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Technical Preparatory Meeting on
Telecommuncations Industries in Africa

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TELECOMMUNICATIONS

INDUSTRIES FOR THE MANUFACTURING OF TELE-

COMMUNICATIONS EQUIPMENT IN AFRICA

Report *

prepared by

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* The views expressed in this document are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has not been edited.

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Executive Summary

During the last two decades the telecommunications sector has undergone spectacular technological and structural changes. Together with computer technology this sector forms the basis for the creation of the information society. This shift, already under way in some countries, will accelerate over the next decades leading to far-reaching changes and influences on industry and society.

The range of products by the telecommunication industry is rapidly being expanded as well as the volume of total supply. Nowadays, not only the simple telephone set can be assigned to the product group "terminal equipment at user premises", but also more enhanced versions of telephone set with built-in memory and additional functions and/or

- mobile telephone equipment
- paging equipment
- computer terminals with built-in telephone modem
- telex, teletex, videotex and facsimile terminals
- answering machines
- modems
- private automatic branch exchanges (PABX)
- local area networks (LAN)
- subscriber carrier equipment
- alarm systems
- antennas
- equipment for broadband networks (cable TV).

The situation in Africa is quite a different one. Telephone density on the continent averages less than 0.7 per 100 inhabitants, compared to 2.8 per 100 inhabitants in Asia, 5.2 per 100 in Latin America and over 60 per 100 in Europe and North America. Between 80 and 90 percent of telephone services are provided for urban areas only.

The African market for telecommunication equipment was estimated for the year 1982 at 0.4 billion US$ and will increase with an average annual growth rate of 8.2 percent to 1 billion US$ in 1992. This amount should serve as a good basis to start a viable telecommunications industry in Africa. Compared to other regions in the world it is of priority to provide basic telephony to

the public, and also telegraphy and telex. As factors for the restricted growth of services it can be stated that Africa relies totally on the world market for the purchase of equipment as it has no indigenous telecommunications industry. Only little consensus exists concerning the appropriate technology for the use in Africa. A broad range of technologies is in place, which makes operation and maintenance of the systems a difficult task. And the original suppliers often have stopped the production of spare parts of older systems which results into the fact that equipment still giving adequate service has to be replaced, simply because the necessary spare parts cannot be obtained.

A few African countries have started with the production of telephone sets and instruments, cables and wires, switching and transmission equipment and some accessories like poles and PVC ducts. However, a large potential of resources is available to extend the volume of production and the product range.

For the achievement of a higher degree of self-sufficiency a strategy and an adequate planning is therefore proposed including:

- The development of structural links between the developing telecommunications industry and other better developed industrial sectors such as metal-working, plastics, electrochemical, electromechanical, and electronics industries. From the systematic use of existing supply industry not only the telecommunications sector would benefit through the possibility to acquire accessory equipment but also the related industries through a wider range of production possibilities.

- The development of local know how through the deglobalization of techniques and procedures, especially of turnkey contracts.

- The establishment of regional research and development capacity, which may lead as a first step to the creation of a regional Environmental Testing Centre and a regional Tropicalisation Centre.

- The promotion of regional industrial co-operation.

UNIDO is now implementing such a regional environmental Testing and Tropicalization Centre in Zimbabwe.

Taking the present situation and the possibilities for local production into consideration, Governments and P&T Authorities have to define priorities. To realize these priorities a twofold approach for industrialization is proposed:

- The production of spare parts on a small scale basis at
  * workshops for repair and maintenance
  * assembling units
  * multipurpose production units

- The production of components and equipment on large scale basis in industrial units.

An appropriate approach to activate a telecommunications industry may be the multipurpose production units, manufacturing batches of a variety of spare parts for existing installations, but for different endusers. As a result of the Harare seminar the establishment of multipurpose production projects is proposed, whereby three dominant production routes have been identified as possible, from which choices have to be made by each country:

- mechanical production route
- electromechanical production route
- electronic production route

A well defined and comprehensive strategy is required to realize viable industrial projects on the telecommunications sector. Governmental support as well as the strong will and active role of the local P&T Authority are required in the following areas:

- Evaluation for the needs of components and equipment
- The choice of telecommunications technology and the selection of products
- The choice of manufacturing technology

- Relations with original suppliers
- Relations with national sectoral industries
- Negotiations on patents and licences

A revision in the design, contracting and management of telecommunications projects from turnkey basis to individual contracts may be advisable to incorporate and enhance local works, local products and local staff.

The majority of African population lives in rural areas. Therefore special emphasis has to be laid on the appropriate equipment configuration for rural networks. Out of the analysis of the advantages and disadvantages of different sizes of switching exchanges and different modes of transmission as there are:

- open wire carrier systems
- cable carrier system
- optical fibre cable system
- radio system in HF, VHF, UHF, SHF
- satellite system

the following conclusions for rural equipment configuration derived:

- small local exchanges between 50 and some 100 lines are mainly required
- more than 1.000 subscribers to a local exchange cannot be expected
- open wire carrier systems are still the most cost effective transmission system for low traffic
- VHF/UHF radio systems may be best suited for low to moderate traffic volume.
- Single channel per carrier satellite systems may be suitable for sparsely populated, inaccessible and difficult terrain.

