SECTION 4

DEMAND FORECASTS

SECTION 4 DEMAND FORECASTS

The main purpose of demand forecasting in this study is to examine the growth in telephone and non-telephone subscriber demand and to provide the basis for economic and technical study of the long-term plan for development of the telecommunications network in the Republic of Zambia.

1. Telephone Demand Forecast

Telephone demand is forecasted by Macroscopic (Top-down) forecast method, namely ITU regression model and Logistic curve model, applying the historical data of telephone growth (in density), nationwide population, Gross Domestic Product (GDP) and GDP per capita.

The forecasting base year is set at 1992, and successive forecasts are made for 20 years up to 2012 with 5 years intervals.

Nationwide macroscopic demands obtained are projected to respective provinces and exchanges, based on the existing conditions of telephone subscribers and applicants.

1.1 Socio-Economic Growth

1.1.1 Population

The officially announced population of Zambia was 7,818,447 in the census made in August 1990 as summarized in Table 4-1-1 below. The annual growth rate of the total population increased from 3.0% in the period 1969-1980 to 3.2% in the period 1980-1990.

Table 4-1-1 Population by Province, 1990 Census

Province	Population	%
Central	725,611	9.3
Copperbelt	1,579,542	20.2
Eastern	973,818	12.5
Luapula	526,705	6.7
Lusaka	1,207,980	15.5
Northern	867,795	11.1
North-Western	383,146	4.9
Southern	946,353	12.1
Western	607,497	7.7
Zambia	7,818,447	100.0

(Source : 1990 Census Preliminary Report)

(1) Urbanization

The employment opportunities and relatively high wages offered in the post-independence period in the copper mines and associated industries led to the strong rural-to-urban migration. The result has been to make Zambia one of the most urbanized countries in Africa.

According to the 1990 census, more than half the population of Zambia, 58.0 %, live in rural areas while 42.0 % live in urban areas. The two largest provinces, Lusaka and Copperbelt, include over 70 % of the population in the urban areas.

(2) Future Population Trend

Looking at past population growth rates, Zambia saw growth of 3.07% in its population between 1969 and 1980, and 3.28% between 1980 and 1990, as shown in Table 4-1-2 below.

By 1990, the total population reached 7.8 millions. However, the present Government is committed to birth control and better education and, as a result, nuclear families will remarkably increase in urban areas and the population growth rate is expected to decrease over the next two decades, as shown in Table 4-1-3.

Table 4-1-2 Population Growth Rate, 1969-1990

Province	Growth Rate		
	1969-80	1980-90	1969-90
Central	3.20%	3.55%	3.40%
Copperbelt	3.90%	2.35%	3.19%
Eastern	2.50%	4.10%	3.13%
Luapula	2.08%	2.26%	2.16%
Lusaka	6.27%	5.74%	6.00%
Northern	1.95%	2.54%	2.23%
North-Western	2.45%	2.38%	2.40%
Southern	2.79%	3.48%	3.10%
Western	1.56%	2.24%	1.88%
Total	3.07%	3.28%	3.17%

Table 4-1-3 Population Growth Rate for Next Two Decades

Year	G.Rate(%)	Pop.	Year	G.Rate(%)	Pop.
1993	3.25	8,608,865	2003	3.05	11,738,347
1994	3.24	8,887,898	2004	3.04	12,095,166
1995	3.23	9,175,000	2005	3.03	12,461,000
1996	3.22	9,470,520	2006	3.02	12,837,123
1997	3.19	9,772,895	2007	3.00	13,222,790
1998	3.16	10,082,194	2008	2.98	13,616,228
1999	3.14	10,398,437	2009	2.95	14,017,376
2000	3.11	10,721,000	2010	2.92	14,426,000
2001	3.08	11,051,808	2011	2.89	14,842,481
2002	3.07	11,390,638	2012	2.86	15,266,000

G.Rate: Growth Rate, Pop.: Population

The population for each forecasted year and province is shown in Table 4-1-4.

Table 4-1-4 Population for Province ('000)

Year	1992	1997	2002	2007	2012
Central	775	906	1,046	1,204	1,376
Copperbelt	1,647	1,847	2,101	2,383	2,705
Eastern	1,054	1,276	1,524	1,818	2,165
Luapula	549	603	667	754	850
Lusaka	1,344	1,742	2,203	2,711	3,221
Northern	915	1,038	1,170	1,319	1,512
North-Western	403	458	527	612	713
Southern	1,018	1,214	1,422	1,650	1,913
Western	632	688	730	771	814
Total	8,337	9,772	11,390	13,222	15,269

1.1.2 Gross Domestic Product (GDP)

Table 4-1-5 GDP Per Capita and Growth Rate

GDP per capita	ZK 26,238 US$425 in 1991
Total GDP Growth Rate	-1.8% in 1990/91
Average Exchange Rate	61.728 ZK/US$ in 1991

GDP gives a useful index to be applied to a structural pattern of production in economy, and helps to measure the rate of growth. It is available both at current and constant prices which estimate a measure of the real change. The productive system of Zambia in the last decade is given in the following Tables 4-1-6 and 4-1-7.

Real change rate in Gross Domestic Product (GDP) during the 1980-1990 period lagged behind population growth. Droughts in 1982/84 incurred much damage on the economic growth, because most of small scale farmers depend heavily on extensive water conservation.

In general, GDP during the 1982-1987 period indicated a real change of GDP (under 1.0%) which implies GDP's negative growth due to the 1983/84 contraction. Agriculture was affected by drought, mining was affected by falling world prices and relative strength of the Zambian Kwacha. Zambia remains in a vicious cycle of low growth, declining investment, stagnant employment, and foreign-exchange shortage. Fortunately in 1988, GDP real change turned higher, due to favorable weather conditions in the agricultural seasons in 1987/88.

According to the New Economic Recovery Program (1992 -1994), the GDP growth in 1993 is estimated to be 3.0%. On the other hand, the 1989-1993 Fourth National Development Plan assumes an average annual GDP growth rate of 3.2%, as major economic objectives. The newly estimated GDP growth rate will be accomplished with good weather and bumper crops.

The mining and quarrying sector plays a significant role in the national economy, contributing about 7.3% to the GDP, and brings in 90% of Zambia's foreign currency revenue, with 106,375 persons engaged in this sector in 1989, as shown in Tables 4-1-8 and 4-1-9.

Until 1975 Zambia was one of the most prosperous countries in Sub-Saharan Africa. When the world copper price slumped in 1975, so did the rest of the economy. Zambia was left with a legacy of debt, foreign exchange shortages and falling production output. To add to the country's problems, copper reserves are declining rapidly.

Although agriculture accounts for less than 15.7% (1991) towards GDP, it is by far the most important economic activity in Zambia with 60% of the population depending on it, as shown in Tables 4-1-10 and 4-1-11.

Drought severely affected its agriculture, resulting in decline in exports. It occurs two or three times in every decade, appearing as a natural cycle and affects the economy to a certain extent.

The manufacturing sector contributes about 36.3% to the GDP, with the number of employment amounting to 125,254 in 1989. This sector consists of heavy industries in chemical, rubber and plastic products, non-metallic mineral products and metal products, etc. and light industries in foodstuff, drink, tobacco, textiles and clothing, etc.

Table 4-1-6 GDP by Kind of Economic Activity 1989-1991

(At 1977 Constant Price)

Item	1982	1987	1988	1989	1990	1991
Agriculture	290	366	436	425	387	407
Mining & Quarrying	215	184	160	176	163	166
Manufacturing	415	463	547	544	587	524
Electricity, Gas & Water	76	62	61	50	59	64
Construction	84	77	70	63	63	62
Wholesales & Retail Trade	179	182	185	187	181	181
Restaurants and Hotels	53	47	49	46	54	54
Transport, Storage and Communications	119	115	113	110	102	97
Financial Institutions	71	51	60	53	54	55
Real Estate and Business Services	156	189	191	193	183	178
Community, Social and Personal Service	394	371	374	376	382	388
Import Duties	28	23	17	17	16	15
Less Imputed Bank Service Charge	20	14	17	15	15	15
Gross Domestic Product	2059	2114	2247	2224	2214	2174
Real Change Ratio (%)		2.7	6.3	-1.0	-0.5	-1.8

Table 4-1-7 GDP Real Change of Factor Cost

Sector	1982-1987	1987-1991	1982-1991
Agriculture	4.70	2.10	3.44
Mining and Quarrying	-3.00	-2.00	-2.50
Manufacturing	2.20	2.50	2.30
Electricity and Water	-3.90	0.60	-1.70
Construction	-1.70	-4.20	-2.99
Wholesales and Trade	0.30	-0.10	1.11
Hotel and Restaurants	-2.30	2.80	0.18
Transport, Communications	-0.60	-3.30	-2.00
Financial, Institutions	-6.40	-1.50	-2.50
Real Estate	3.90	-1.20	1.30
Community, Social Service	-1.20	0.90	-0.15
Import Duties	-3.80	-8.10	-6.00
Less: Imputed Banking Service	-6.80	1.30	-2.80
Gross Domestic Product at Factor Cost	0.52	0.56	0.54

Table 4-1-8 Industrial Origin of GDP at Current Price

Sector	1986		1991	
	ZK(MN)	(%)	ZK(MN)	(%)
Agriculture & forestry	1,578	12.2	32,979	15.7
Mining & quarrying	2,355	18.2	14,832	7.3
Manufacturing	2,936	22.7	74,121	36.3
Electricity, gas and water	166	1.3	1,108	0.5
Construction	292	2.3	6,210	3.0
Wholesales and retail trade	1,638	12.6	15,415	7.6
Hotels, restaurant, etc.	262	2.0	5,030	2.5
Transport, communication	594	4.6	11,379	5.6
Financial institutions	445	3.4	4,461	2.2
Real estate	752	5.8	9,560	4.7
Community, social services	934	13.1	18,248	8.9
Import duties	900	6.9	12,700	6.2
Less: imputed banking service changes	125	1.0	1,223	0.5
GDP at factor cost	12,728	100.0	203,920	100.0

Source: Economic Review 1992

Table 4-1-9 Employment by Sector

Sector	1980	1989	Real change
Agriculture	681,454	1,555,567	128%
Mining	64,788	106,375	64%
Manufacturing	64,540	125,255	94%
Electricity	9,100	18,177	100%
Construction	36,804	39,716	8%
Wholesale	85,691	162,573	90%
Transport	48,616	70,378	45%
Finance	22,137	37,619	70%
Community & Social	220,472	252,444	15%
Not stated	69,338	145,356	110%
Total	1,302,940	2,513,460	93%

Source: Main Results of the Labor Force Survey 1986-1987

1.1.3 Economic Growth Forecast

In the last decade, mining was hit by falling world prices, agriculture by drought and manufacturing by the consequent foreign exchange shortage and decrease of domestic demand, as explained in the preceding paragraph.

Overall, the average economic growth showed low rate of 0.54% during 1982 - 1992. Particularly, the figures for the last 3 years recorded the negative growth.

Under this situation, the Zambia Government has been taking various means and ways in order to vitalize its economy. The Zambian economy is expected to take a favorable turn by achievement of the Government's programs, such as follows:

- Stabilizing and restructuring the national economy
- Designing to free the Zambian economy from excessive dependence on copper
- Embarking on a Privatization Program

Although the future economic growth rate is not announced by the Zambia Government, the rates up to 2012 are set up for the study with the assumption that stable growth rate of industries will be achieved keeping the foreign investments, and privatization in industries will be promoted in line with the Government's policy.

Table 4-1-10 Economic Growth Rate

Year	Modest Case	Optimism Case
1993	4.0%	5.0%
1995	2.0%	3.1%
2001	3.2%	4.2%
2005	3.3%	4.3%
2010	3.4%	4.7%
2012	3.4%	4.7%
Average	2.7%	3.7%

1.1.4 Gross Regional Domestic Product (GRDP) in 1991

Statistical data taken by Zambia Central Statistical Office (ZCSO) includes the data on the size of the work force in each major sector by province obtained when the 1980-1990 census was made. The GRDP was estimated based on this data and Gross Domestic Product (GDP) by major sector. The figures were then revised using the data compiled by individual provinces, such as production of agriculture products and commercial scales which are obtained by mainly observational trip. The Gross Regional Domestic Product for respective provinces are shown in Table 4-1-11 below.

Table 4-1-11 Gross Regional Domestic Product

Province	GRDP/CAP (ZK)	GRDP/CAP (US$)
Central	23,112	374
Copperbelt	40,988	664
Eastern	17,826	289
Luapula	21,568	349
Lusaka	40,109	650
Northern	18,841	305
North-Western	13,757	223
Southern	17,586	285
Western	13,494	219
Total	26,238	425

1991 Current Price
Exchange Rate: 61.728 Kwacha/US$

Following economic profile of respective provinces are observed during the survey.

a) Eastern Province

The province lies on the eastern part of Zambia and borders with Malawi on the east. It is mainly involved in agriculture production in crops and livestock. The province is a major tourist center which earns some foreign currency from the several game parks such a Mfuwe and Chicheli in the South Luangwa.

b) Luapula Province

The province which is north of Zambia shares a border with Zaire in the north. the presence of a number of lakes and rivers makes fishing major activity. Tea and banana production contribute to the national agriculture production.

c) Central Province

This is the country's major agriculture producer in crops and livestock. It is involved in the mining of copper, lead and zinc despite the decline production in the past years. It is also involved in agriculture-related manufacturing.

d) Western Province

The province which is on the western part of Zambia and bordering with Angola and Namibia is involved in fishing, from the Zambezi river which runs across the province, and cattle rearing.

e) Northern Province

The province lies on the northeast and borders with Tanzania. Fishing, farming and tourism form the bulk of the economic activities of the province, Fishing is on the Chambeshi river across the province and Lake Tanganyika to the north. Recently, a number of game resorts, which attract a several tourists, have been opened on the shores of the Lake Tanganyika. The province is the only coffee producer in the country.

This province supports the major railway route for exports and imports through the Dar-es-salaam port in Tanzania.

f) North Western Province

Farming has been the main economic activity. the province has a fruit processing plant.

g) Southern Province

This province lies on a plateau and has been the main agriculture center for the country but increasingly, this has been eroded by the severe drought and cattle diseases. The province has the only national sugar estate. The number one tourist attraction, the Victoria Falls, is found in this province.

Livingstone, the southern most town of the province, has been used as an inlet for road and railway imports from South Africa and Botswana. This route became less popular at the height of freedom struggle in Southern Africa when Ian Smith unilaterally declared independence to present Zimbabwe. An alternative route was created after the completion of the Tanzania Zambia railways (TAZARA) which runs from Kapiri Mposhi in Central Province through Northern Province to Tanzania.

h) Lusaka Province

This is the smallest province where the capital city, Lusaka, is located. A lot of industries are distributed around Lusaka such as beef production, food processing, textile manufacturing, fertilizer production, limestone mining, industrial manufacturing etc. Lusaka is the center for commercial and administrative activities of the country.

Compared to the Copperbelt, it is the second urbanized province with a population of 1.2 million (1990 census). It serves as a national and international gateway for road, railway and air transportation. The international exchange and earth satellite station are located in Lusaka for international telephone communication.

i) Copperbelt Province

All towns in this province are involved in copper mining. Copper production accounts for about 90 percent of country's foreign currency earnings. Other minerals, such as emeralds and cobalt are also mined in the province. Increasingly, agriculture is contributing to the economic activities of the province more especially in Ndola rural. The Copperbelt is the hub of industrial activities such as manufacturing.

The province is the most urbanized with a population of 1.58 million (1990 census). The majority of the country's population is employed by the mining industry.

1.1.5 Gross Domestic Product (GDP) Growth

As the results of the study stated in Paragraph 1.1.3 Economic Growth Forecast, the average growth ratio of GDP is estimated at 2.7 % per annum as a modest case figure, and 3.7 %, as an optimistic case figure.

The estimated amount of GDP and GDP/capita for each forecasted year and growth ratios applied are shown in Table 4-1-12.

Table 4-1-12 Gross Domestic Product Growth

Year	1992	1997	2002	2007	2012
GDP (MIL. US$)					
(2.7%)	3,031	3,446	3,952	4,639	5,481
(3.7%)	3,031	3,634	4,409	5,458	6,867
GDP/CAP. (US$)					
(2.7%)	364	353	347	351	359
(3.7%)	364	372	387	413	450

(1992 Constant price at factor cost)

1.2 Historical Telephone Demand Growth

The total number of telephone subscribers and waiting applicants in each province in the past years (1985-1992) is listed in Table 4-1-13.

Table 4-1-13 Subscribers and Applicants for 1985-1992

Year	1987	1988	1989	1990	1991	1992
Central	4,201	4,427	4,610	5,650	7,115	7,403
Copperbelt	29,739	31,613	34,924	38,751	48,914	56,335
Eastern	1,999	2,192	3,016	3,286	4,022	4,095
Luapula	1,685	1,771	2,006	2,394	2,739	3,218
Lusaka	26,191	27,390	29,729	31,220	37,949	38,030
Northern	2,850	3,006	3,577	4,025	5,053	5,672
N-Western	1,620	1,690	1,847	1,931	2,144	2,609
Southern	5,902	5,973	6,822	8,549	10,042	11,002
Western	1,388	1,437	1,571	1,762	1,971	2,152
Total	75,575	79,499	88,102	97,568	119,949	130,516
Telephone density/100p	1.06	1.08	1.16	1.24	1.48	1.56

1.3 Process of Demand Forecast

1.3.1 ITU Regression Model

The ITU regression model is widely used for nationwide macroscopic telephone demand forecast. This model represents the correlation between telephone density and economic level of the countries, i.e., the number of main telephone lines + waiting applicants per 100 population and GDP per capita. The data are given in DATA BOOK (Table 4-1).

In this forecast, correlation is examined by means of regression analysis using the 5-year (1985-1989) statistics of 42 countries over the world.

The expression is given below:

$$Dt = a \times (GDP/cap.)^{b}$$

therefore,

$$\ln(Dt) = \ln(a) + b \times \ln(GDP/cap.)$$
$$Y = \ln(Dt),\quad A = \ln(a),\quad Z = \ln(GDP/cap.)$$

then,

$$Y = A + bZ$$

where,

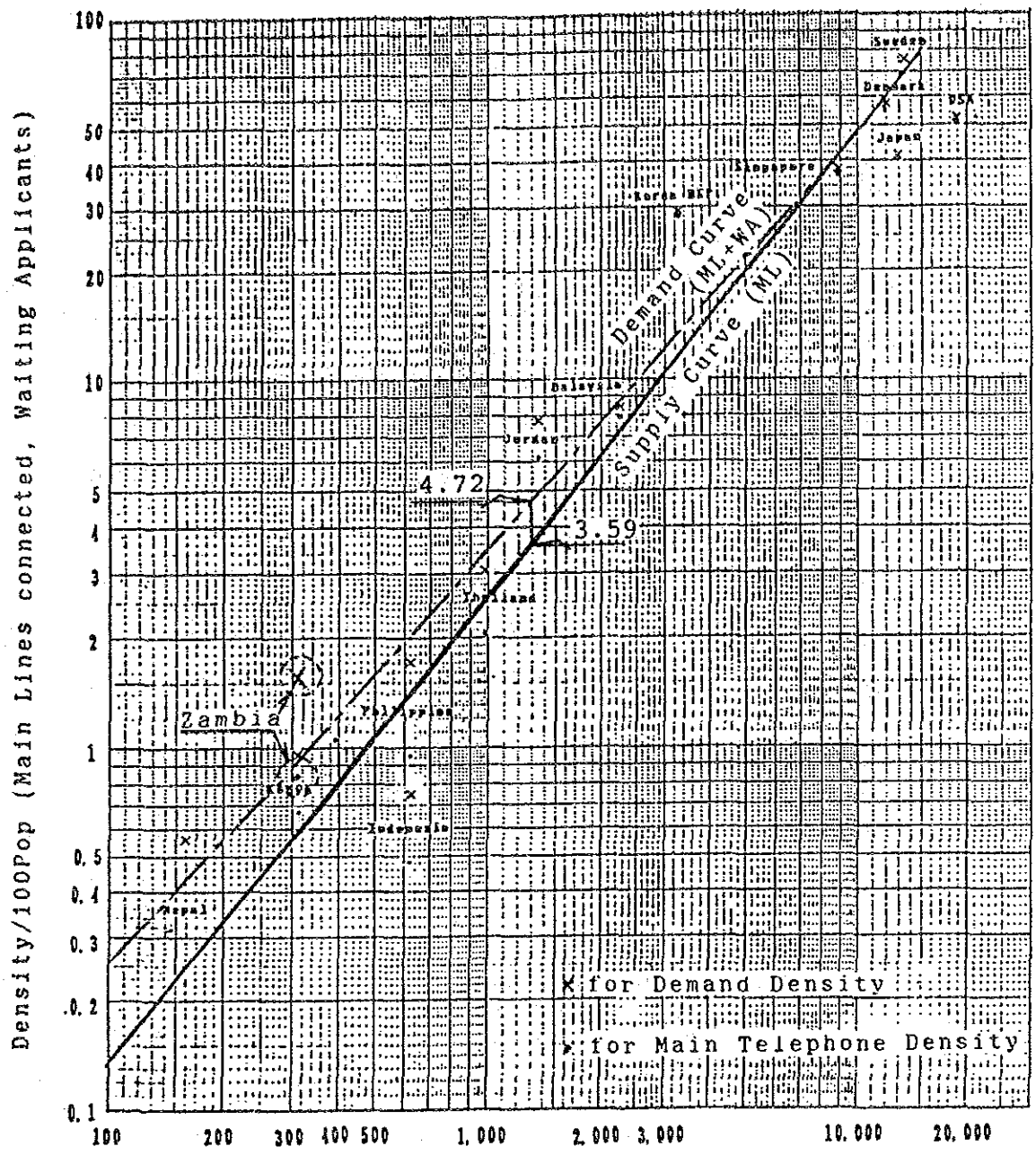
t : year to be forecasted.
Dt : t year's demand density.
GDP/cap. : t year's Real GDP per capita (1985 constant price in US$).
a and b : Constants.

