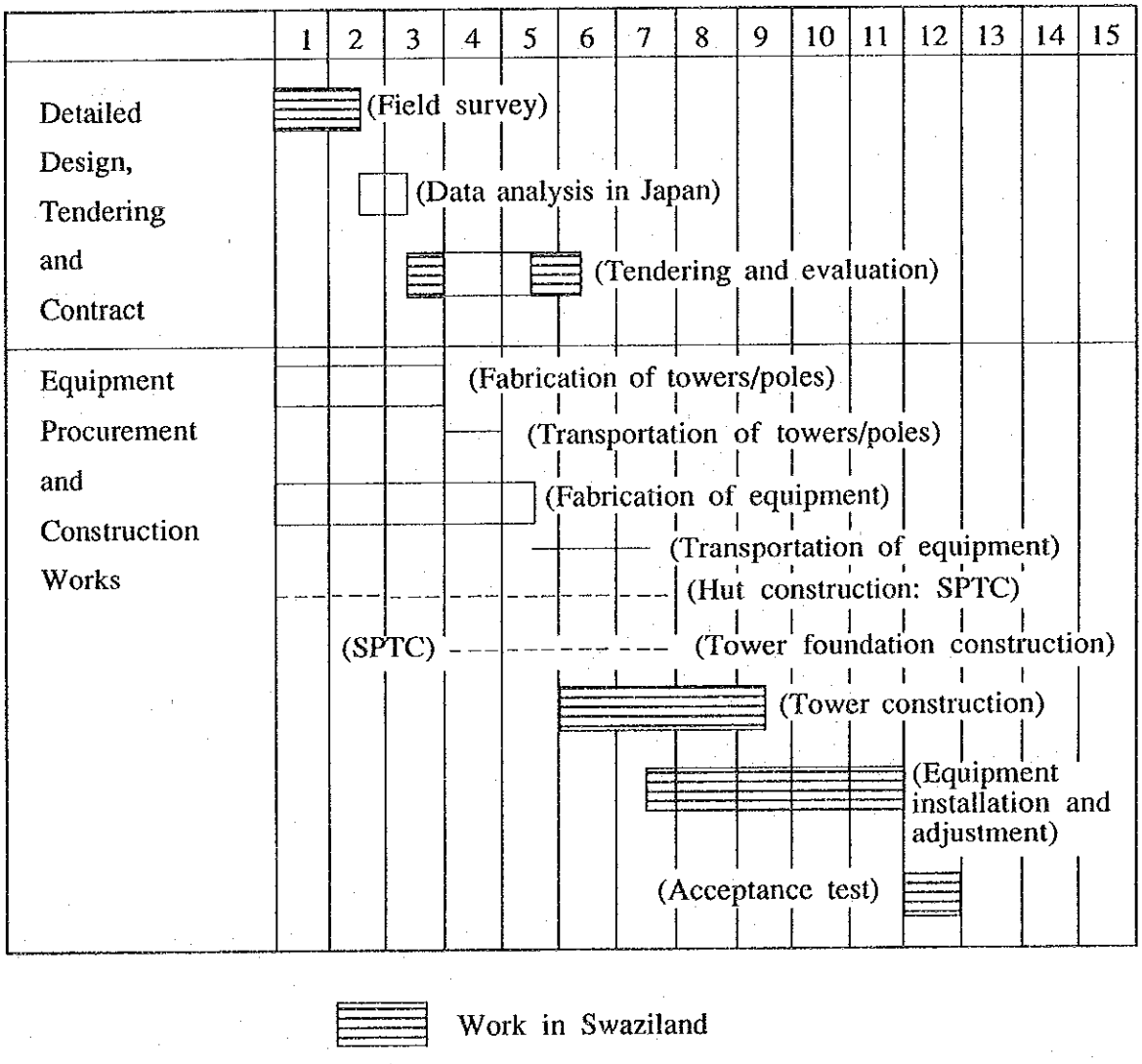


Figure 5-1 Project Implementation Schedule