As a result, the constants obtained are: a = (-6.5582)
: b = (1.12992)
with Correlation Coefficient (0.9289)

It is to say that the regression line obtained by the formula above shows the international average of "the demand density" in commensurate with the economic level of the country concerned. This regression formula is applied to the estimation of the future demand, and results using modest case GDP growth ratio (2.7 %) and optimistic case growth ratio (3.7 %) respectively are shown in Table 4-1-14. The regression line obtained is shown in Figure 4-1-1.

Table 4-1-14 Telephone Demand by ITU Model

Year	1992	1997	2002	2007	2012
DEMAND (x1,000)					
(GDP 2.7%)	92.5	104.7	119.9	140.9	167.0
(GDP 3.7%)	92.5	111.2	135.6	169.3	215.4
DEMAND/100P.					
(GDP 2.7%)	1.10	1.07	1.05	1.06	1.09
(GDP 3.7%)	1.10	1.13	1.19	1.28	1.41



GDP / Capita (1985 Constant U.S$)

Note

Demands:No. of Main Telephone and Waiting Applicants

GDP per Capita :International Financial Statistics (1985-1989)

Figure 4-1-1 ITU Regression Line 42 Countries (1985-1989)

1.3.2 Logistic Curve Model

The logistic curve model expression which describes the telephone density in terms of the maximum expected density is given below:

For the maximum density of residential telephones, 20 per 100 population is adopted, assuming that 1 (one) family could have 1 (one) telephone in the ultimate stage.

For the maximum density of business telephones, 10 per 100 economically active population is adopted. The figure of economically active population is obtained from the "LABOR FORCE SURVEY 1986" issued by the Central Statistical Office in 1989, and the definition of this population is as follow:

Economically active population comprises all persons aged 12 years and above who were "employed" during the last week, i.e., the preceding week of the interview for census.

According to the above statistics, economically active population in 1986 reached 1,055,000, out of the total population of 6,873,000, except for subsistence farmers.

The proportion of both populations is applied to estimate the number of economically active population in each forecasted year and the result is shown in DATA BOOK (Table 4-2).

The formula for determining a particular year's demand is given below.

$$Dt = Dmax / (1 + a \times e(-b(T-To)))$$

where,

Dmax	:	the maximum density.
a and b	:	constants to be calculated by past data
To	:	the base year for forecast.
T	:	the year to be forecasted.

if,

$Y = 1/Dt$, $Dmax = 20$, $Z = (T-To)$

$$Y = (1 + a \times e(-b \times Z))/20$$

$$Y-1/20 = (a/20)e(-b \times Z) \qquad Y'' = Y-1/20$$

$$\ln(Y'') = \ln(a/20)-b \times Z$$

$Y''' = \ln(Y'')$, $A = \ln(a/20)$, $B = -b$

$b = -B$, $a = 20 \times e\ (A)$

$$Y''' = A + B \times Z$$

$$Dt = 1/Y = 1/(Y''' + (1/20)) = 1/(e\ Y''' + 1/20)$$

Telephone demand in each province is forecasted by applying the formula mentioned above, and the demand for the whole Zambia is estimated by aggregation of demands in provinces. The result is shown in Table 4-1-15.

Table 4-1-15 Telephone Demand by Logistic Model

Year	1992	1997	2002	2007	2012
(x1,000)					
Central	6.8	9.6	14.5	21.5	31.5
Copperbelt	57.5	67.6	101.0	148.1	213.0
Eastern	3.5	7.7	14.2	26.3	47.9
Luapula	3.2	4.9	8.2	14.4	24.9
Lusaka	38.0	58.8	86.8	123.2	167.8
Northern	5.7	8.2	13.6	22.4	37.2
N-Western	2.6	3.5	5.2	7.7	11.2
Southern	11.0	17.1	29.3	49.7	83.2
Western	2.1	2.5	3.0	3.8	4.6
Total	130.4	179.9	275.8	417.1	621.3
Telephone Density	1.56	1.84	2.42	3.15	4.06

1.3.3 Modified Regression Model

This model takes into account the GDP per capita and population for each forecast year, with the past data of the number of subscribers and waiters as parameters.

The functional formula of this model is shown below:

$$Dt = f(Gt, Pt, St)$$

$$Dt = a((Gt \wedge b) \times Pt\text{-}S(t\text{-}1)) \wedge c$$

where,

Dt : t year's demand
Gt : t year's real GDP/capita
Pt : t year's population
St : t year's sub.+ waiters (in the past years)

a,b and c : constants figures

As a result of regression analysis,

Constants obtained are : a = (8.203E-10)
: b = (0.0747284)
: c = (1.3015838)
with Correlation Coefficient (0.9794815)

therefore,

$$Dt = \log(8.203E\text{-}10) + 0.0747284 \times 0 + 1.3015838 \times 1$$

The result obtained by this formula is shown in Table 4-1-16.

Table 4-1-16 Telephone Demand by Modified Model

Year	1992	1997	2002	2007	2012
(x1,000)					
Central	6.8	8.6	11.6	15.7	21.2
Copperbelt	57.5	60.7	81.0	108.0	143.6
Eastern	3.5	6.9	11.4	19.2	32.2
Luapula	3.2	4.4	6.6	10.5	16.8
Lusaka	38.0	52.8	69.5	89.8	113.1
Northern	5.7	7.3	10.9	16.3	25.1
N-Western	2.6	3.2	4.2	5.6	7.6
Southern	11.0	15.4	23.5	36.3	56.1
Western	2.1	2.2	2.4	2.7	3.1
Total	130.4	161.5	221.1	304.1	418.8
Telephone Density	1.56	1.65	1.94	2.29	2.74

1.3.4 Demand Forecast Result

The telephone demands obtained by the above three models are shown in Table 4-1-17.

Table 4-1-17 Telephone Demands by All Models

Year	1992	1997	2002	2007	2012
DEMAND (x 1,000) ITU MODEL					
(GDP 2.7%)	92.5	104.7	119.9	140.9	167.0
(GDP 3.7%)	92.5	111.2	135.6	169.3	215.4
LOGISTIC MODEL	130.4	179.9	275.8	417.1	621.3
MODIFIED MODEL	130.4	161.5	221.1	304.1	418.8

The growth curves obtained from these three models, and transition of past demands are shown in Figure 4-1-2. The middle curve of the Modified model demand is adopted as a nationwide demand and the other two curves are considered respectively as pessimistic and optimistic cases in this study.

1.3.5 Demand Forecast for Each Exchange

Forecasted demand for each province is projected for each exchange area based on the present situation, i.e., the proportion of the total number of subscribers and waiting applicants in each exchange to the total in province, using the figure of March, 1992.

The estimation result for each exchange is shown in DATA BOOK (Table 4-3).

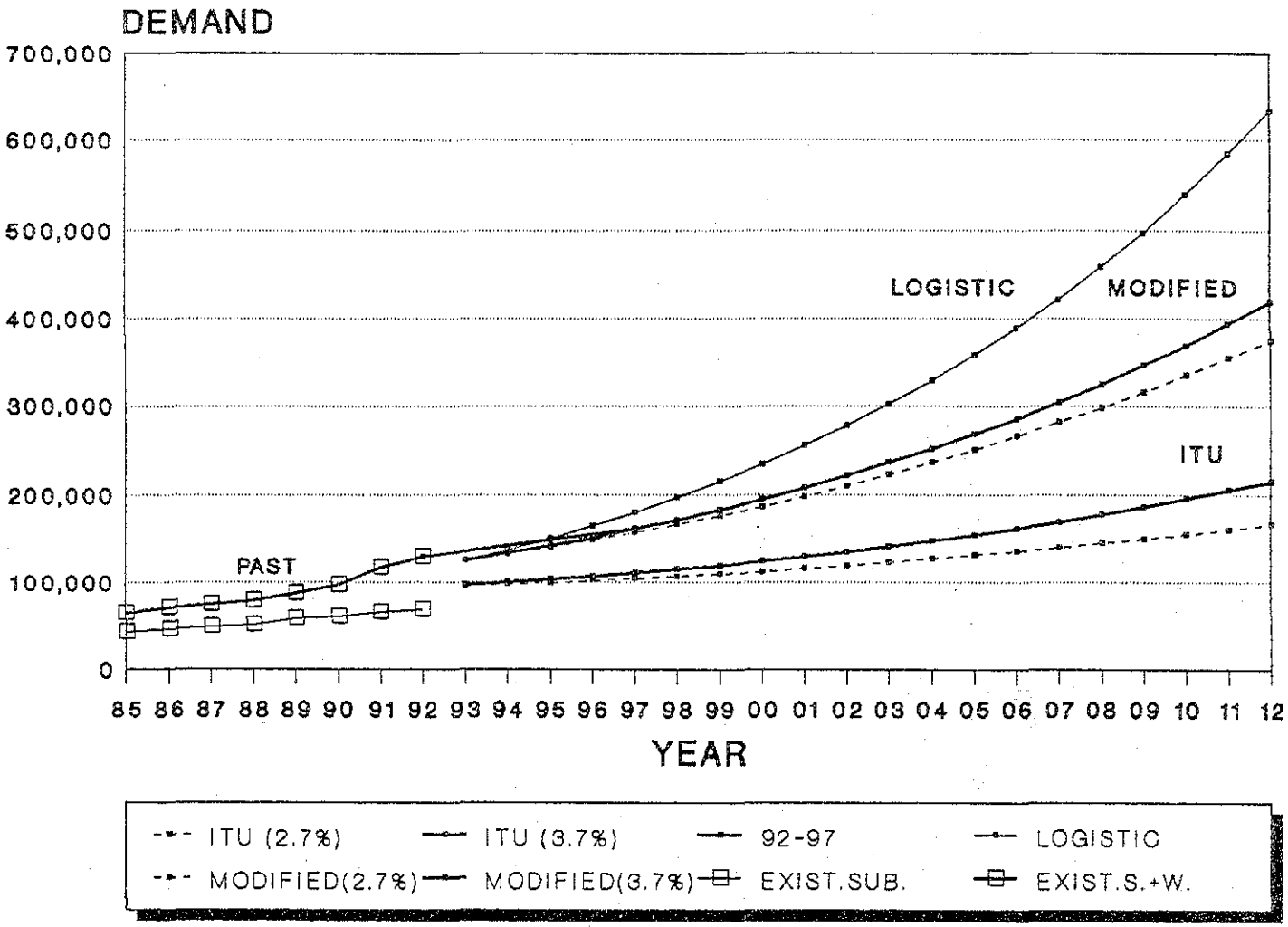


Figure 4-1-2 Total Demand

1.4 Demand Forecast for Rural Area

Exchange basis demand forecasted in Paragraph 1.3.5 is projected for rural and urban areas based on the method stated below:

1.4.1 Method

At present there is no sufficient information/data to indicate the rural area and urban area demands. Therefore, the statistical data on expenditure and income levels of rural and urban inhabitants in each province are taken into account.

According to the national census conducted in 1989 and issued by Central Statistical Office, "the monthly average total expenditures by individual families in rural and urban areas" are shown in Table 4-1-18.

Table 4-1-18 Monthly Average Expenditures by Families in Rural and Urban Areas

Rural	Small scale farmer	K 2,022
	Medium scale farmer	K 5,605
	Large scale farmer	K 10,789
	Non agriculture family	K 2,262
Urban	Low cost area	K 7,440
	Middle cost area	K 10,900
	High cost area	K 13,436

For the study purpose, the number of large scale farmers in rural areas and inhabitants living in middle/high cost urban areas is considered as the number of possible telephone demands.

The number of households having monthly income more than 15,000 K in rural areas and 10,000 K in urban areas and its ratio in percentage against the total number of households in provinces are shown below. The data to be referred to is the same census as mentioned above, "Monthly Household Income by Province and Rural/Urban Areas" is shown in Table 4-1-19.

Table 4-1-19. Monthly Household Income by Province

Province		No. of H/H	Ratio to Total
Central	Rural	6,924	9.19%
	Urban	11,522	23.56%
Copperbelt	Rural	2,192	14.69%
	Urban	28,782	13.89%
Eastern	Rural	6,369	3.78%
	Urban	6,729	20.89%
Luapula	Rural	4,378	3.85%
	Urban	6,693	15.23%
Lusaka	Rural	912	9.62%
	Urban	20,856	36.20%
Northern	Rural	2,292	1.43%
	Urban	7,511	22.74%
N-Western	Rural	839	1.37%
	Urban	4,304	20.83%
Southern	Rural	7,788	7.38%
	Urban	8,450	22.63%
Western	Rural	4,372	3.75%
	Urban	4,354	20.80%

It is assumed in this study that the ratio obtained may not be changed in the future and the ratio is applied to the estimated population of every province and every forecasted year.

1.5 Result of Demand Forecast

The proportion obtained through the above province basis calculation is applied for demand forecast for every exchange.

The result is summarized in Table 4-1-20. The demand forecast for every exchange is given in DATA BOOK (Table 4-4).

Table 4-1-20 Rural and Urban Area Demand

(x 00)	1993		1997		2002	
	Rural	Urban	Rural	Urban	Rural	Urban
Central	32.4	35.5	41.4	44.6	56.3	59.6
Copperbelt	34.3	455.8	42.8	564.3	56.8	752.7
Eastern	25.5	20.9	37.8	30.9	62.8	51.4
Luapula	16.9	13.2	24.5	19.2	37.2	28.9
Lusaka	15.6	405.4	19.0	509.1	24.0	671.3
Northern	24.8	28.6	34.1	39.1	50.8	58.1
N-Western	8.1	16.6	10.3	21.3	13.5	28.2
Southern	61.3	49.1	85.1	68.9	129.3	106.1
Western	10.7	8.6	12.2	9.8	13.4	11.0
Total	229.6	1,033.7	266.0	1,307.2	444.1	1,767.3
T. Density	0.46	2.84	0.47	3.12	0.69	3.55

(x 00)	2007		2012	
	Rural	Urban	Rural	Urban
Central	76.7	80.2	104.0	108.2
Copperbelt	75.9	1,003.8	102.8	1,333.3
Eastern	105.4	86.3	177.5	145.2
Luapula	59.9	44.8	97.3	70.7
Lusaka	29.1	869.0	36.0	1,095.3
Northern	76.6	86.7	117.5	133.1
N-Western	18.1	37.9	24.0	51.5
Southern	198.1	164.5	304.4	256.2
Western	15.0	12.5	16.9	14.5
Total	654.8	2,385.7	980.4	3,208.0
T. Density	0.88	4.07	1.15	4.72

1.5.1 Public Call Office (PCO), Public Phone Demand

As per PTC's guideline for PCO, PCO will be provided to the locations of Hospitals, Clinics, Post offices, Schools and so on where first priority is given in the whole country in consideration of public accessibility and maintainability including protection from any vandalism.

According to the above guideline and current providing condition of PCOs, 1 % of total telephone demand in each area are considered as PCO demand in this Long-Term Plan.

1.5.2 Definition of Rural Area in Study

It is necessary to define the term "rural area" for estimation of the telephone demand in rural areas.

In general, ITU-GAS 3 and GAS 5 are quoted in defining the "rural area" in terms of telecommunication services.

On the other hand, the Zambia Government has a definition of an urban area for their administrative purpose.

And PTC also has a definition of the rural and urban telecommunications services.

(1) ITU's Definition

A rural area generally consists of scattered settlements, villages, and small towns, where the area exhibits one or more of the following characteristics:

a) scarcity or absence of public facilities such as reliable electricity or water supply, roads in poor condition and irregular transport;

b) simplicity of life, where people are primarily concerned with their survival and basic needs, and locally available qualified technical personnel is scarce;

c) severe climatic conditions, particularly in tropical, semi-tropical or desert zones, which make critical demands on the life and maintenance of equipment;

d) sparse and scattered population distribution with relatively poor and/or temporary housing;

e) scarcity or absence of health and education facilities;

f) economic activity limited to basic vocations, such as agriculture, fishing, livestock breeding, mining or cottage industries.

(2) ZAMBIA Government Definition of Urban Area

a) A locality of 5,000 or more inhabitants, at least half of whom are engaged in non-agricultural activities;

b) other settlements with less than 5,000 people but with urban attributes such as piped water supply, electricity, schools, hospitals, etc;

c) administrative centers and other places with sizeable population agglomerations which perform service functions;

d) places of any population size which perform primarily non-agricultural functions (e.g., railway sidings).

(3) PTC's Definition

a) Rural telecommunications service

In Zambia this refers to the service which is provided to the communities outside the Basic Rental Area. They are:

- Villages,
- Rural
- Farmers
- Scattered individuals
- etc.

b) Urban telecommunications services

These include all Zambian towns whose telecommunications services are provided within respective Basic Rental Area.

(4) Definition for This Study

In line with the above three definitions, the following definitions are applied to this Study.

a) Urban area

- An exchange area where administrative offices and proper infrastructures, such as piped water supply, electricity, school, hospital, etc, are provided;
- the area within 8 Km radius from the exchange (Same as BRA) and;
- all multiple exchange areas, such as those located in Lusaka, Kitwe, and Ndola.

b) Rural area

- Any other areas which are not categorized as an urban area stated above.

2. Non-Telephone and New Services Demand Forecasts

The demands for non-telephone and new services, i.e., Telex, Telegram, Mobile telephone service, Radio-paging service, Data communications services and ISDN are forecasted in this study.

The past operating data on the new service are unavailable in a well-organized form in Zambia. The estimation of demand for new services at an initial stage usually needs detailed market surveys including direct interviews for collection of fairly reliable data.

However, to make a forward projection of the amount of demand for the new services in Zambia, the regression model was estimated in this study.

2.1 Telex and Telegram Services

2.1.1 Telex Service

Historical growth of telex services is described in Paragraph 3.2.1 of SECTION 3. The average annual growth rate of telex subscriber lines including the number of teleprinters connected to GENTEX system and waiting applicants is 10% in 1984 through 1991.

During the period, high growth rate of telex subscriber lines was recorded: 17.9% in 1989 and 14.7% in 1990. This extraordinary high growth rate was attributed to the introduction of the second telex exchange in Kitwe in 1989, in addition to the telex exchange in Lusaka.

On the other hand, the telex traffic counted by minute decreased in the past 7 years from 1985 to 1991. The traffic decreased by 13.4% per year as a result of the introduction of the facsimile service in the business field.

Considering the above, the demand is forecasted as shown in Table 4-2-1.

Table 4-2-1 Telex Demand

Year	1992	1997	2002	2007	2012
No. of telex sub. lines	4,366	5,981	6,953	7,468	7,725
Demand growth per year	10.0	4.70	2.21	1.04	0.49

2.1.2 Telegram Service

The telegram service is usually utilized until the diffusion of the telephone service reaches a certain degree. In a number of countries over the world, the telegram service has been absorbed by the introduction of the suitable telephone system.

At present in Zambia, the telegram service is used as a substitute for the telephone service, especially in rural areas. The telephone diffusion rate in the year 2012 will still remain at the low level of 0.15 per 100 inhabitants in rural areas.

The number of messages for domestic use has gradually increased, but the number of international messages decreased in 8 years from 1984 to 1991. The telegram service demand will increase in rural areas. PTC is planning to install teleprinters in telegraph offices where teleprinters are not yet installed.

On the other hand, the telegram demand in urban areas is transferred to other media, such as telephone and facsimile. The shifting portion to other media is assumed to be 10%, 20%, 40%, and 60% in 1997, 2002, 2007 and 2012, respectively. Also, judging from the respective quantities of teleprinters in urban and rural areas, messages among the urban areas are assumed to reach more than 50% of the total messages.

In view of the above, the telegram demand is forecasted as shown in Table 4-2-2.

Table 4-2-2 Telegram Demand

Year	1992	1997	2002	2007	2012
No. of telegram messages (x 1000)	888	1,282	1,846	2,649	3,315
No. of teleprinters of GENTEX system	176	267	406	618	939

Note: Based on the average growth rate of telegram messages, 8.73% per annum from 1988 to 1991.

2.1.3 Facsimile Demand

The total number of facsimile terminals in the world is estimated to be more than 7 millions. The quite large demand for FAX service is attributable to two main reasons. One is the release of the domestic public telephone network for the facsimile service in all the countries during 1970's and 1980's. The other is the international standardization of facsimile terminals by CCITT.

The standard specification of the facsimile recommended by CCITT is shown in Table 4-2-3.

Table 4-2-3 Standard of Facsimile (by CCITT)

Type	Specifications	Network	Recommended
Group I	6 minutes/A4 size, Analog	PSTN	1968
Group II	3 minutes/A4 size, Analog	PSTN	1976
Group III	less than 1 minute/A4 size, Analog	PSTN	1980
Group VI	a few second/A4 size, Digital	Digital	1984

PSTN: Public Switched Telephone Network

The G-II/G-III specification facsimile service is already available in the telephone network in Zambia. The number of terminals is now estimated to be more than 600.

Demand forecast for the facsimile service is made considering the past trend in Japan, because not enough data for forecasting facsimile demand is available in Zambia. The number of facsimile and telephone subscriber lines from 1981 to 1990 in Japan is shown in Figure 4-2-1.

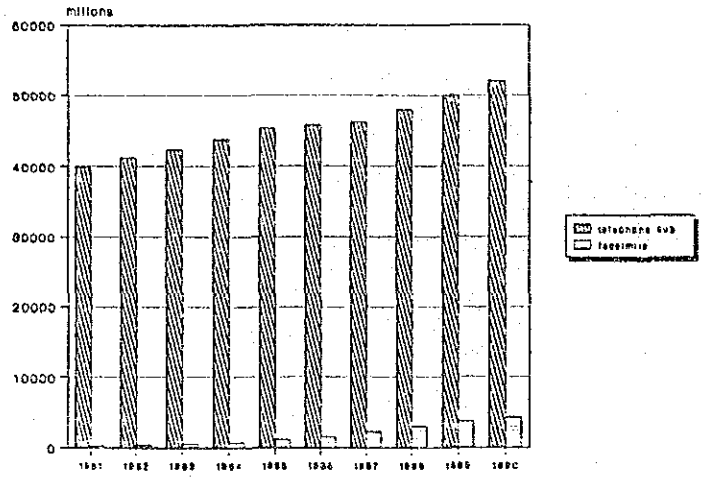


Figure 4-2-1 Facsimiles and Telephone Subscribers in Japan

Although the correlation between the number of facsimile terminals and that of main telephone lines is not clear, the growth ratio of facsimile terminals is higher than that of main telephones. The ratio of facsimile terminals to main telephones stands at as high as 0.08 in Japan.

The demand for facsimile in Zambia is forecasted by applying the ratio in Japan. The demand forecast thus obtained is shown in Table 4-2-4.

The demand in the table includes the demand for tele-facsimile which is provided with both ordinary telephone and facsimile functions.

Table 4-2-4 Facsimile Demand

Item	1992	1997	2002	2007	2012
Facsimile	800	3,448	9,421	19,289	35,018
FAX/TEL	0.012	0.025	0.05	0.075	0.1

2.2 Mobile Telephone and Paging Services

2.2.1 Mobile Telephone Service Demand

Mobile telephone service demand is estimated by the regression model drawn up, based on the relation between the number of main lines and mobile telephone densities in 27 countries. The regression model obtained is as follows:

$$\log(MTt/POPt \times 1000) = -2.657 + 1.837 \times \log(MLt/POPt \times 100) \quad (R = 0.911)$$

where,

log : natural logarithmic operator
MTt : the number of mobile telephones in period t
POPt : population in period t
MLt : the number of main lines in period t

The result of the demand forecast for mobile telephone service up to 2012 is shown in Table 4-2-5.

Table 4-2-5 Mobile Telephone Demand

Year	1992	1997	2002	2007	2012
No. of mobile tel. lines	413	1,292	2,015	3,149	4,921

The data used for the regression analysis for the mobile telephone demand estimate are given in DATA BOOK (Table 4-5).

2.2.3 Radio-Paging Service Demand

The radio-paging service is now being spread in many countries. The demand forecast for radio-paging service is as follows:

$$\log(PGSt/POPt \times 1000) = -1{,}042 + 1{,}509 \times \log(MLt/POPt \times 100) \quad (R = 0.873)$$

where,

log : natural logarithmic operator
PGSt : the number of radio-paging subscribers in period t
POPt : population in period t
MLt : the number of main lines in period t

The result of demand forecast for radio-paging service up to 2012 is shown in Table 4-2-6.

Table 4-2-6 Radio-Paging Demand

Year	1992	1997	2002	2007	2012
No. of paging subs.	2,208	5,799	8,588	12,729	18,847

The data used for the regression analysis for the demand estimate for the radio-paging service are given in DATA BOOK (Table 4-6).

The demand for radio-paging service is strongly linked to the diffusion of PCOs (Public Call Offices). That is, the radio-paging demand growth will be pessimistic up to the time when the PCOs diffusion becomes enough to permit the called person to call back to the caller as an response to calling signals. The radio-paging service will be provided in major cities for business users.

2.3 Data Communication Services

There are a variety of networks over which data communications could be implemented:

- Leased circuits
- PSTN (Public Switched Telephone Network)
- CSPDN (Circuit Switched Public Data Network)
- PSPDN (Packet Switched Public Data Network)
- ISDN (Integrated Services Digital Network)

At present, data communications in Zambia are provided only by leased circuits.

For data communications services, the demand for leased circuits and packet data communication service has been estimated in this study.

2.3.1 Leased Circuits Used for Data Communications

The growth rate of leased circuits during the 6 years period from 1987 to 1992 was 1.6%-5.8% per annum. According to the recent trend, the higher demand growth is not expected in the near future. However, in other countries, data communication needs are steadily expanding, and the demand for data communication between computers as the essential infrastructure in business is also growing in developing countries.

For an estimate of the future demand, the following regression model presents a correlation between main line and leased circuit densities in 21 countries:

$$\log(LCt/POPt \times 1000) = -3.133 + 1.425 \times \log(MLt/POPt \times 100) \quad (R = 0.908)$$

where,

log : natural logarithmic operator
LCt : the number of leased circuits in period t
POPt : population in period t
MLt : the number of main lines in period t

The result of demand forecast for leased circuits service up to 2012 is shown in Table 4-2-7.

Table 4-2-7 Leased Circuits Demand

Year	1992	1997	2002	2007	2012
No. of leased circuits	275	694	1,014	1,481	2,168

Note: Including international subscribers

The data for the demand estimation for the leased circuits service are given in DATA BOOK (Table 4-7).

2.3.2 Packet Data Communication

At present, PTC has not provided the packet switched public data network (PSPDN) services yet. However, in consideration of economic and technological development and demand for easy and efficient data exchange, PTC has already planned to establish a packet data network in the Ten-Year Telecommunications Development Plan (1992-2002).

For an estimate of the future demand for data terminal equipment, the following regression model is developed, based on the relation between main line and data terminal equipment densities in 21 countries:

$$\log(DTt/POPt \times 1000) = -2.224 + 1.042 \times \log(MLt/POPt \times 100) \quad (R = 0.899)$$

where,

log : natural logarithmic operator
DTt : the number of data terminal equipment on public telephone network (PSTN), telex network and dedicated data network in period t
POPt : population in period t
MLt : the number of main lines in period t

The result of demand forecast in the number of data terminal equipment up to 2012 is shown in Table 4-2-8.

Table 4-2-8 Data Terminal Equipment Demand

Year	1992	1997	2002	2007	2012
No. of data terminal equipment	742	1,515	2,084	2,856	3,924

The data used for the regression analysis for demand forecast for data terminal equipment are given in DATA BOOK (Table 4-8).

The potential packet data communication users will be major companies, i.e, banks, airways, electric companies, travel agents and government offices.

2.3.3 ISDN Services

The evolution towards an ISDN is the declared aim of most of the world's telephone administrations. From telecommunication infrastructures which utilize analog technology for switching and transmission, the intention is to progress, via an integrated digital network (IDN), to a first-generation "Narrowband ISDN".

Essentially, the enhanced telephone network, such as ISDN, will support a wide range of both telephone and data communication services and offer standard access through the network terminal equipment and the terminal adapter. The principal services provided by ISDN are divided into the following two categories:

- bearer services that provide complete capability of transmitting any signals between users/network interfaces.

- tele-services that provide complete capability for of communication between users, including terminal equipment functions.

The benefits for users from the service provided by ISDN are as below:

- ISDN enables a user to make an access to both plain old telephone services (POTS) and new services, through a single port.

- Worldwide use of ISDN terminal equipments is possible because of their standardization.

- A user can use a digital transmission path of high-speed (64 Kbit/s for basic access services) and high-quality.

- Adoption of the standard interface will make terminal equipment markets more competitive, leading to low prices of terminal equipments.

At present, several countries in the world have already carried out their respective ISDN field trials, and some of them have launched offering commercial ISDN services mostly to business customers.

The demand for telex, telegram and data communications described in the previous respective paragraphs will become a portion of the demand for ISDN services.

SECTION 5

LONG-TERM DEVELOPMENT PLAN

SECTION 5 LONG-TERM DEVELOPMENT PLAN

1. Development Policy

Following the policy of Zambian Government, new telecommunications operating entity should be managed to develop a sound financial potential taking into account the future privatization and to provide services to meet the telecommunication demands within 20 years.

1.1 First Stage : *CREATION* Decade (1993 - 2002)

The first Stage is characterized as the decade of CREATION.

The Government of Zambia plans to split the PTC into two corporations as Posts and Telecommunications in 1993 and intends to push forward an open-market policy gradually. The Government of Zambia approved the participation of private entities in Telecommunications field as for providing terminal equipment to be installed in the customer's premises. Following this policy, the newly established telecommunication operating entity should be so organized as to cope with commercialization and a partially competitive market.

In this decade,

- to create New Organization as an independent operating entity
- to restructure the telecommunications network to ensure stable operation and easiness of expansion
- to improve billing system and to establish New Tariff Policy for self supporting accounting system.

1.2 Second Stage : *GROWTH* Decade (2003 - 2012)

The second Stage is regarded as the decade of GROWTH.

In this decade, the expansion of network shall be accelerated, requiring more funds allocated and the organization restructured accordingly.

As to the organization, simplification in various intra-corporation procedures and exploitation of more stable finance sources shall be pursued.

In this decade,

- to develop market-oriented organization in competitive environment
- to develop more sophisticated telecommunications networks towards ISDN
- to develop the sound and stable financial bases leading to autonomy.

2. Development Strategy

The strategy to be adopted by the telecommunication operating entity split from the PTC in 1993 is proposed in terms of privatization, provision of telecommunications services, tariffing and investment.

It is proposed that the privatization will be realized within the third decade (2013 to 2022), the basic services such as telephone, telegraph, telex, etc. are to be provided by the entity and other services such as mobile/hand-held telephone is to be provided by the private company or in cooperation of the private company and the entity. The development strategy is shown in Table 5-2-1.

Table 5-2-1 Development Strategy in Telecommunications Sector

	1993 - 2002	2003 - 2012	2013 - 2022
1. Ownership	Government	Government	Open
2. Service provider *Basic Service Non-basic service	 Corp. Open	 Corp. Open	 Open Open
3. De-regulation by Min. of Comm. and Trans.	Non-basic Service Joint Venture	Basic Service	Free Market
4. Tariff control by	Commission	Commission	Competitive (Commission)
5. Investment to Telecom. Rural area Urban area	 Government Corp. (Grant)	 Government Corp. (Loan)	 Government Corp.

* mark: ordinary telephone services.

3. Long-Term Supply Plan

3.1 Basic Concept for Supply Plan

The following are the basic concepts applied in establishing the long-term supply plan.

- To improve the services in both quantity and quality for supporting and enhancing the socio-economic activities in this country, and
- To provide appropriate telecommunications facilities in an economical manner to avoid heavy financial constraints.

3.1.1 Supply Plan for Telephone Service

Two supply plans are prepared for the telephone service: one for the urban area (the area within BRA) and the other for the rural area (the area outside BRA), based on the demand densities and investment costs per subscriber in respective areas. In demand density, the urban area stands higher than the rural area, and in investment cost, the rural area stands higher.

In accordance with the development policy, an attention has been focused on effective investments so as to obtain a telecommunications network having sound financial potential, giving priority to profitable areas, i.e., the urban areas.

The capacity of the respective facilities shall be determined, based on the provision periods, in consideration of not only immediate but also future requirements, with a view to achieving total economy in establishing the network.

3.1.2 Supply Plan for Urban Area

The supply volume to satisfy all the demand in the urban area is calculated based on the demand estimates, and shown in Table-5-3-1 as Case 1.

In addition, a further study was made, in consideration of the international average ratio.

The ratio of the telephone demand (subscribers + waiters) to the number of main lines in 42 countries in the world during the 1985-1989 period was 0.76 (main lines/demand) on an average according to the data of "Yearbook of Common Carrier Telecommunication Statistics (19th edition)" issued by International Telecommunication Union (ITU). The Figure 4-1-1 in SECTION 4 shows the relation between the number of main lines and demand, and relative data are shown in DATA BOOK (Table 4-1).

This international average ratio (76%) is considered applicable as the supply volume target for the urban area in each development decade, since GDP/capita in Zambia during the 1993-2012 period is not likely to grow remarkably.

The supply volume estimated, based on this international average ratio (76%) is also shown in Table-5-3-1 as Case 2.

Table 5-3-1 Supply Volume and Telephone Demand (Urban)

Decade	2002	2012
Case 1		
Telephone Demand	176,700	320,800
Telephone Density	3.55	4.72
Case 2		
Supply Volume	129,900	244,100
Telephone Density	2.61	3.59
Difference	46,800	76,700

3.1.3 Supply Plan for Rural Area

The establishment of rural telecommunications is of vital importance to the rural development in this country.

To achieve the following objectives, adequate and efficient telecommunications facilities must be expanded to all the rural areas.

a) To reduce isolated areas and to enable inhabitants in remote areas to access to essential communication services;

b) To promote activities of commercial and industrial companies in rural areas;

c) To save time and manpower for travelling which would otherwise be necessary;

d) To retain the migrated rural inhabitants; and

e) To provide support services to promote activities in such fields as agriculture, rural development, small scale industries, education and health.

However, a large amount of investments will be required to cater for the demand in the rural area, fully at once, since inhabitants are sparsely distributed in vast areas.

Therefore, it is necessary to give the priority to respective social groups other than the PCO (Public call office) in the area. Social groups given the priority are listed in Table 5-3-2.

Table 5-3-2 Groups Given The Priority in Rural Area

Priority Order	Social Group	
1st	Public group Agric./Business	Rural health centers Schools Government offices Council offices, Farming Small scale industries Shops
2nd	Residential group	Inhabitants residences

At the initial stage, services are provided to applicants given the priority including those who play an important role in the community, and at the next stage for the remaining applicants; therefore, services are to be expanded gradually using allowable budgets without financial constraints.

(1) Estimation of Supply Volume for Rural Area

The following formula is used to estimate the supply volume for each rural area as discussed in the above paragraph,

$$IR = NIRu / ND$$

where,

IR : Ratio of increase in the supply volume
NIRu : Supply volume to be increased in each estimated year in the rural area
ND : Total demand in each estimated year in excess of the number of subscribers as of 1992

And the IR can be expressed also by,

$$IR = IvR / CR$$

where,

IvR : Ratio of investment in the rural area per annum to total investments
CR : Ratio of telephone services cost per one (1) subscriber in the rural area to that in the urban area therefore,

$$NIRu = ND \times IvR / CR$$

From the above formula, the following can be estimated.

a) Number of Total Demand (ND)

Total demand for each forecasted year

Year	1997	2002	2007	2012
('000)	161.5	221.1	304.1	418.8

Increments from present subscribers (69,000) in 1992

Year	1997	2002	2007	2012
('000)	92.5	152.1	235.1	349.9

b) Investment Ratio (IvR)

According to the feasibility study report "The Regional African Satellite Communication System" (RASCOM), Volume IV, issued in 1990, the average investment in the rural area per year in 50 African countries accounts for 11.8% of the total investments for the telecomm sector, while in the investments in Zambia only, 7.26% in 1986.

In this study, it is assumed that 10.0% of the total investments will be allotted to the rural area.

c) Cost Ratio (CR)

To estimate the CR, typical costs have been collected from the data of certain projects, and given in Table 5-3-3. In this case, 2,000 telephone main lines are to be installed in the rural area (outside BRA) and 3,000 in the urban area (inside BRA). And a unit of investment cost is indicated by a monetary unit for comparison purposes.

According to this estimation, the investment cost per subscriber for the rural area is approximately 3 times that of the urban area. Estimated costs by sub-system are also shown in Table 5-3-3.

Table 5-3-3 Cost Comparison between Urban and Rural

SYSTEM	TOTAL	URBAN	RURAL
SWITCHING	1,970	1,180	790
TRANSMISSION			
MARS SYSTEM	2,850	-	2,850
CABLE PCM	1,270	-	1,270
TRUNK SYSTEM	-	-	-
EXTERNAL PLANT	5,120	3,070	2,050
POWER PLANT	2,160	200	1,960
ANTENNA MAST	1,680	150	1,530
SHELTER	1,320	120	1,200
TRANS./INSTALL.	10,560	4,230	6,330
TEST EQ./SPARES	800	480	320
TOTAL	27,730	9,430	18,300
COSTS/SUBSCRIBER	-	3.143	9.160

Approx. Ratio of urban : rural = 1 : 3

(2) Results

The supply volume for the rural area thus estimated is shown in Table 5-3-4.

Table 5-3-4 Supply Volume and Telephone Demand (Rural)

Decade	2002	2012
Telephone Demand	44,400	98,000
Telephone Density	0.69	1.15
Supply Volume	6,400	12,960
Telephone Density	0.09	0.15

3.2 Case Study for Telephone Supply Volume

In order to establish the most recommendable supply target, a comparative study was made between Case 1 and Case 2, from the viewpoints of PTC's repayment possibility, project achievement (financial aspect) and recent economic growth in Zambia.

Table 5-3-5 presents the total demand and total supply volumes in Case 1 and Case 2, together with those for respective areas.

Table 5-3-5 Total Demand and Supply Volume

Decade	2002	D/100	%	2012	D/100	%
Total Demand	221,100	1.94	-	418,800	2.74	-
Urban area	176,700	3.55	-	320,800	4.72	-
Rural area	44,400	0.69	-	98,000	1.15	-
Case 1						
Total Supply	183,100	1.61	83	333,800	2.19	80
Urban area	176,700	3.55	100	320,800	4.72	100
Rural area	6,400	0.10	14	13,000	0.15	13
Case 2						
Total Supply	136,300	1.20	62	257,000	1.68	61
Urban area	129,900	2.61	74	244,100	3.59	76
Rural area	6,400	0.10	14	13,000	0.15	13

Note: D/100 is telephone density per 100 population.
% shows the ratio to total demand.

3.2.1 Conditions for Case Study

For the study purpose, the project implementation schedules under the long-term plan and the unit installation costs for each subsystem such as switching, transmission and external plant, are tentatively established and applied to both cases.

The packages are made by combinations of several projects including comprehensive projects comprising necessary subsystems.

Table 5-3-6 shows the scale of each case established based on the above conditions and Table 5-3-7 (1/2, 2/2) shows tentative implementation schedules with yearly costs.

Table 5-3-6 Scales of Case 1 and Case 2

Items		Case 1	Case 2
1st Decade (1993-2002)			
No. of subs. at 2002		183,100	136,300
Telephone density		1.61	1.20
Increased subs.		112,300	65,400
Investment costs	(M.US$)	321.15	261.32
2nd Decade (2003-2012)			
No. of subs. at 2012		333,800	257,000
Telephone density		2.19	1.68
Increased subs.		150,600	120,700
Investment costs	(M.US$)	388.83	303.88
Total increased subs.		262,900	186,100
Total investment costs	(M.US$)	710.00	565.20
Investment costs/sub.	(US$)	2,700	3,037

Table 5-3-7 (1/2) Project Implementation Schedule Case 1

UNIT : Million US$

FISCAL YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	PACKAGE TOTAL
PACKAGE 1 Urgent Program		2.1	4.9																		7.00
PACKAGE 2 Lusaka Kabwe Kitwe			20.83	24.35	24.39																69.57
PACKAGE 3					12.93	43.07	30.16														86.16
PACKAGE 4							11.91	27.78													39.69
PACKAGE 5								14	32.65												46.65
PACKAGE 6											29.43	68.64									98.07
PACKAGE 7													91.74	74.86							166.60
PACKAGE 8															23.78	55.47					79.26
PACKAGE 9																	13.64	31.81			45.45
PACKAGE 10 Rural (1)			6.18	14.45																	20.63
PACKAGE 11 Rural (2)					5.79	13.54															19.33
PACKAGE 12 Rural (3)													5.21	12.15							17.36
PACKAGE 13 Rural (4)															6.72	15.65					22.37
PACKAGE 14 EPMC (1)				1.11	2.58																3.69
PACKAGE 15 EPMC (2)																	1.13	2.64			3.77
PACKAGE 16 NMS											1.05	2.45									3.50
PACKAGE 17 Vehicle (1)					4.5																4.50
PACKAGE 18 Vehicle (2)										4.5											4.50
PACKAGE 19 Vehicle (3)															6.5						6.50
PACKAGE 20 Vehicle (4)																			6.5		6.50
PACKAGE 21 Computer												0.25									0.25
PACKAGE 22 Main Flame Computer				1.24																	1.24
PACKAGE 23 Earth Station					2.71	6.85	6.33														15.89
PACKAGE 24 POC													9.23								(4.42)
TOTAL COST	0.00	2.1	31.97	41.19	52.9	65.66	48.4	41.78	32.65	4.5	28.48	71.34	36.95	26.21	37.01	71.12	14.77	34.45	6.5	0.00	789.98

YEAR (FISCAL)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	PACKAGE TOTAL
PACKAGE 25 Mobile Phone (1)								2.89	6.54												9.34
PACKAGE 26 Mobile Phone (2)												1.83	5.10	4.26							12.19
PACKAGE 27 Mobile Phone (3)														0.72	2.37	1.66					4.75
PACKAGE 28 Mobile Phone (4)																		4.82	11.24		16.06
PACKAGE 29 Radio Paging (1)								1.38	3.19												4.57
PACKAGE 30 Radio Paging (2)																1.35	3.15				4.50
PACKAGE 31 Packet Network (1)								1.25	2.89												4.14
PACKAGE 32 Packet Network (2)																		0.70	1.63		2.33
TOTAL COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.42	12.62	0.00	0.00	1.83	5.10	4.98	2.37	3.01	3.15	5.52	12.87	0.00	57.88

NOTE : .....Line Indicate Preparation Work for Project

_____Line Indicate Execution of Project

FILE : INF2-A8.WJ2

Table 5-3-7 (2/2) Project Implementation Schedule Case 2

UNIT : Million US$

YEAR (FISCAL)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	PACKAGE TOTAL
PACKAGE 1 Urgent Prograe		2.86	4.94																		7.80
PACKAGE 2 Lusaka-Kapue Kitwe			15.14	17.67	17.67																50.48
PACKAGE 3					9.49	31.65	22.15														63.29
PACKAGE 4							9.75	22.76													32.51
PACKAGE 5								10.82	25.24												36.06
PACKAGE 6											22.01	51.34									73.35
PACKAGE 7													24.72	56.61							80.88
PACKAGE 8															16.82	39.29					56.12
PACKAGE 9																	10.02	23.37			33.40
PACKAGE 10 Rural (1)			6.18	14.45																	20.63
PACKAGE 11 Rural (2)					5.79	13.54															19.33
PACKAGE 12 Rural (3)													5.27	12.10							17.37
PACKAGE 13 Rural (4)															6.69	15.61					22.30
PACKAGE 14 EPMC (1)				1.11	2.58																3.69
PACKAGE 15 EPMC (2)																	1.13	2.64			3.77
PACKAGE 16 NMS											1.05	2.45									3.50
PACKAGE 17 Vehicle (1)					1.58																4.58
PACKAGE 18 Vehicle (2)										4.58											4.58
PACKAGE 19 Vehicle (3)															6.58						6.58
PACKAGE 20 Vehicle (4)																			6.58		6.58
PACKAGE 21 Computer												8.25									8.25
PACKAGE 22 Main Fleet Computer				1.24																	1.24
PACKAGE 23 Earth Station					2.71	9.05	6.33														18.09
PACKAGE 24 PCO																					(3.22)
TOTAL COST	0.00	2.86	26.26	34.47	42.74	54.24	38.23	33.58	25.24	4.58	23.06	61.04	29.48	68.71	30.02	54.90	11.16	26.01	6.58	0.00	565.28

YEAR (FISCAL)	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	PACKAGE TOTAL
PACKAGE 25 Mobile Phone (1)								2.89	6.54												9.34
PACKAGE 26 Mobile Phone (2)												1.83	6.18	4.26							12.19
PACKAGE 27 Mobile Phone (3)														0.72	2.27	1.66					4.75
PACKAGE 28 Mobile Phone (4)																		6.82	11.24		16.06
PACKAGE 29 Radio Paging (1)								1.38	3.19												4.57
PACKAGE 30 Radio Paging (2)																1.35	3.15				4.50
PACKAGE 31 Packet Network (1)								1.25	2.89												4.14
PACKAGE 32 Packet Network (2)																		0.70	1.63		2.33
TOTAL COST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.52	12.62	0.00	0.00	1.83	6.18	4.98	2.27	3.01	3.15	5.52	12.87	0.00	57.88

NOTE : .....Line Indicate Preparation Work for Project

_____Line Indicate Excution of Project

3.3 Financial Projection

3.3.1 Introduction

Case 1 and Case 2 were prepared as Long-Term Plan in line with the two kinds of telephone densities indicated at the beginning of this section. The economic aspects of both plans will be examined so that the Republic of Zambia can select a Long-Term Plan which focuses on feasibility rather than financial aspects.

3.3.2 Comparison Method of Supply Volume

A great demand for telecommunications services exists in Zambia. Furthermore, the returns on investment are high. However, the Post and Telecommunication Corp. (PTC) of Zambia suffers from a chronic shortage of funds for capital investment and finds itself unable to implement supply plans to meet demand.

This means that although telecommunication networks need to be established in order to promote economic growth, there is a shortage of the funds required to construct such a system.

Recently, most funds required for large-scale projects in Zambia have been provided through overseas assistance. Over 90% of such funds come from foreign grants.

The above situation has been taken into consideration in comparing the financial aspects of the proposed Long-Term Plan Case 1 and 2. It has also been assumed that the introduction of facilities will be covered by foreign grants for the first 8 years including rural area projects.

The size of the foreign grants has been set at a maximum of US$200 million for first 8 years, given the financial restrictions. The shortfalls will be made up using Long-Term Loans. For the next 12 years, funds needed for investment will be raised through Long-Term Loans. In evaluating the Long-Term Plans Case 1 and 2, financial situation in the year 2012 for both cases under the cost and revenue conditions set out below.

The financial situations that result from operating the existing network are also forecasted and incorporated into the evaluation. The effects of introducing the Long-Term Plan are examined thereof.

3.3.3 Methodology

(1) Project Life

1993 - 2012 (20 years)

(2) Base Price

Nominal basis with first planning year is applied for this analysis. This means estimated prices and cost in 1993 are used and they are assumed constant during the whole projects. No compensation has been made for future inflation.

(3) Exchange Rate

1 US$ = 360.0 Kwacha

(4) Total Investment Cost

The total investment cost can be summarized as shown in Table 5-3-8 for the case study.

Table 5-3-8 Total Investment Cost

Project year	Case 1		Case 2	
	No. of Main Lines	Investment (M.US$)	No. of Main Lines	Investment (M.US$)
94/95	80,756	2.10	79,756	2.10
95/96	98,874	31.97	87,675	26.22
96/97	116,992	41.19	95,594	34.47
97/98	135,109	52.90	103,513	42.74
98/99	144,707	65.66	110,064	54.24
99/00	154,305	48.40	116,615	38.23
00/01	163,903	41.78	123,166	33.58
01/02	173,501	32.65	129,717	25.24
02/03	183,101	4.50	136,269	4.50
03/04	196,024	30.48	148,341	23.06
04/05	208,947	71.34	160,413	54.04
05/06	221,870	36.95	172,485	29.48
06/07	234,793	86.21	184,557	68.71
07/08	247,714	37.01	196,627	30.02
08/09	264,927	71.12	208,699	54.90
09/10	282,140	14.77	220,771	11.16
10/11	299,353	34.45	232,843	26.01
11/12	316,566	6.50	244,915	6.50
12/13	333,779	0.00	256,985	0.00
Total	333,779	709,980	256,985	565,200

(5) Foreign Grant Aid

The facilities and equipment normally comprising telecommunication networks are supplied by advanced nations. The greater part of the funds required for the project for first 8 years including rural projects is covered by a foreign grant. However, Zambia must also supply a portion of the required funds, namely, the portion paid in local currency, such as personnel expenses and installations for subscriber lines. This portion has been calculated to be about 5% of the total and the decision has been made to fund such costs through equity financing.

(6) Long-Term Loans

Long-term loans are assumed to be provided by international financial organizations or through bilateral assistance.

The conditions for these long-term loans are as follows, using leasing conditions currently applied to PTC.

Interest Rate : 10.0% p.a.

Repayment : 40 times / 20 years
Equal Semi-Annual payment for 20 years including Grace Period of 5 years

(7) Tax

a) Income Tax

Income tax of 40% is imposed on taxable income.

b) Sales Tax

Sales tax of 20% is imposed on gross sales.

(8) Depreciation

In the Long-Term Plan, depreciation is straight line and runs over 20 years.

3.3.4 Sales Projection

(1) Present Tariff System

Present PTC's tariff system for telephone subscribers is summarized in following Table 5-3-9.

Table 5-3-9 Tariff System (1993)

Item	Price (Kwacha)
Call Charge	13.0/unit
Installation	2,500.0/line
Rental	800.0/quarterly

Call charges within the telecommunication exchange area is constant (Local calls), but the charge to other exchange area (STD calls) depends on distance and duration.

Installation fee and rental fee referring to in terms of "Within BRA" and "Outside BRA" and a premium charges shall be borne by a subscriber according to distance from BRA.

(2) Revenue Estimation

Annual revenue of calls is calculated by the following formula:

AR = Annual Revenue

BT = Busy hour originating and terminating traffic

BCR = Busy hour concentration ratio

National : 14.3%
International : 12.5%

MT : Mean holding time of complete calls (180s)

SCR : Successful call ratio

1993 : 30%
2002 : 50%
2012 : 60%

RC : Revenue per completed call

National Calls
Local Calls : ZK 13.0
STD Calls : ZK 78.0

International Calls
Indian Ocean Region : US$ 21.9
Atlantic Ocean Region : US$ 16.5
Terrestrial Route : US$ 8.4

WD : Annual average of working days (300 days)

CR : Collecting ratio (67%)

Total Annual Revenues of call charge, Installation fee and Rental fee for this Long-Term Plan are shown in Table 5-3-10. Revenues shown in the table are those obtained through the operation of the telecommunication network established under the current Long-Term Plan, and do not include the present revenues. The revenues are deemed as the operating income in this Long-Term Plan.

Table 5-3-10 Total Annual Revenues

Project year	Case 1		Case 2	
	Additional Main Lines	Additional Revenues (1,000 US$)	Additional Main Lines	Additional Revenues (1,000 US$)
94/95	0	0	0	0
95/96	0	0	0	0
96/97	43,236	17,360	21,838	10,007
97/98	61,353	26,354	29,757	15,559
98/99	70,951	32,751	36,308	21,447
99/00	80,549	39,216	42,859	27,354
00/01	90,147	46,716	49,410	34,296
01/02	99,745	51,464	55,961	38,485
02/03	109,345	55,307	62,513	41,769
03/04	122,268	59,766	74,585	45,626
04/05	135,191	64,218	86,657	49,459
05/06	148,114	68,685	98,729	53,304
06/07	161,037	73,748	110,801	57,743
07/08	173,958	79,451	122,871	62,821
08/09	191,171	86,029	134,943	68,154
09/10	208,384	91,741	147,015	72,647
10/11	225,597	97,469	159,087	77,151
11/12	242,810	102,854	171,159	81,309
12/13	260,023	108,253	183,229	85,477

3.3.5 Operation and Maintenance Cost

Table 5-3-11 is the summary of the direct operation costs not including interest payment and depreciation. The operation and maintenance (O&M) costs in the representative years are listed in this Table since the O&M costs in every year increase due to the increase of number of terminals.

Table 5-3-11 Additional Operation and Maintenance Cost

Case 1 Unit: 1,000 US$

Items	Project year		
	96/97	02/03	12/13
Staff Costs	1,101	3,796	5,660
Other Costs	6,555	16,577	39,421
Total	7,656	20,373	45,081

Case 2 Unit: 1,000 US$

Items	Project year		
	1994	2002	2012
Staff Costs	625	2,036	1,112
Other Costs	3,311	9,477	11,513
Total	3,936	27,778	32,656

Staff relating costs include Salaries, Staff Housing, general and social welfare charges, sick leaves, etc. General expenses presents the costs for spare parts, Motor Vehicle expenses, Printing & Stationary, Communications, Travelling Expenses and Miscellaneous items, etc.

3.3.6 Financial Situation of Existing Network

As mentioned in Section 2, PTC currently suffers from a shortage in funds accompanied by accumulating debts. As facilities become antiquated, this situation is expected to deteriorate further. Current operation conditions must be evaluated in order to compare Case 1 and Case 2.

This means that the fund position must be forecast given a condition in which the existing network continue to operate. The financial effects on the Long-Term Plans must be incorporated and evaluated.

The current financial situation of PTC has been set as follows:

(1) Accumulated debts as of March 1992 were given as foreign debts. Repayment of these debts have been included in accordance with the repayment conditions of each loan.

(2) Existing facilities become increasingly antiquated every year and impossible to use. Therefore, the supply capacity of existing facilities will decrease each year.

(3) By maintaining the exchange rate of January 1, 1993 (1US$ = 360 Zambian Kwacha), no exchange loss will occur from after 1993.

Table 5-3-12 shows the projected financial situation of PTC today based on the above.

3.3.7 Examination and Comparison of Finance

Cash flows resulting from Long-Term Plans obtained through the above processes and current operational conditions have been incorporated. Table 5-3-13 (1/4), (2/4), (3/4) and (4/4) indicates each case.

(1) Long-Term Plan Case 1

The Plan will meet 100% and 3% of the expected growth in demand in urban and rural areas respectively by the year 2012.

A foreign grant of US$200 million is expected in the first 8 years. The remaining portion where a foreign grant is subtracted from the total funds required will be covered by long-term loans with an interest rate of 10.0% p.a. and a repayment period of 20 years including grace period 5 years currently set by the Zambian Government.

The financial balance in this case will still suffer even with the introduction of a foreign grant of US$200 million. In the second half of the 12 year period, PTC will experience an annual shortfall in funds.

When PTC's current financial situation is taken into consideration, PTC manages to operate during the period when funds required for investment are covered by foreign grants. However, when the amount of long-term borrowing increases and repayment starts from after 2006, PTC will experience an annual financial shortfall.

The loss over the period of the Long-Term Plan will reach US$14 million. Namely, implementing this Long-Term Plan will not improve PTC's operating conditions. Rather, the situation will deteriorate.

(2) Long-Term Plan Case 2

This plan will meet 76% and 3% of expected growth in demand by the year 2012 in urban and rural areas respectively.

Case 2 is evaluated using the same financial conditions set out in Case 1.

Case 2 and the profit and loss forecast of the facilities already operating show that a grant of US$200 million to be extended from 1994 to 2000 would turn PTC's total result of annual operations into positive figures starting 1996. However, from the year

2000 PTC invests the total amount of US$327 million financed by the proceeds of equity infusion and long-term borrowing. This would increase PTC's depreciation costs, thus the results of operations would be reversed to red figures over the nine years 2004-2012.

Therefore, although the accumulated profit and loss forecast would start to show positive figures from 2001, the organization's operations would start to deteriorate again from about 2004, and for several years from 2008 PTC would show a slight accumulated loss. However, the accumulated loss would be offset by profits in 2013, and PTC would start making money from around 2014. The above described PTC's annual profit registration starting 1996 would be attributable to the rapid effect of the investment made under the overseas grant. The cause of the temporary negative operations starting 2004 would be the increased depreciation costs in advance of the realization of the corresponding revenues under the large scale investment which comprises equity and long-term loans at the percentage ratio of 30-70%.

Looking at the annual cash flow, PTC registers cash surplus from 1997 and onward. As the accumulated cash flow shows surplus from 2008, the PTC's operations would be stabilized starting that year, notwithstanding the slight accumulated loss for the several years.

(3) Conclusion

In Case 1, the amount of investment required for 1 line unit is lower, owing to economic of scale. However, the amount of investment required to achieve 100% density is extremely large. The forecast financial conditions consequently highlight difficulties in operations along with a continued shortage in funds for the whole project period. This means that although demand is totally met and the number of subscribers is large, PTC will find itself in a difficult financial situation with the principal factor being the burden of repaying the large amounts of long-term loans introduced. It is therefore difficult to justify this investment.

The aim of the Long-Term Plan is to improve Zambian PTC's operating conditions while expanding the telephone services. Case 2 should be selected based on the understanding that by implementing the Long-Term Plan, the privatization of PTC can become and acceptable proposition.

Implementing Case 2 will improve PTC's operating conditions, and enable repayment of presently accumulating debts to be completed. Case 2 also demonstrates a sound financial condition, with a surplus of cash.

Table 5-3-12 Projected Financial Situation of Existing Network

Unit: 1,000 US$

Year	Number of Mainlines	Expected Revenue	Interest for LT Loan	Amortised Ex-Loss	Profit After Tax	Repayment	Cash Flow
1(93/94)	73,756	44,435	5,748	18,765	-8,592	8,539	-16,375
2(94/95)	73,756	44,435	4,897	18,765	-7,741	8,924	-15,909
3(95/96)	73,756	44,435	3,849	13,781	-1,710	6,381	-7,335
4(96/97)	68,494	41,265	3,328	8,797	1,827	3,821	-1,677
5(97/98)	63,231	38,094	2,971	8,797	1,339	3,821	-2,184
6(98/99)	58,843	35,451	2,583	8,797	987	3,821	-2,553
7(99/00)	54,455	32,807	2,194	8,681	704	3,821	-2,852
8(00/01)	48,361	29,136	1,817	8,091	470	3,513	-2,800
9(01/02)	46,848	28,224	1,460	8,091	483	3,513	-2,793
10(02/03)	46,848	28,224	1,102	8,091	697	3,513	-2,579
11(03/04)	46,848	28,224	745	8,091	912	3,513	-2,364
12(04/05)	46,848	28,224	443	2,552	4,416	1,317	3,336
13(05/06)	46,848	28,224	307	2,552	4,498	1,317	3,418
14(06/07)	45,882	27,642	170	2,552	4,451	1,317	3,367
15(07/08)	43,875	26,433	34	2,552	4,265	1,317	3,174
16(08/09)	41,868	25,224	0	431	5,290	171	5,339
17(09/10)	41,275	24,867	0	215	5,340	85	5,472
18(10/11)	40,682	24,509	0	0	5,391	0	5,605
19(11/12)	40,682	24,509	0	0	5,391	0	5,605
20(12/13)	40,682	24,509	0	0	5,391	0	5,605

Table 5-3-13 (1/4) Cash Flow Statement (Case 1)

Unit: 1,000 US$

Year	Number of Additional Main Lines (Case 1)	Sales Revenue	Investment Schedule (Case 1)				O/M Interest Depre. Tax	Profit After Tax
			Equity	Loan	Grant (Urban)	Grant (Rural)		
1(93/94)	0	0	0	0	0	0	0	0
2(94/95)	0	0	105	0	1,995	0	5	-110
3(95/96)	0	0	1,599	0	24,192	6,180	85	-1,684
4(96/97)	43,236	17,360	2,060	0	24,681	14,450	13,733	1,567
5(97/98)	61,353	26,354	2,645	0	44,465	5,790	20,377	3,331
6(98/99)	70,951	32,751	3,283	0	48,837	13,540	24,928	4,540
7(99/00)	80,549	39,216	8,107	24,200	16,093	0	30,394	715
8(00/01)	90,147	46,716	12,534	29,246	0	0	38,147	-3,965
9(01/02)	99,745	51,464	9,795	22,855	0	0	44,511	-2,841
10(02/03)	109,345	55,307	1,350	3,150	0	0	49,189	4,768
11(03/04)	122,268	59,766	9,144	21,336	0	0	53,891	-3,269
12(04/05)	135,191	64,218	21,402	49,938	0	0	60,908	-18,092
13(05/06)	148,114	68,685	9,522	22,218	0	5,210	68,408	-9,245
14(06/07)	161,037	73,748	22,218	51,842	0	12,150	77,072	-25,542
15(07/08)	173,958	79,451	9,087	21,203	0	6,720	86,701	-16,337
16(08/09)	191,171	86,029	16,644	38,836	0	15,640	95,314	-25,929
17(09/10)	208,384	91,741	4,431	10,339	0	0	103,402	-16,092
18(10/11)	225,597	97,469	10,335	24,115	0	0	109,416	-22,282
19(11/12)	242,810	102,854	1,950	4,550	0	0	115,197	-14,293
20(12/13)	260,023	108,253	0	0	0	0	118,483	-10,230
Total	260,023	1,101,382	146,211	323,828	160,263	79,680	1,110,161	-154,990

Table 5-3-13 (2/4) Cash Flow Statement (Case 1)

Year	Accumulate Profit & Loss Case 1 + Exist	Cash Flow		Accumulated Cash Flow	
		Case 1	Case 1 + Exist	Case 1	Case 1 + Exist
1(93/94)	-8,592	0	-16,375	0	-16,375
2(94/95)	-16,444	-105	-16,014	-105	-32,389
3(95/96)	-19,838	-1,599	-8,933	-1,704	-41,322
4(96/97)	-16,444	1,755	78	52	-41,244
5(97/98)	-11,773	3,652	1,468	3,703	-39,776
6(98/99)	-6,246	5,025	2,472	8,728	-37,304
7(99/00)	-4,827	2,815	-37	11,543	-37,341
8(00/01)	-8,322	224	-2,576	11,767	-39,917
9(01/02)	-10,681	2,980	187	14,747	-39,731
10(02/03)	-5,216	10,814	8,235	25,561	-31,495
11(03/04)	-7,574	4,301	1,937	29,862	-29,558
12(04/05)	-21,249	-6,954	-3,618	22,908	-33,176
13(05/06)	-25,996	2,874	6,292	25,782	-26,884
14(06/07)	-47,087	-11,056	-7,689	14,729	-34,573
15(07/08)	-59,159	-1,639	1,535	13,087	-33,038
16(08/09)	-79,798	-9,107	-3,768	3,980	-36,807
17(09/10)	-90,549	857	6,328	4,837	-30,478
18(10/11)	-107,440	-5,393	212	-556	-30,266
19(11/12)	-116,343	1,117	6,722	561	-23,544
20(12/13)	-121,182	3,329	8,934	3,890	-14,610

Table 5-3-13 (3/4) Cash Flow Statement (Case 2)

Unit: 1,000 US$

Year	Number of Additional Main Lines (Case 2)	Sales Revenue	Investment Schedule (Case 2)				O/M Interest Depre. Tax	Profit After Tax
			Equity	Loan	Grant (Urban)	Grant (Rural)		
1(93/94)	0	0	0	0	0	0	0	0
2(94/95)	0	0	105	0	1,995	0	5	-110
3(95/96)	0	0	1,311	0	18,729	6,180	71	-1,382
4(96/97)	21,838	10,007	1,724	0	18,297	14,450	7,659	624
5(97/98)	29,757	15,559	2,137	0	34,813	5,790	11,462	1,959
6(98/99)	36,308	21,447	2,712	0	37,988	13,540	15,337	3,398
7(99/00)	42,859	27,354	1,912	0	36,319	0	19,200	6,242
8(00/01)	49,410	34,296	8,185	13,432	11,963	0	24,197	1,914
9(01/02)	55,961	38,485	7,572	17,668	0	0	28,681	2,233
10(02/03)	62,513	41,769	1,350	3,150	0	0	32,331	8,088
11(03/04)	74,585	45,626	6,918	16,142	0	0	36,468	2,241
12(04/05)	86,657	49,459	16,212	37,828	0	0	42,304	-9,057
13(05/06)	98,729	53,304	7,281	16,989	0	5,210	48,558	-2,535
14(06/07)	110,801	57,743	16,983	39,627	0	12,100	54,816	-14,056
15(07/08)	122,871	62,821	6,999	16,331	0	6,690	61,720	-5,898
16(08/09)	134,943	68,154	11,787	27,503	0	15,610	67,821	-11,454
17(09/10)	147,015	72,647	3,348	7,812	0	0	73,699	-4,400
18(10/11)	159,087	77,151	7,803	18,207	0	0	78,422	-9,074
19(11/12)	171,159	81,309	1,950	4,550	0	0	83,035	-3,676
20(12/13)	183,229	85,477	0	0	0	0	85,795	-318
Total	183,229	842,608	106,289	219,239	160,104	79,570	771,581	-35,261

Table 5-3-13 (4/4) Cash Flow Statement (Case 2)

Year	Accumulate Profit & Loss Case 2 + Exist	Cash Flow		Accumulated Cash Flow	
		Case 2	Case 2 + Exist	Case 2	Case 2 + Exist
1(93/94)	-8,592	0	-16,375	0	-16,375
2(94/95)	-16,444	-105	-16,014	-105	-32,389
3(95/96)	-19,536	-1,311	-8,646	-1,416	-41,034
4(96/97)	-17,084	781	-896	-635	-41,930
5(97/98)	-13,786	2,223	39	1,589	-41,891
6(98/99)	-9,401	3,798	1,245	5,386	-40,646
7(99/00)	-2,455	6,737	3,885	12,123	-36,761
8(00/01)	-70	3,490	690	15,614	-36,071
9(01/02)	2,645	5,070	2,277	20,684	-33,794
10(02/03)	11,430	11,151	8,572	31,835	-25,221
11(03/04)	14,582	6,456	4,092	38,291	-21,129
12(04/05)	9,942	-2,139	1,197	36,152	-19,932
13(05/06)	11,905	5,596	9,014	41,748	-10,918
14(06/07)	2,300	-3,766	-398	37,983	-11,317
15(07/08)	667	4,676	7,849	42,658	-3,467
16(08/09)	-5,496	926	6,265	43,585	2,798
17(09/10)	-4,556	7,731	13,203	51,316	16,000
18(10/11)	-8,240	2,466	8,071	53,782	24,072
19(11/12)	-6,525	7,340	12,945	61,122	37,016
20(12/13)	-1,453	8,716	14,321	69,838	51,338

3.4 Non-Telephone and New Services

3.4.1 Target Supply Volume to be Proposed

Basically, the non-telephone and new services will be provided to meet the demand mentioned in SECTION 4.
The supply volume of these services are shown in Table 5-3-14.

Table 5-3-14 Supply Volume of Non-Telephone and New Services

(No. of Sub.)

Service category	1997	2002	2007	2012
Telex (*1)	5,981	6,953	7,468	7,725
Packet data comm.	1,515	2,084	2,856	3,924
Mobile telephone	1,292	2,015	3,149	4,921
Radio-paging	5,799	8,588	12,729	18,847

*1: The number of telex terminals includes the number of GENTEX terminals.

3.4.2 Supply Plan for Telex Services

The expansion of the telex exchange capacity and trunk lines should be made according to the demand growth mentioned in SECTION 4.

At present, Lusaka exchange commissioned in 1976 has exceeded its mechanical life and PTC has planned to replace this exchange with new one under the Ten-Year Telecommunications Development Plan (1992-2002).

In view of the expected moderate demand growth, however, it is considered economically advantageous to expand the capacity of Kitwe Exchange, instead of replacing the overage equipment in Lusaka, and to transfer the subscribers of Lusaka Exchange to Kitwe Exchange gradually. That is, the capacity of Kitwe Exchange should be expanded, keeping pace with the demand growth during the next twenty years.

The old type teleprinter should be replaced with the multi-function telex workstation equipped with telex and word processor functions.

3.4.3 Supply Plan for Telegram Services

It is estimated that the telephone density will be still low in rural areas during the next twenty years, and the telegram services will remain to be an important communication method in these areas.

Quick delivery areas will be expanded so as to make possible the telegram delivery within 1-2 days throughout the country by the year 2012. Considering this and the expected growth of both population and demand for telegram during the next twenty years as well, it is recommended that the number of telegram offices should be increased up to 160, which is equal to the number of post offices in Zambia as of 1992. The installation of teleprinters should be promoted for existing telegraph offices where obsolete Morse code is still in use. Finally, 763 teleprinters of GENTEX system in addition to the existing 176 teleprinters should be provided in both existing and new telegraph offices in line with the demand growth in each service area by 2012.

3.4.4 Supply Plan for Mobile Telephone and Radio-paging

Up to the present, conventional telecommunications services have been developed by using fixed terminals. Consequently, enhancement of accessibility to the telecommunications terminals is a major objective of telecommunications network development.

In developing countries, Mobile communications service is a remedy to accelerate telecommunications network development which is often delayed due to the difficulty of subscriber network improvement. Radio-Paging is a convenience method to alert an individual in a remote or unknown location to the fact that someone wishes to talk with them by phone. In consequence, the demands for the mobile communication service and Radio-paging service are rapidly increasing in the world.

In Zambia, Mobile telephone service and Radio-paging service will be provided in major cities during the next twenty years. It is recommended that Cellular radio networks should be established because cellular radio networks permit efficient use of the radio spectrum through "re-using" base stations or "cell" to satisfy the future demand.

3.4.5 Supply Plan for Data Communications

(1) Leased Circuit

For the development of data communications, existing networks, such as a public telephone network for leased circuits, should continue to be improved and enhanced until the establishment of the common network for ISDN with the sophisticated network management system. The high bearer services should be provided for business users planning their own private networks.

(2) Packet Data Network

New digital telephone exchanges which are now being introduced into the Zambia telecommunications are so designed that it will be able to have the packet switching function, when equipped with a module. For economical establishment of the packet network, it is not recommended to install exclusive packet exchanges (node) in Zambia. The above option package should be installed in the existing digital exchanges of major cities.

(3) ISDN

The development of ISDN services depends entirely on the strategic marketing and the technological development for the introduction of IDN (Integrated Digital Network)/ISDN (Integrated Services Digital Network).

The services to be provided by IDN/ISDN will bring evolution in the future not only in business activities but also in social activities, for both users and service providers.

As mentioned in SECTION 4, all the existing telecommunications services, i.e., telephone service, non-telephone services including packet data and leased circuits services, will be integrated into ISDN services.

Through IDN and Narrow-band ISDN, a part of bearer services (64 Kbit/s, Speech, 3.1 KHz audio), tele-services (group 4 telefax, teletex) and supplementary services (Message recording, Message handling, etc. service) are introduced in the limited areas by the end of 2012. The services to be provided by ISDN will penetrate from Lusaka and major large cities to small cities after the year 2012.

4. Development Target

Development Targets are summarized in Table 5-4-1 below.

Table 5-4-1 Development Targets

Category	1992	2002	2012
Servicse			
1. Telephone			
Subscribers	70,750	136,300	257,000
Urban	69,450	129,900	244,000
Rural	1,300	6,400	13,000
Telephone Density	0.88	1.20	1.68
Urban	1.95	2.61	3.59
Rural	0.03	0.10	0.15
2. Major objective area		Urban	Rural
3. Quality (Successful Call Ratio)	30%	50%	60%
Facilities			
1. Automatization	99.9%	100%	100%
2. Digitalization			
Switch	44%	90%	100%
Transmission	5%	60%	100%
3. ISDN	-		Lusaka
4. Introduction of New Technology	IDR	Mobile Tel. Digital Sat.	SDH
Human Resources			
1. Staff/1000 DEL	47.3	32.0	22.0
2. No. of staff	3,345	4,361	5,654
3. University/Diploma/ Secondary School	51/1292/978	122/1919/1308	283/2612/1696
Dist. ratio (%)	1.6/38.6/29.2	2.8/44/30	5.0/46.2/30
4. Organization		New Telecom	

Note: IDR : Intermediate Data Rate
SDH : Synchronous Digital Hierarchy

4.1 Service

4.1.1 In CREATION decade, to carry out prompt rehabilitation and expand telephone networks.

Telephone density reaches 1.20 per 100 inhabitants:
Urban area 2.61 per 100 inhabitants.
Rural area 0.10 per 100 inhabitants.

4.1.2 In GROWTH decade, to develop telephone networks.

Telephone density reaches 1.68 per 100 inhabitants.
Urban area 3.59 per 100 inhabitants.
Rural area 0.15 per 100 inhabitants.

4.2 Operation and Maintenance

Recommended targets for telecommunication systems are given in Table 5-4-2.

4.2.1 External Plant

The target figure on faults/line/year is upgraded from 1.5 to 0.5 for the first decade and 0.2 for the second decade, and the target figure, 95% on maintenance efficiency is retained in CREATION decade, but is upgraded to 99% in GROWTH decade.

4.2.2 Microwave Link

Target figure, 99.99% availability, is retained for both decades. However, new additional target figures on system reliability, i.e., percent of time the bit error rate exceeds a specified value for digital system.

4.2.3 Earth Station

Target figure, 99.99% on availability is retained for both decades.

4.2.4 Carrier System

Target figures on maintenance efficiency are to be newly established, i.e., 99.0% for CREATION decade and 99.99% for GROWTH decade.

4.2.5 Telex Exchange

Target figures on availability are to be newly established,i.e., 99.9% for CREATION decade and 99.99% for GROWTH decade.

Table 5-4-2 Targets for Operation and Maintenance

Category	Item	CREATION Decade	GROWTH Decade
External Plant	Faults/line/year	0.5	0.2
	Maintenance Efficiency	95.00%	99.00%
Microwave Link (analog)	Availability	99.99%	99.99%
Microwave Link (digital)	Availability	99.99%	99.99%
Earth Station	Availability	99.99%	99.99%
Carrier System	Maintenance Efficiency	99.00%	99.99%
Telex Exchange	Availability	99.9 %	99.99%

SECTION 6

NETWORK EXPANSION PLAN

SECTION 6 NETWORK EXPANSION PLAN

1. Fundamental Technical Plan

1.1 Network Hierarchy and Routing Plan

1.1.1 Trunk Network

As the number of primary centers (PC) is relatively small in the telecommunication network in Zambia and digitalization of primary centers is expected to be 90 percent completed within 10 years, a simple network hierarchy is recommended. The basic principle of networking is to interconnect primary centers by a mesh network. Secondary center (SC) is recommended to be installed for the following purposes.

a) To provide an interconnection link between two primary centers which are not provided with a direct interconnection link for economy because there is very small traffic between them.

b) To provide an alternative route to carry the overflow traffic from the high usage route between primary centers, which enhances the network availability.

c) To provide a dual homing arrangement to access to two secondary centers from a primary center, which enhances the network reliability.

d) To provide access links to the international gateway exchanges.

Two secondary centers are recommended to be located in Lusaka and Kitwe respectively with the following grouping:

Lusaka SC :	Lusaka PC, Kabwe PC, Choma PC, Chipata PC, Mongu PC, Living Stone PC
Kitwe SC :	Kitwe PC, Ndola PC, Mansa PC, Kasama PC, Solwezi PC

Figure 6-1-1 shows the recommended network hierarchy.

1.1.2 Multi-Exchange Area Network

For multi-exchange areas like Lusaka, the high usage routing is also recommended with alternative routing via a local tandem exchange. Figure 6-1-2 shows the recommended multi-exchange area network in Lusaka.

The principle of this routing is to provide a direct interconnection between two local exchanges as a high usage route and overflow traffic from the high usage route is carried through a local tandem exchange. The local tandem function can be combined with a toll transit exchange.

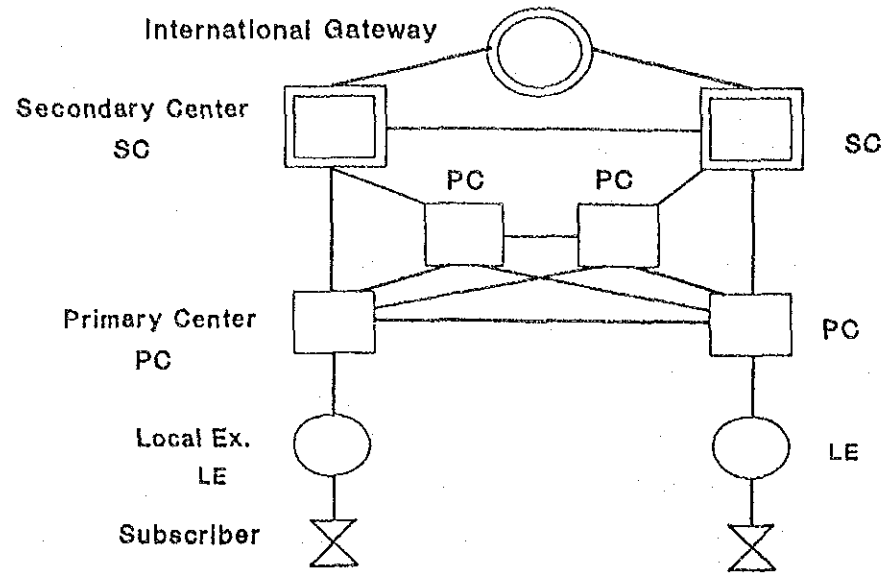


Figure 6-1-1 Network Hierarchy

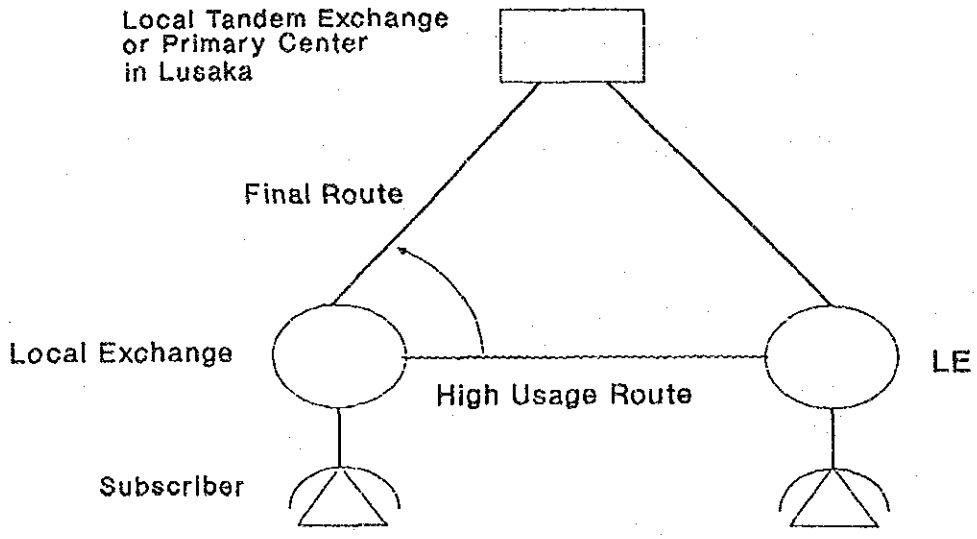


Figure 6-1-2 Multi-Exchange Area Network

1.2 Numbering Plan

Because of the difficulty and inconvenience for both PTC and subscribers in changing numbering plan, the national numbering plan should be determined to cover a long-term period. The recommended period is fifty years. The existing numbering scheme is "0" for trunk access prefix and one digit for area code followed by six digits for a subscriber number.

0 + A + B C + X1 X2 X3 X4

Theoretically, this national numbering scheme can provide a maximum of eight hundreds thousands subscriber numbers, which is forecasted enough for the whole subscriber numbers during fifty years. In case some area's subscriber number exceeds the numbering capacity in far future, one digit could be added to the existing six digits to conform with the CCITT's Recommendation E163.

00 + 260 + A + BCD + X1 X2 X3 X4

When ISDN (Integrated Services Digital Network) is introduced into the national network, the numbering plan should conform with the CCITT's Recommendation E164. The Recommendation E164 requires the following four key differences which will affect the design of new exchanges:

a) Extended international numbers (up to 15 digits following the international prefix)

b) Concept of "direct dialling in (DDI)"

c) Concept of "sub-addressing" (so-called "network address extension")

d) Concept of two-stage call set-up for the support of interworking

1.3 Signalling Plan

The key issue of the signalling plan is to introduce the CCITT Common Channel Signalling System No.7 (CCS No.7) into Zambian national telecommunication network, as well as the international gateway exchanges. Figure 6-1-3 illustrates the basic network structure of CCS No.7.

The application of CCS No.7 on Zambian national network is summarized as below.

a) ISDN call connection
b) Data transfer
c) Mobile services
d) Network administration, operation and management

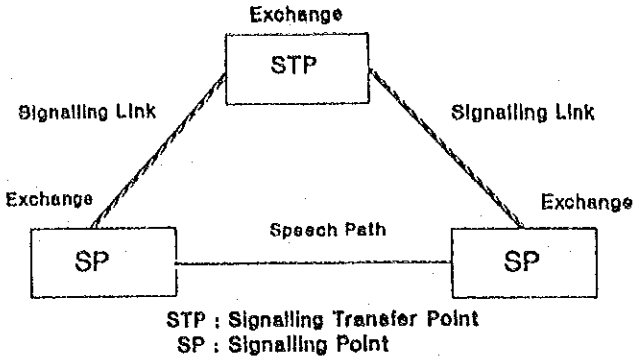


Figure 6-1-3 Structure of CCS No.7

1.4 Network Synchronization Plan

The synchronization of digital networks is to minimize the slip rate to achieve the highly reliable data and message transmission between digital exchanges where the reading clock and writing clock are working.

The effect of slip differs depending on telecommunication services as follows;

a) **PCM coded speech** has very low effect because of its high redundancy. Slip merely produces click noise in the decoded analog signal.

b) **PCM coded voiceband data modem** may lose synchronization. High-speed modem using phase-shift modulation causes burst errors due to phase shift.

c) **Telephony using common channel signalling** has no significant influence on the signalling functions in the network.

d) **Data transmission** has a relatively high effect. The data transmission has significantly less tolerance of slip. Using error detection codes the affected data blocks can be recognized as faulty, and requests a complete retransmission of the data blocks. Thus it ultimately results in a delay.

e) **Facsimile** can be affected by a slip. Disturbance is dependent on the coding technique used. A slip can result in a displacement or in streaks in the line being scanned. At worst a slip can ruin the whole picture and make retransmission necessary.

There are several methods of network synchronization with the different characteristics.

a) **Plesiochronous Method**

The plesiochronous method is recommended for the international digital network because of oscillator administration. The oscillator used for the international gateway exchange should be a type of highest precision oscillators like caesium beam tube oscillators.

b) **Master-Slave Method**

The master-slave method is easy to implement and has no network stability problems. The master oscillator frequency stability is usually determined so that a phase-locked oscillator (PLO) at a slave office can pull-in. When the master oscillator is used as an international gateway reference, the required frequency stability should be the same as the reference oscillator in the plesiochronous method.

c) **Mutual Synchronization Method**

This method can be realized generally by using simple and low cost oscillators. A well constructed mutual synchronization network has high stability. On the other hand, this requires complex control and single oscillator failure would affect network stability.

Among these three synchronization methods, the master-slave method is recommended for the national network.

Figure 6-1-4 shows the recommended network synchronization plan. In this network, the master clock with the highest accuracy and stability shall be installed in the Lusaka international gateway exchange to be a master clock in the domestic national network. Other national exchanges receive the clock signal from the master clock and work as a salve exchange.

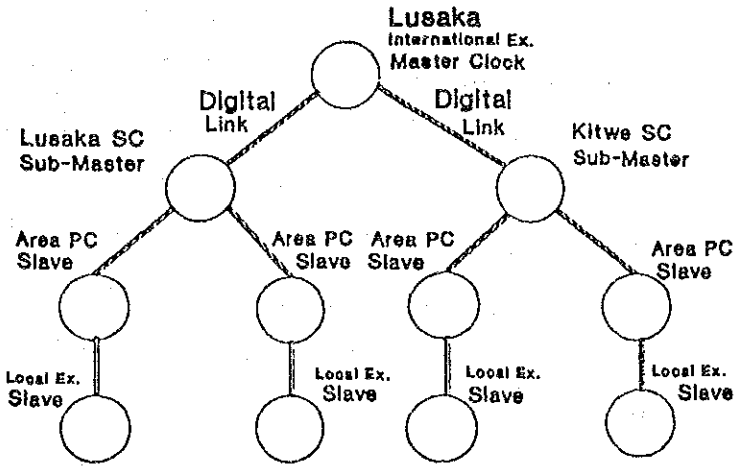


Figure 6-1-4 Network Synchronization

If PTC has a plan to install independent master oscillator separately from the international gateway exchange, the international gateway exchange can work as a slave exchange receiving the master clock signal from the master oscillator. This master oscillator can provide reference clock signal for neighboring countries.

1.5 Transmission Plan

To achieve a high quality of transmission in Zambian telecommunication network, various aspects shall be studied and the standard values are to be set as planning parameters. They are:

a) Transmission Loss
b) Stability
c) Crosstalk
d) Bit Error Rate and Quantizing Distortion
e) Echo and Propagation Delay

Among them, the key issue is to set up the Zambian standard transmission loss allocation. As the target of the long-term planning parameters, the following are to be recommended.

1.5.1 Transmission Loss Allocation

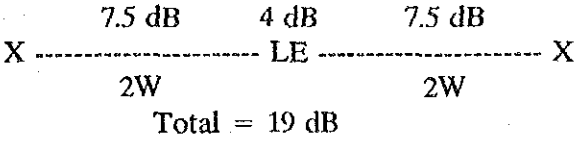
The transmission loss should be allocated for each call connection type based on the standard LR (Loudness Rating) which is recommended by CCITT as 13dB to 23dB for IDN (Integrated Digital Network) where all switching systems and transmission systems are of digital type. The Table 6-1-1 shows the typical standards for connection types which are recommended for the target of final stage of year 2012.

Table 6-1-1 Transmission Loss Allocation

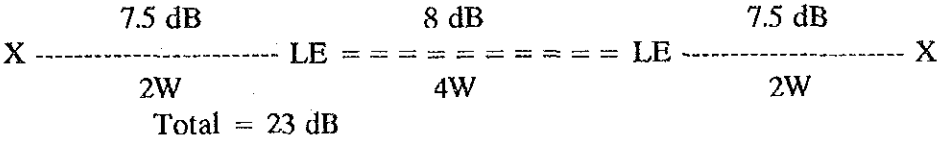
a.	Subscriber Loop	:	Max. 15 (7.5×2)dB
b.	Intra-Office	:	4 dB
c.	Local Connection	:	8 dB
d.	Trunk Connection	:	8 dB

The overall transmission loss allocation for each call connection type is as follows:

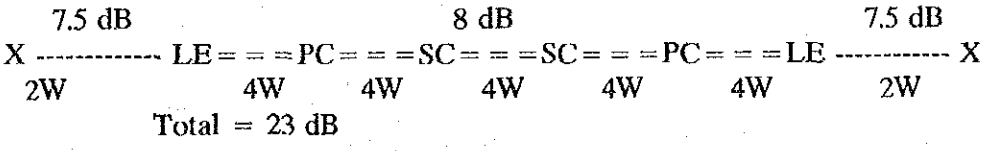
a) Intra-Office Connect



b) Local Connection



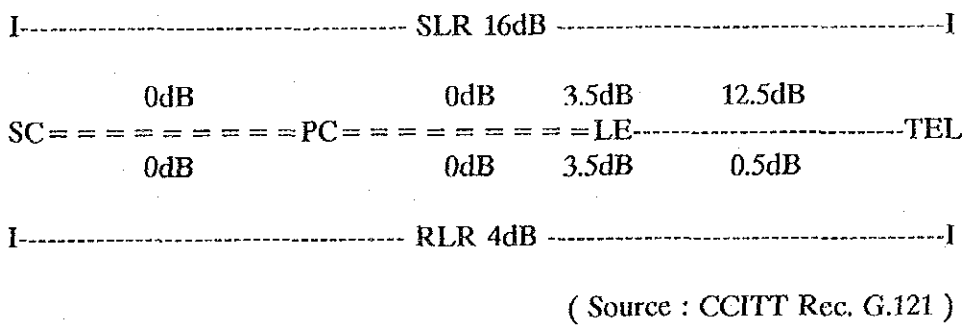
c) Trunk Connection



where, LE : Digital SPC Local Exchange (4-Wire)
PC : Digital SPC Primary Center (4-Wire)
SC : Digital SPC Secondary Center (4-Wire)
Loss in telephone set : not included
X : Subscriber's Telephone Set

During the long-term development period of 20 years, the final target of nominal LR including telephone set is shown below.

Final Target (up to year of 2012)



(Source : CCITT Rec. G.121)

2. Traffic Forecasts and Circuits Calculation

2.1 General

Traffic forecasts are one of the most essential processes in the network planning. The accurate estimates of the traffic to be carried in the network make it possible to dimension the optimum capacity of subscriber line concentrators, switching equipment and control devices, junctions and transmission equipment.

The following paragraphs describe the principle of traffic forecasting method which is applied for the long-term planning of Zambian telecommunication network.

2.1.1 General Sequence of Traffic Forecasting Methods

The traffic forecasting methods differ depending on whether the sufficient existing traffic data can be collected or not. Figure 6-2-1 shows the sequence of the forecasting processes which are applied to the long-term plan study.

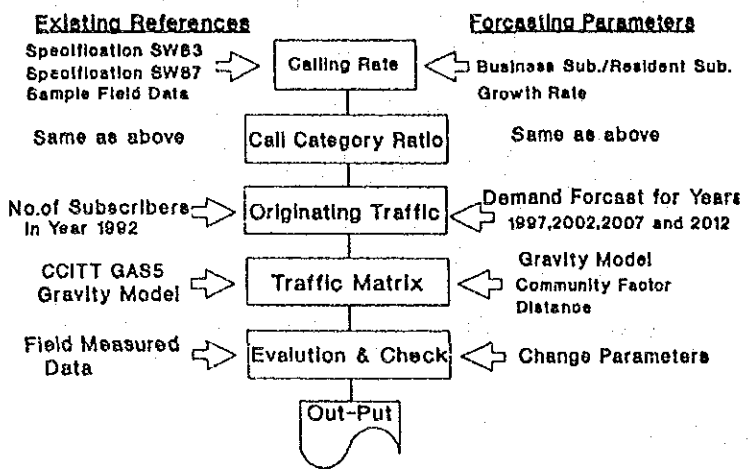


Figure 6-2-1 Sequence of Traffic Forecasting

2.1.2 Determination of Calling Rate

As for the existing data, the following documents and data are studied:

- Specification No. SW83
- Specification No. SW87
- Sample Field Data

To forecast the future calling rate, the subscriber demand forecast's result is mainly considered.

- Ratio of Business Subscribers and Residential Subscribers
- Effect of " Traffic Stimulus "
- Neighboring Countries' Reference Data

Figure 6-2-2 indicates the relation between the ratio of Business/Residential subscribers and transition of calling rate. As seen in the Figure, the growth rate of residential subscribers who have lower calling rate is larger than the growth rate of business subscribers, which results in reducing the average calling rate.

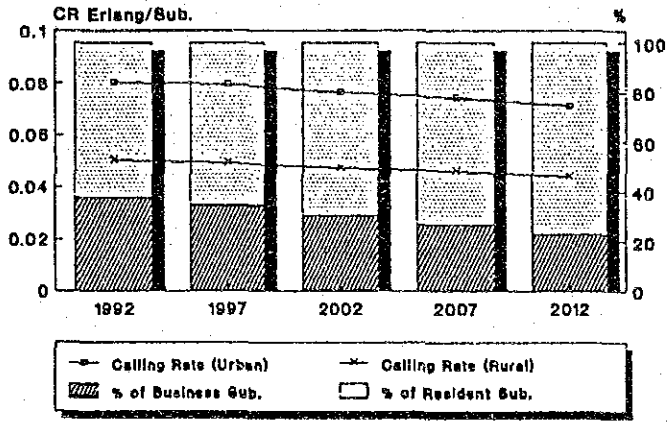


Figure 6-2-2 Calling Rate (Originating Traffic Per Sub.)

2.1.3 Call Category Ratio

The distribution of originating and terminating traffic to own area and trunk traffic is estimated based on the sampled field data and PTC's specifications No.SW83 and SW87. The distribution ratio has been evaluated and amended comparing the existing field data.

2.1.4 Originating Traffic

The originating traffic is calculated considering the subscriber calling rate and the number of subscribers (supply volume) of each targeted year.

2.1.5 Traffic Matrix

The gravity traffic model is used to check and complete the traffic flow matrix. This model is to calculate the traffic t from exchange i to exchange j, t(i,j), as a function of the distance between these exchanges. The traffic t(i,j) can be derived from the following formula:

$$t(i,j) = \frac{K \times Di \times Aj}{d(i,j)^a \times TT}$$

where

Di is the originating traffic from exchange i
Aj is the incoming traffic to exchange j
TT is the total traffic of the matrix
d(i,j) is the distance between exchanges i and j
K and a are the coefficients

2.1.6 Evaluation and Review

The coefficients of "K" and "a" are determined directly by the planner based on his experience, which could make sometimes discrepancy in calculation results and actual field data. The calculation results shall be reviewed and recalculated, if necessary, to adjust the discrepancy between the calculation results and actual field data of the initial year. Such sensitivity studies are necessary in the planning process.

2.1.7 Output Data

All of computer output data of traffic forecasts are listed in DATA BOOK (Table 5-22 and Table 5-23).

2.2 Trunk Traffic

The originating trunk traffic from each province is shown in Figure 6-2-3 as one of the traffic forecasting results. The trunk traffic matrices of inter-provinces are given in the Table 6-2-1.

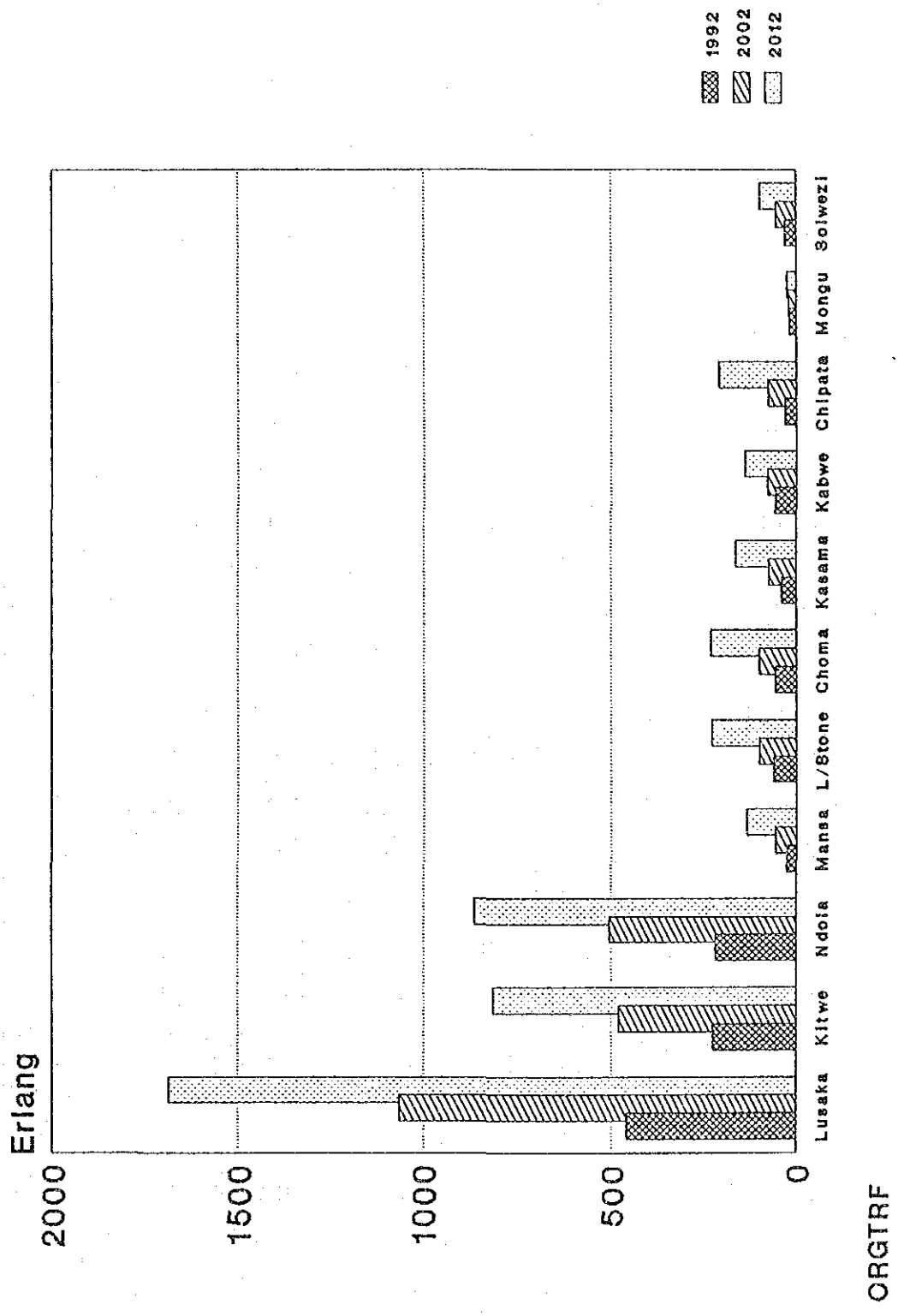


Figure 6-2-3 Originating Trunk Traffic

ZMP2002C Basic Plan

TRUNK TRAFFIC MATRIX FOR 2002

FILE (Kij) (Erlang)

TO / FROM	1 LUSAKA	2 KITWE	3 NDOLA	4 MANSA	5 L/STONE	6 CHOMA	7 KASAMA	8 KABWE	9 CHIPATA	10 MONGU	11 SOLWEZI	TOTAL
1 LUSAKA	0.00	339.81	358.59	36.17	64.60	65.53	47.53	51.44	49.58	13.67	35.65	1062.57
2 KITWE	332.32	0.00	75.21	7.29	12.32	12.34	9.41	9.85	9.67	2.65	7.13	478.19
3 NDOLA	353.34	75.78	0.00	7.69	13.03	13.06	9.96	10.43	10.26	2.80	7.48	503.83
4 MANSA	35.12	7.30	8.06	0.00	1.32	1.32	1.03	1.04	1.04	0.28	0.76	57.27
5 L/STONE	62.85	12.20	13.65	1.32	0.00	2.45	1.74	1.81	1.81	0.51	1.30	99.64
6 CHOMA	63.87	12.20	13.62	1.31	2.44	0.00	1.73	1.82	1.80	0.51	1.30	100.60
7 KASAMA	46.13	9.38	10.47	1.04	1.74	1.74	0.00	1.36	1.40	0.37	0.99	74.62
8 KABWE	50.19	9.78	10.83	1.03	1.80	1.81	1.34	0.00	1.40	0.38	1.01	79.57
9 CHIPATA	48.18	9.61	10.77	1.05	1.81	1.81	1.40	1.41	0.00	0.39	1.01	77.44
10 MONGU	13.29	2.63	2.94	0.28	0.52	0.51	0.37	0.39	0.39	0.00	0.28	21.60
11 SOLWEZI	34.63	7.13	7.83	0.76	1.30	1.30	0.99	1.02	1.01	0.28	0.00	56.25
TOTAL	1039.92	485.82	511.97	57.94	100.88	101.87	75.50	80.57	78.36	21.84	56.91	2611.58

ZMP2012C Basic Plan

TRUNK TRAFFIC MATRIX FOR 2012

FILE (Kij) (Erlang)

TO / FROM	1 LUSAKA	2 KITWE	3 NDOLA	4 MANSA	5 L/STONE	6 CHOMA	7 KASAMA	8 KABWE	9 CHIPATA	10 MONGU	11 SOLWEZI	TOTAL
1 LUSAKA	0.00	495.28	523.82	71.64	125.11	126.73	87.60	75.18	112.47	14.09	52.26	1684.18
2 KITWE	491.05	0.00	150.33	19.75	32.66	32.67	23.72	19.59	30.01	3.74	14.30	817.93
3 NDOLA	525.08	151.99	0.00	20.97	34.72	34.75	25.26	20.97	32.03	3.97	15.09	864.83
4 MANSA	70.31	19.72	21.84	0.00	4.73	4.72	3.53	2.80	4.39	0.54	2.07	134.65
5 L/STONE	123.12	32.26	36.17	4.73	0.00	8.61	5.80	4.80	7.43	0.96	3.47	227.35
6 CHOMA	125.02	32.24	36.07	4.70	8.58	0.00	5.76	4.81	7.38	0.95	3.44	228.95
7 KASAMA	85.93	23.57	26.37	3.54	5.82	5.80	0.00	3.42	5.49	0.67	2.50	163.11
8 KABWE	74.27	19.54	21.68	2.78	4.77	4.79	3.39	0.00	4.34	0.54	2.03	138.13
9 CHIPATA	110.48	28.75	33.41	4.40	7.44	7.42	5.49	4.38	0.00	0.84	3.15	206.76
10 MONGU	13.85	3.70	4.15	0.54	0.96	0.95	0.67	0.55	0.85	0.00	0.40	26.62
11 SOLWEZI	51.33	14.27	15.70	2.07	3.46	3.45	2.49	2.04	3.14	0.40	0.00	98.35
TOTAL	1670.45	822.32	869.54	135.12	228.25	229.89	163.71	138.64	207.53	26.70	98.71	4590.86

Table 6-2-1 Trunk Traffic Matrix

2.3 Area Traffic

The originating area traffic within the same province, so-called "area traffic", is given in DATA BOOK (DATA 5) for all exchanges. The area traffic is routed on a star-network to the terminating exchange via a primary center within the same province.

2.4 Local Traffic

A mesh network is recommended for Lusaka multi-exchange area to carry the local traffic on a high usage route which connects directly the originating and terminating exchanges if the traffic exceeds some certain volume. Figure 6-2-4 shows the mesh network configuration.

A local tandem exchange is also recommended to carry the overflow traffic from a high usage route and carry the inter-exchange traffic where there is no high usage route between exchanges. This local tandem function can be combined with toll tandem function in a exchange when the total traffic is relatively small.

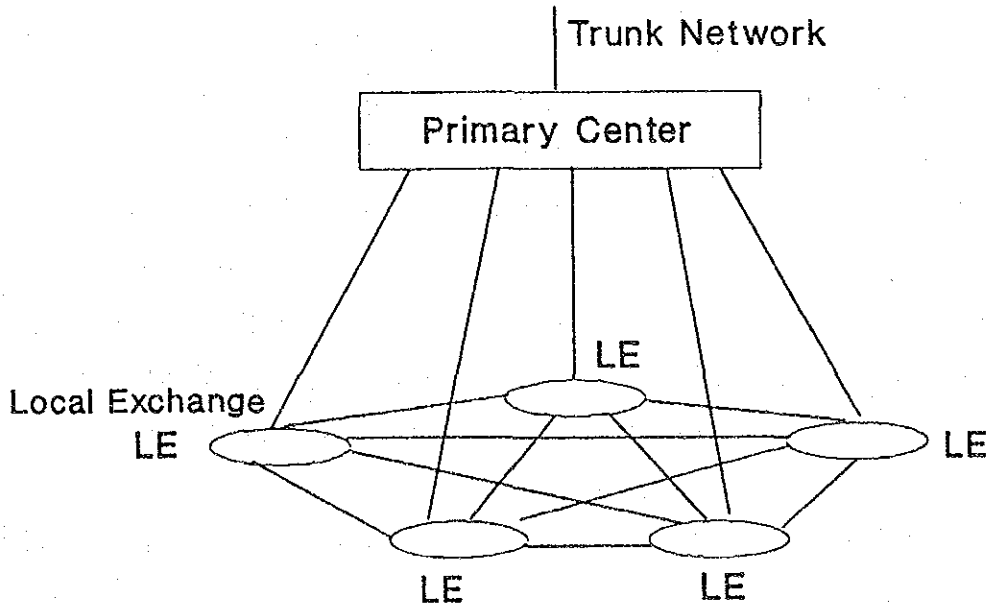


Figure 6-2-4 Mesh Network Configuration

The traffic matrices of Lusaka multi-exchange area is given in Table 6-2-2 .

Table 6-2-2 Traffic Matrix (Lusaka Multi Exchange Area)

ZMP2002C Basic Plan

TRAFFIC MATRIX IN LUSAKA FOR 2002

FILE (Tij) (Erlang)

TO / FROM	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
1 LUSAKA 1	0.00	43.60	34.32	15.16	15.86	2.91	6.82	24.11	18.06	40.09	20.31	221.24
2 LUSAKA 2	43.60	0.00	34.32	15.16	15.86	2.91	6.82	24.11	18.06	40.09	20.31	221.24
3 CHILSTON	35.14	35.14	0.00	13.49	14.20	2.78	6.34	21.38	16.59	36.86	18.87	200.79
4 CHINIKA	14.01	14.01	12.17	0.00	5.66	1.03	2.44	8.48	6.40	14.14	7.26	85.60
5 EMMASDALE	14.68	14.68	12.84	5.67	0.00	1.09	2.56	8.79	6.81	14.83	7.61	89.56
6 I/AIRPORT	2.63	2.63	2.45	1.01	1.06	0.00	0.48	1.60	1.24	2.75	1.43	17.28
7 MAKENI	6.19	6.19	5.62	2.39	2.51	0.48	0.00	3.74	2.89	6.43	3.31	39.75
8 RIDGEWAY	22.82	22.82	19.76	8.68	8.98	1.67	3.91	0.00	10.37	23.20	11.63	133.84
9 ROMA	16.94	16.94	15.20	6.49	6.90	1.28	2.99	10.28	0.00	17.44	8.90	103.36
10 WOODLANDS	41.56	41.56	37.32	15.86	16.62	3.15	7.35	25.41	19.28	0.00	21.89	230.00
11 OTHERS	25.25	25.25	22.91	9.77	10.22	1.97	4.54	15.27	11.79	26.25	0.00	153.22
TOTAL	222.82	222.82	196.91	93.68	97.87	19.27	44.25	143.17	111.49	222.08	121.52	1495.88

ZMP2012C Basic Plan

TRAFFIC MATRIX IN LUSAKA FOR 2012

FILE (Tij) (Erlang)

TO / FROM	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
1 LUSAKA 1	0.00	67.59	52.96	23.40	24.52	4.49	10.55	37.20	27.93	61.99	39.21	349.84
2 LUSAKA 2	67.59	0.00	52.96	23.40	24.52	4.49	10.55	37.19	27.93	61.99	39.21	349.83
3 CHILSTON	54.16	54.16	0.00	20.69	21.83	4.26	9.75	32.79	25.52	56.68	36.23	316.07
4 CHINIKA	21.65	21.65	18.72	0.00	8.72	1.59	3.76	13.03	9.86	21.79	13.97	134.74
5 EMMASDALE	22.72	22.72	19.78	8.74	0.00	1.68	3.95	13.53	10.51	22.91	14.67	141.21
6 I/AIRPORT	4.07	4.07	3.77	1.56	1.64	0.00	0.74	2.46	1.91	4.24	2.76	27.22
7 MAKENI	9.59	9.59	8.66	3.69	3.87	0.75	0.00	5.77	4.47	9.94	6.39	62.72
8 RIDGEWAY	35.22	35.22	30.37	13.34	13.83	2.57	6.02	0.00	15.97	35.73	22.36	210.63
9 ROMA	26.22	26.22	23.42	10.01	10.65	1.98	4.62	15.83	0.00	26.94	17.16	163.05
10 WOODLANDS	64.19	64.19	57.39	24.39	25.60	4.85	11.33	39.06	29.72	0.00	42.11	362.83
11 OTHERS	49.84	49.84	45.03	19.20	20.12	3.88	8.94	30.01	23.23	51.69	0.00	301.78
TOTAL	355.25	355.25	313.06	148.42	155.30	30.54	70.21	226.87	177.05	353.90	234.07	2419.92

2.5 International Traffic

The international traffic is forecasted by the regression method considering the past traffic growth and the future business subscribers' growth. The forecast results are given in the Figure 6-2-5.

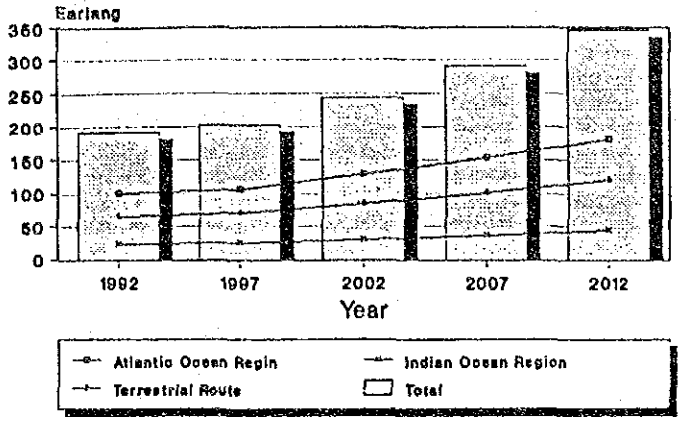


Figure 6-2-5 International Traffic

2.6 Circuits Calculation

2.6.1 Trunk Circuit

The number of trunk circuits is calculated based on the predetermined trunk traffic matrix between two PCs (Primary Centers) which is given in Table 6-2-1. The direct route shall be provided between two PCs if the calculated number of trunk circuits exceeds 15 circuits per outgoing and incoming route respectively, considering the minimum provision of a digital PCM link of 30 channels. If there is no direct route, the traffic between these PCs shall be routed via Lusaka SC (Secondary Center) or Kitwe SC.

The following conditions are given to determine the number of the final trunk routes.

a) Grade of Service : B = 0.01
(probability of 1 lost call due to all trunk busy among 100 calls)

a) Trunk Efficiency : Maximum 75 %
(permissible maximum usage efficiency of trunk circuit)

The result of the calculation of trunk circuits is given in Table 6-2-3.

2.6.2 Area Trunk Circuit

The number of area trunk circuits which are provided between local exchanges and Primary Centers is calculated based on the traffic forecasts given in DATA BOOK (Table 5-22 and Table 5-23).

The following conditions are given to determine the number of area trunk circuits:

a) Grade of Service : B = 0.01
(probability of 1 lost call due to all trunk busy among 100 calls)

b) Trunk Efficiency : Maximum 75 %
(permissible maximum usage efficiency of trunk circuit)

The result of the calculation of area trunk circuits is given in DATA BOOK (Table 5-24 and Table 5-25).

2.6.3 Local Junction Circuit

The local junction circuits between exchanges in Lusaka multi-exchanges are to be calculated based on the traffic matrix given in Table 6-2-3.

The following conditions are given to determine the number of local junction circuits,

a) Grade of Service : B = 0.01
(probability of 1 lost call due to all circuit busy among 100 calls)

b) Trunk Efficiency : Maximum 83 %
(permissible maximum usage efficiency of trunk circuit)

The result of the circuit calculation of local junction circuits is given in Tables 6-2-4 and 6-2-5.

ZMP2002C2

INTER-PROVINCE CIRCUIT MATRIX FOR 2002

Max. 75% : TRF >39 erl.

TO / FROM	1 LUSAKA	2 KITWE	3 NDOLA	4 MANSA	5 L/STONE	6 CHOMA	7 KASAMA	8 KABWE	9 CHIPATA	10 MONGU	11 SOLWEZI	TOTAL
1 LUSAKA	0	452	479	49	118	119	63	94	92	29	48	1543
2 KITWE	444	0	204	32	21	21	39	18	18	8	32	837
3 NDOLA	536	135	0	0	0	0	0	0	0	0	0	671
4 MANSA	54	27	0	0	0	0	0	0	0	0	0	81
5 L/STONE	94	42	0	0	0	0	0	0	0	0	0	136
6 CHOMA	94	42	0	0	0	0	0	0	0	0	0	136
7 KASAMA	71	32	0	0	0	0	0	0	0	0	0	103
8 KABWE	75	35	0	0	0	0	0	0	0	0	0	110
9 CHIPATA	72	35	0	0	0	0	0	0	0	0	0	107
10 MONGU	24	14	0	0	0	0	0	0	0	0	0	38
11 SOLWEZI	52	26	0	0	0	0	0	0	0	0	0	78
TOTAL	1516	840	683	81	139	140	102	112	110	37	80	3840

ZMP2012C2

INTER-PROVINCE CIRCUIT MATRIX FOR 2012

Max. 75% : TRF >39 erl.

TO / FROM	1 LUSAKA	2 KITWE	3 NDOLA	4 MANSA	5 L/STONE	6 CHOMA	7 KASAMA	8 KABWE	9 CHIPATA	10 MONGU	11 SOLWEZI	TOTAL
1 LUSAKA	0	660	699	95	224	226	116	137	203	34	70	2464
2 KITWE	655	0	252	63	45	45	71	30	42	9	47	1259
3 NDOLA	734	219	0	21	33	34	24	21	31	0	15	1132
4 MANSA	116	42	22	0	0	0	0	0	0	0	0	180
5 L/STONE	194	72	34	0	0	0	0	0	0	0	0	300
6 CHOMA	195	71	35	0	0	0	0	0	0	0	0	301
7 KASAMA	143	48	25	0	0	0	0	0	0	0	0	216
8 KABWE	118	46	21	0	0	0	0	0	0	0	0	185
9 CHIPATA	174	67	32	0	0	0	0	0	0	0	0	273
10 MONGU	27	17	0	0	0	0	0	0	0	0	0	44
11 SOLWEZI	86	34	15	0	0	0	0	0	0	0	0	135
TOTAL	2442	1276	1135	179	302	305	211	188	276	43	132	6488

CIRCUIT MATRIX IN LUSAKA FOR 2002

TO / FROM	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
1 LUSAKA 1	0	57	46	24	25	0	0	35	28	53	0	268
2 LUSAKA 2	57	0	46	24	25	0	0	35	28	53	0	268
3 CHILSTON	47	47	0	22	23	0	0	32	26	49	0	246
4 CHINIKA	23	23	21	0	12	0	0	16	13	23	0	131
5 EMMASDALE	24	24	21	12	0	0	0	16	14	24	0	135
6 I/AIRPORT	0	0	0	0	0	0	0	0	0	0	0	0
7 MAKENI	0	0	0	0	0	0	0	0	0	0	0	0
8 RIDGEWAY	33	33	30	16	17	0	0	0	18	34	0	181
9 ROMA	26	26	24	13	14	0	0	18	0	27	0	148
10 WOODLANDS	55	55	50	25	26	0	0	36	29	0	0	276
11 OTHERS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	265	265	238	136	142	0	0	188	156	263	0	1653

TO / FROM	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
LUSAKA TDM	46	46	43	22	23	29	58	31	26	48	140	512

0

FROM / TO	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
LUSAKA TDM	42	42	39	19	20	27	53	27	22	44	173	508

Table 6-2-4 Circuit Matrix in Lusaka for 2002

LSC2012B Basic Plan

CIRCUIT MATRIX IN LUSAKA FOR 2012

TO / FROM	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
1 LUSAKA 1	0	83	67	34	35	0	0	50	39	77	0	385
2 LUSAKA 2	83	0	67	34	35	0	0	50	39	77	0	385
3 CHILSTON	68	68	0	31	32	0	0	45	37	71	0	352
4 CHINIKA	32	32	29	0	16	0	0	22	18	32	0	181
5 EMMASDALE	33	33	30	16	0	0	0	22	19	33	0	186
6 I/AIRPORT	0	0	0	0	0	0	0	0	0	0	0	0
7 MAKENI	0	0	0	0	0	0	0	0	0	0	0	0
8 RIDGEWAY	48	48	42	22	23	0	0	0	25	48	0	256
9 ROMA	37	37	34	18	19	0	0	25	0	38	0	208
10 WOODLANDS	79	79	72	35	37	0	0	52	41	0	0	395
11 OTHERS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	380	380	341	190	197	0	0	266	218	376	0	2348

TO / FROM	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
LUSAKA TDM	79	78	72	35	37	42	86	51	41	81	256	858

FROM / TO	1 LUSAKA1	2 LUSAKA2	3 CHILSTON	4 CHINIKA	5 EMMASDALE	6 I/A. PORT	7 MAKENI	8 R/WAY	9 ROMA	10 W/LANDS	11 OTHERS	TOTAL
LUSAKA TDM	68	68	64	29	30	38	78	43	34	73	326	851

Table 6-2-5 Circuit Matrix in Lusaka for 2012

3. Urgent Program to be Carried out by PTC

To solve major imminent problems which may incur vital losses to PTC, three(3) Task Force teams and one(1) Assessment team are organized directly under the Managing Director.

Each of the three Task Force teams deals with (1) External plant maintenance and new subscriber connection, (2)Billing system, and (3) Vehicle survival operation, respectively as outlined below.

3.1 PROGRAM 1 - External Plant Maintenance and New Subscriber Connection

Purpose: (a) Enhancement of fault correction work to eliminate repeated occurrence of faults in the same line, reviewing standard procedures presently used, and enforcing observation of the established procedures

(b) Elimination of waiting subscribers due to non-availability of lines.

(c) Management of claims to facilitate collection of charges

- Maintenance efficiency of the external plant was worsened to 58% in 1991, implying that approx. 40% of faults were carried over to 1992, possibly leading to suspension of payment by customers and disagreement to hiking tariff.

- The number of waiting subscribers is approximately 57,000 as of September, 1992 in national total and that in Lusaka, Kitwe and Ndola areas is approximately 18,000.

A special construction team is organized for installation of cables in the areas mentioned above to increase new subscribers. Table 6-3-1 shows additional subscribers to be implemented by the urgent program 1.

Table 6-3-1 Summary of Additional Subscriber

Area Line Unit	Switching Line	Working	Waiter Subscriber	Additional Subscribers
Lusaka	47,512	23,748	11,727	7,303
Kitwe	28,500	15,569	14,480	7,134
Ndola	16,000	12,077	10,202	3,785
Total	92,012	51,394	36,409	18,222

3.2 PROGRAM 2 - Improvement of Billing System

Purpose:

a) Collection of unpaid charge for telecommunication services

b) Expediting commencement of total operation of already installed country-wide network for billing system

c) Charging methodology

- monthly billing and collection
- study on cost based prices to determine tariff for telephone, telegraph and telex
- recommendation on new tariff

To collect unpaid charges, analysis of claims from subscribers and study of countermeasures thereof are indispensable since this problem is entangled with the quality of services provided by PTC. And also investigation of unrighteous international calls and illegal connection of line to non-subscriber is essential.

It shall be noted that collection of charges and hike in tariff need credit by customers.

Target of improvement for the telephone charge collection rate is set at around 70%.

3.3 PROGRAM 3 - Vehicle Survival Operation

The objective area of this operation is the whole country.

Purpose:

a) Repairing of faulty vehicles, procurement of parts and organization of vehicle repair teams

b) Review of criteria for replacement of vehicles as well as allocation, utilization period and usage of vehicles

Each team shall make report weekly to a manager appointed by the Managing Director, on achieved performances and particular findings, if any.

The assessment team shall analyze performances achieved by each Task Force team and report the results with comments, inspect each Task Force team on site, as required, and report the results to the manager appointed by the Managing Director.

Target of improvement for the percentage of utilization is set at around 70%.

4. Facility Expansion Plan

In order to realize the development target in the Year 2012, The following Facility Expansion Plans are to be recommended:

The period of 20 years objected by The Long-Term Plan is divided into two (2) parts. i.e., CREATION decade and GROWTH decade, for the development program of telephone switching network, as follows:

CREATION (First) Decade	: 1993 - 2002
GROWTH (Second) Decade	: 2003 - 2012

4.1 Expansion Plan of Switching System

4.1.1 Expansion Criteria

Considering the existing status of the switching network in Zambia, mentioned in SECTION 3, the following provision plan is to be applied for expansion of the telephone switching facilities.

a) To expand the local and toll switching equipment to meet the supply plan mentioned in SECTION 5, Item 3 in the whole country.

b) To replace the obsolete manual switching boards with the digital switching units.

c) To digitalize the telephone switching network by replacement of the existing analog switching equipment with digital one gradually.

4.1.2 Replacement Criteria

The following switching equipment is to be replaced according to the expansion plan mentioned above.

a) the obsolete manual switching boards with the digital switching equipment/units

b) analog automatic switching equipment to be given the priority by the following conditions:

Priority 1. Equipment which is difficult to maintain and operate for the lack of spare parts;

Priority 2. Equipment which is operating exceeding its economic life;

c) Digital equipment are to be kept up to the year 2012, if not affected by the ISDN Scheme.

Table 6-4-1 shows the expansion and replacement schedule according to the Criteria mentioned above.

Table 6-4-1 Replacement Year of Telephone Exchange

System	Installed Period (Year)	Replacement Period		
		INST+15	INST+20	INST+25
Analog (NX1E)	1980-1984	1995-1999	2000-2004	2005-2009
Analog (MCR)	1980-1989	1995-2004	2000-2009	2005-2014
Cross bar (ARF,ARK,C22)	1967-1981	1982-1996	1987-2001	1992-2006
Digital (E10,NEAX61E)	1987-1993		2007-2013	2012-2018

4.1.3 Criteria of Switching System Selection

(1) Local Exchange

Local exchange type is defined depending upon initial and ultimate line unit capacities as follows:

Ultimate Capacity		type
more than 5,000	:	ESS independent
5,000 or less	:	Digital Remote Unit or Concentrator (note)

(Note): The digital junction lines are necessary between Digital Remote Unit or Concentrator and its control exchange (parent exchange).

Table 6-4-2 shows the exchanges classified by the ultimate capacity in Zambia.

Table 6-4-3 shows the higher capacity exchanges and Primary Centers.

Table 6-4-2 Classified Exchange Capacity

Scale of exchange	No. of exchanges	Remarks
more than 30,000	2	Lusaka, Kitwe
20,000 - 30,000	0	
10,000 - 20,000	5	
7,500 - 10,000	5	
5,000 - 7,500	6	
2,500 - 5,000	13	
1,000 - 2,500	14	
500 - 1,000	22	
less than 500	26	

Table 6-4-3 Higher Capacity Rank and Primary Center

Code No.	Exchange	SW. Capacity At 2012
301 (*)	Kitwe	34,200
101 (*)	Lusaka Main	32,900
401 (*)	Ndola Main	18,000
109	Woodland	16,500
304	Chingola	11,000
307	Mufulira	11,000
610 (*)	Livingstone	10,600
107	Ridgeway	9,900
901 (*)	Chipata	9,500
102	Chelston	9,000
801 (*)	Kabwe	8,000
601 (*)	Choma	5,400
501 (*)	Mansa	4,700
701 (*)	Kasama	4,700
1101 (*)	Solwezi	2,600
1001 (*)	Mongu	1,000

(*): Primary center

(2) Toll, Trunk, and Transit Exchange

From the view point of economic network planning, toll, trunk and transit functions could be combined into the local switching system as much as possible.

If the traffic combined with local, toll, trunk, and transit exceeds the maximum traffic capacity of the switching equipment, rearrangement of the switching system is to be carried out.

4.1.4 Expansion Plan of Switching System

According to the Provision Policy of Telephone Switching Equipment, the following expansion plan is to be recommended for CREATION Decade:

Table 6-4-4 Expansion Plan for CREATION Decade

CODE NO.	EXCHANGE NAME	DEMAND 1992.9	SW CAPA. 1992.9	1993-2002 REMOVE	1993-2002 EXPAND	SW.CAPA 2002	SUPPLY 2002	INST.COST (X1000 $)
100	LUSAKA METRO	34,475	47,512	-18,512	24,400	53,400	45,013	10,687.9
200	LUSAKA	4,660	4,216	-2,968	5,940	7,188	5,540	2,503.8
300	KITWE	35,124	32,000	-15,000	24,700	41,700	33,441	10,512.9
400	NDOLA	22,411	16,096	-3,000	14,328	27,424	22,705	5,078.4
500	LUAPULA	3,218	1,768	-384	1,928	3,312	2,656	2,048.2
600	SOUTHERN	10,620	9,552	-3,828	6,556	12,280	9,254	4,624.6
700	NORTHERN	5,553	4,380	-3,676	5,400	6,104	4,900	4,026.5
800	CENTRAL	6,162	6,310	-5,030	4,700	5,980	4,683	1,635.0
900	EASTERN	3,614	3,708	-2,828	5,328	6,208	4,776	3,698.9
1000	WESTERN	2,070	1,724	-20	228	1,932	1,031	125.9
1100	NORTHWEST	2,609	1,608	-512	1,900	2,996	2,265	1,488.5
	TOTAL	130,516	128,874	-55,758	95,408	168,524	136,264	46,430.6

Table 6-4-5 shows the expansion plan according to the same criteria mentioned above. However, the type of the switching equipment may differ from that of CREATION Decade because of introduction of ISDN Services.

Table 6-4-5 Expansion Plan for GROWTH Decade

CODE NO.	EXCHANGE NAME	SW.CAPA 2002	2003-2012 REMOVE	2003-2012 EXPAND	SW.CAPA 2012	SUPPLY 2012	INST.COST (X1000 $)
100	LUSAKA METRO	53,400	0	36,400	89,800	75,971	10,450.2
200	LUSAKA	7,188	-1,888	6,600	11,900	9,716	2,767.6
300	KITWE	41,700	0	31,200	72,400	61,170	9,441.4
400	NDOLA	27,424	-224	22,200	49,400	41,651	6,531.3
500	LUAPULA	3,312	-512	5,200	8,000	6,666	2,184.9
600	SOUTHERN	12,280	-980	15,900	27,200	22,550	5,050.0
700	NORTHERN	6,104	-704	8,800	14,200	11,447	3,595.5
800	CENTRAL	5,980	-1,280	5,900	10,600	8,695	1,882.6
900	EASTERN	6,208	-1,008	11,200	16,400	13,635	4,250.3
1000	WESTERN	1,932	-832	800	1,800	1,366	491.7
1100	NORTHWEST	2,996	-96	2,400	5,300	4,235	1,114.8
	TOTAL	168,524	-7,524	146,600	307,000	257,102	47,760.2

4.2 TransmissionSystem

As a result of traffic estimation based on the 2 Mbps transmission system circuit calculation, approximately one thousand systems are required, between the PCs, at the end of year 2012.

Table 6-4-6 Summary of Transmission Expansion

ROUTE	EXIST SYSTEM		PROPOSED SYSTEM		EXPANSION CAPACITY 2M SYSTEM	
	FREQUENCY	CAPACITY	FREQUENCY	CAPACITY	2002	2012
LUSAKA--LIVINGSTONE	6 GHZ	960 CH	6 GHZ	155 Mbps	54	85
LUSAKA--MONGU	6	960	6	155	47	68
LUSAKA--CHINGOLA	6	1800	6	155	124	173
CHINGOLA--SOLWEZI	2	960	6	155	22	25
LUSAKA--CHIPATA	2	960	6	155	27	38
LUSAKA--KASAMA	6	960	6	155	36	51
KASAMA--MANSA	2	960	6	155	28	38
SOLWEZI--ZAMBEZI	2	300	2	155	22	25
KASAMA--ILONDA	6	960	6	155	22	27
KASAMA--MBALA	2	300	2	155	22	27
TOTAL	-	-	-	-	404	557

In order to satisfy this circuit requirement, and to establish modern transmission networks, digital transmission should be introduced in all the links.

Accordingly, construction of terrestrial transmission links is to be accelerated within the period of the Long-Term Plans, in order to improve domestic and international services.

4.2.1 Expansion Criteria

The formulation of the transmission network structure is determined by the circuit requirements in the Long-Term Plans and by taking into account the geographical conditions of the area concerned.

(1) Backbone Route

The expansion concept for the backbone terrestrial transmission systems are as follows:

a) The transmission system of the backbone routes is to be terrestrial microwave radio basically.

b) Digitalization of the existing analog backbone transmission system is to be accelerated.

c) A ring configuration (loop connection) should be arranged for the main transmission routes to make provision for the specific circuit interruption.

d) The digital links to be introduced should cope with ISDN applications, in the future.

(2) Spur Route

The spur routes should be provided with expanded transmission capacities to meet additional requirements for local exchanges (LE) throughout the country.

The spur link should basically consist of a small capacity radio system. However, links intended for TV transmission should be provided with sufficient capacity for the purpose.

(3) Satellite System

The existing earth station, Mwembeshi I, for Indian Ocean Region (IOR) which was commissioned in 1974 has run out of service life. Spare parts to maintain equipment in reliable operating condition are now becoming difficult to acquire.

Pursuant to the digitalization program of INTELSAT, both Mwenbeshi I and II should be digitalized. Further the analog microwave link between Lusaka International Telephone Exchange and Mwenbeshi Earth Station is to be digitalized. In the case of Mwenbeshi I, another antenna and communication system is required.

4.2.2 *Expansion Plan of TransmissionSystem*

(1) CREATION (First) Decade

a) To accelerate digitalization of existing analog backbone transmission system taking the improvement of service quality and the introduction of new services into consideration.

The existing analog transmission systems will be replaced gradually by digital systems. The digitalization ratio of the transmission system is to be 60% of the total signal channels to be implemented in the Long-Term Plans. The overall transmission network at end of this decade is shown in Table 6-4-6 and Figure 6-4-1.

b) To introduce the loop connection to the existing star configuration of the transmission systems. This loop lines would ensure continuity of communication between stations in the event of a total failure of the connecting transmission link.

In this decade, the loop lines to cater for the heavy traffic route between Lusaka and the Copperbelt (Kitwe) is proposed. To achieve this objective, the existing Lusaka to Mongu and Kitwe to Zambezi radio links will be connected between Mongu and Zambezi.

c) To provide spur routes with adequate capacity to meet the requirements of Zambia National Broadcasting Corporation (ZNBC) for extending TV coverage to the following stations:

Siavonga
Mumbwa
Senanga
Namwala
Isoka
Kaputa

d) To introduce another satellite earth station at Mwembeshi to replace Mwembeshi I. The new earth station will use appropriate digital techniques in line with INTELSAT's global digitalization program.

(2) GROWTH (Second) Decade

a) To accomplish total digitalization (100%) of all the backbone terrestrial transmission links.

b) To accomplish ring configuration in the terrestrial transmission network by interconnecting the following stations:

Ilonda to chama

Mongu to Livingstone.

Table 6-4-6 and Figure 6-4-2 show the resultant terrestrial transmission system network by the year 2012.

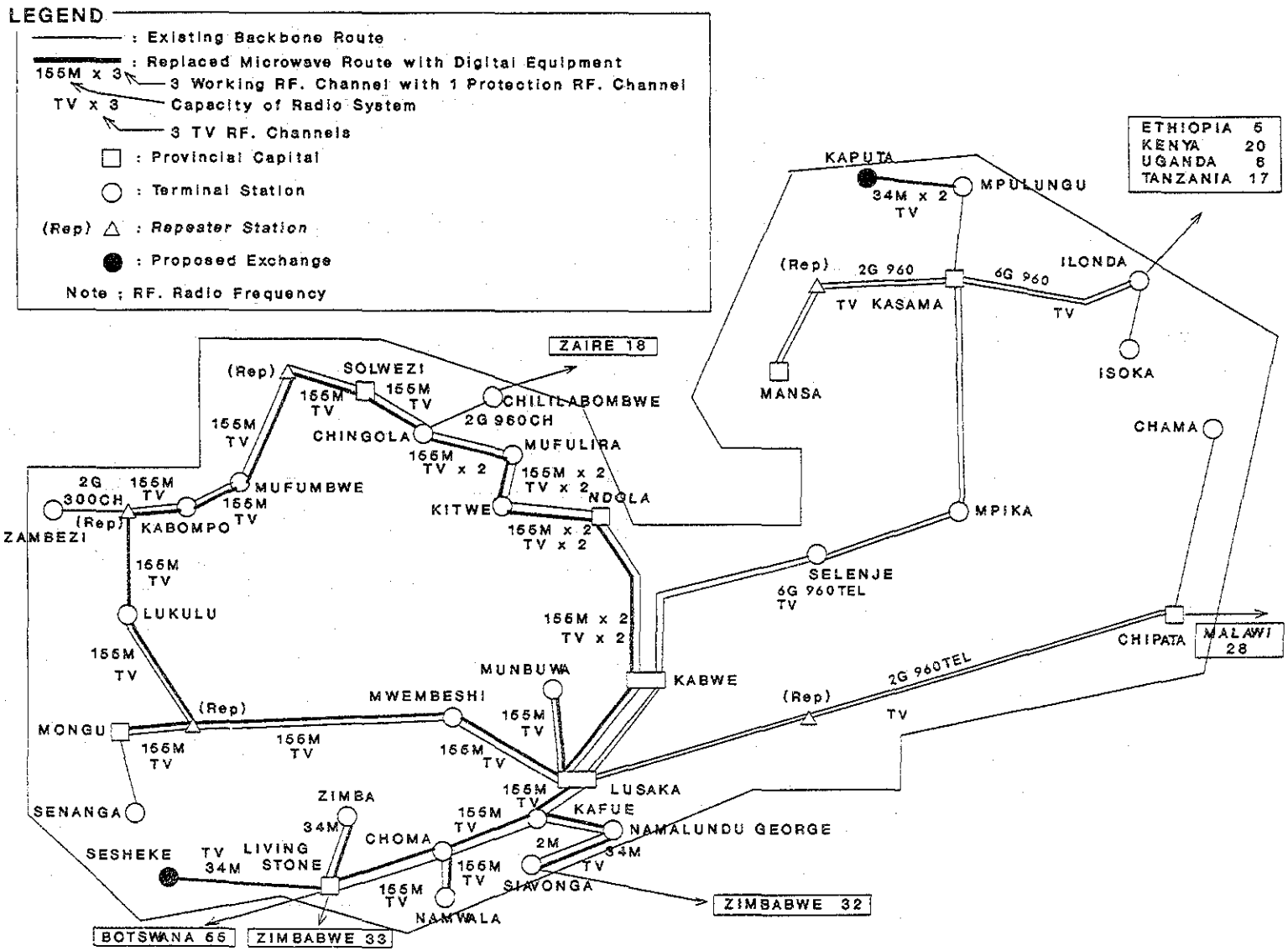


Figure 6-4-1 Terrestrial Backbone Transmission System (2002)

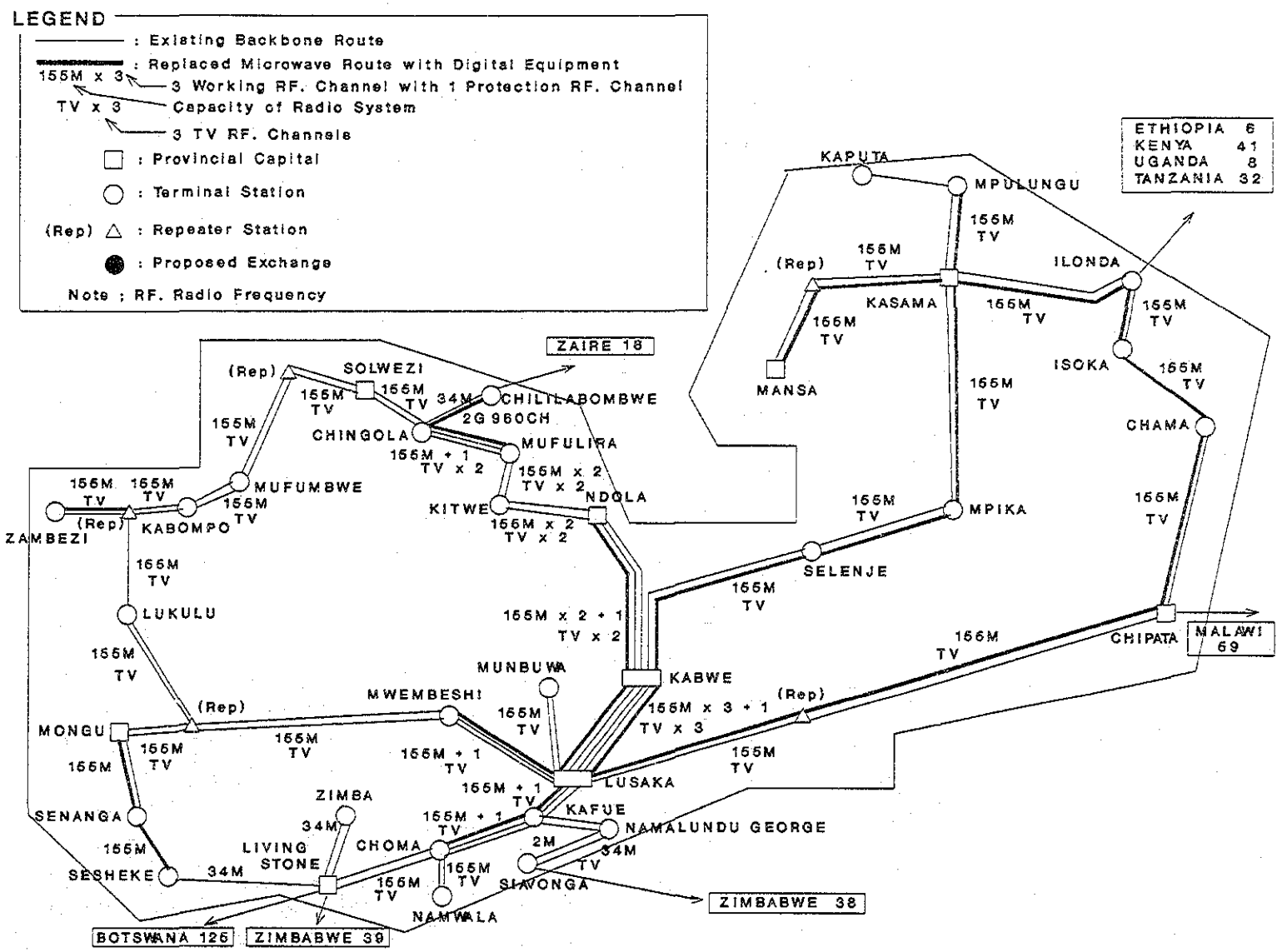


Figure 6-4-2 Terrestrial Backbone Transmission System (2012)

4.3 External Plant System

4.3.1 Expansion Criteria

The expansion of external plant facilities on exchange basis for the whole Zambia is planned in accordance with the supply volume distributed to the urban (inside BRA) and rural (outside BRA) areas.

The external plant system can be categorized into two systems in terms of the facilities configuration, i.e., the system includes MARS (Multi-Access Radio System) or similar facilities to connect distant subscribers to the exchange in combination with cable and/or open-wire, and the system not including MARS.

Therefore, the external plant system which includes MARS is applied to the rural area and the other system is applied to the urban area respectively considering the distance between exchange and subscriber, in this study.

Expansion of external plant facilities is planned based on the engineering instructions issued by PTC for planning, and the following concepts.

The PTC's engineering instructions is under the revision for unification of technical specifications of telecommunications equipments to be employed by the whole members of SADC (Southern African Development Community) countries.

4.3.2 External Plant for Urban Area

(1) Distribution System

In case, supply volume (Demand) of an exchange in the provision year is more than 1,400, the Cabinet System together with ducts is applied and otherwise the Direct Wiring System is applied.

(2) Cable Type

Duct/direct buried cable installation methods are employed to install a cable with large number of pairs for which aerial cable is not applicable technically, considering the cable size and environmental condition of the area in principle.

The cable core is of jelly filled type to prevent ingress of water and it is to be applied on all the cable.

(3) Utilization of Existing Facilities

Existing facilities such as poles, cables, ducts, and open-wires, are to be utilized as far as applicable in order to minimize the implementation costs.