Based on the telecommunications strategy and the level of manufacturing capability of a country the following proposals for local manufacture can be made such as:

- electronic switching equipment with 50 to 500 lines, small PABX with 10 to 50 lines.
- electromechanical switching equipment components dedicated for the

maintenance and repair of existing equipment.

- telephone instruments: basic telephone sets and key telephone systems
- cables and wires, together with auxiliary equipment: open wire, aerial cables, underground cables, internal cables, power cables
- multiplex equipment: single channel radio equipment

Summary of approaches
Manufacturing possibilities

possibilities	telecom sector	related industrial sectors
Spare part production	Establishment of Multipurpose production units on - mechanical - electromechanical - electronic level	
Use of existing industry	Rehabilitation/extension/ improvement of existing units, e.g. cable factories	Extension of product mix of the: -metallurgy industry -ceramics industry -plastics industry -electromechanical industry -electronic industry
New manufacturing units	Establishment of new manufacturing units for: - electronic switching equipment - discrete electromechanical semielectronic switching equipment components - telephone instruments - cables, wires - auxiliaries - multiplex equipment (single channel radio)	

1. Introduction

The telecommunications industry in the developed countries is characterized by the following features:

a) Nowadays this industrial sector is technology intensive and its development depends on the fast technological progress from research and development activities. There is a world-wide trend to intensify cooperation of telecommunications manufacturers on R&D activities among themselves and with information suppliers.

b) The sector is capital intensive and its manpower requirements are normally low but highly specialized and skilled.

c) The sector uses a lot of intermediate products produced by subsuppliers.

d) The sector is a highly competitive business of a limited number of multinational companies which control the export of the equipment and also the process of technology transfer to developing countries.

The major reason for the shift in telecommunications technology which commenced in the 1960s was the realization of microelectronics and computers and their application in telecommunications systems. Today, telecommunications and computer technology are practically inseparable. The most distinguishing characteristics of the above-mentioned technological process are the following:

- The development of new transmission systems (fibre optics and satellites) and switching systems (digital electronic and optoelectronic switches);

- Digitalization of the network, switching and transmission systems, as well as terminals at user premises. Owing, however, to the astronomical costs of replacing an analogue telecommunication infrastructure with a digital, it will, in many countries, take several decades to realize a fully digital network;

- The rapid increase in the speed and capacity of data transmission and in data storage;

- The integration of various networks and services into integrated services digital networks (ISDN).

On the other side a few African countries have started with a local production of components and subsystems of telecommunications equipment. Furthermore the production of accessories is performed in a number of countries on a small scale basis. All these efforts, however, are not sufficient to meet local demand as they are mainly used to supplement imported manufacturing products.

Most of the African countries are economically small and have low average incomes and small populations. In 1985, the World Bank classified more than half of all African countries as "low income" countries, having per capita income of US$400 or less. The economies are specialized, and most are dependent on the export of two or three primary commodities. The major part of the population lives in rural areas. Consequently, recent telecommunications policy emphasizes on the development of effective communications with the rural population. However, presently, less than one per cent of the continent's more than 500 million inhabitants have access to a telephone, and the growth rate is approximately 5.5 per cent per annum.

With this situation in mind the Secretary General of the Pan African Telecommunications Union (PATU) stated already in a comment to the report of the Independent Commission for World Wide Telecommunications Development, that as far as the future is concerned, it is becoming more and more obvious that the permanent solutions which must be found can only come from regional programmes covering among other things the creation of regional research and development and manufacturing capacities.

Within the priority sectors defined and developed, the United Nations Industrial Development Organization (UNIDO) has recognized the importance of telecommunications, not only as a catalyst to the overall economic development but also for the profund impact that the manufacture of telecommunications equipment can have on industrial capabilities in a number of related industries.

In 1982, UNIDO, in cooperation with PATU, initiated a programme of technical support to the development of the manufacture of telecommunications equipment in Africa, when it financed the "Regional Seminar on the Promotion and Development of Telecommunications Industries in Africa", Algiers, Algeria, 20 - 28 November 1982. The Algiers seminar was intended to complement efforts already undertaken by PATU and the International Telecommunications Union (ITU) to support the objective of Africa's self-sufficiency in this industry in the context of the United Nations Transport and Communications Decade Programme. As a result of the wide ranging discussions of the Algiers seminar, a number of conclusions and recommendations was elaborated which emphasised national, subregional and regional actions needed at the policies and planning level. One of the follow-up activities was the convening of a seminar "Prospects for the Manufacture of Telecommunications Equipment in Africa", Harare, Zimbabwe, 6 - 11 January 1986.

The Harare seminar was organised under the Technical Advisory Services Component of UNIDO's special programme for the Industrial Development Decade for Africa. For this seminar, five issues were chosen for presentation and discussion, i.e.:

- The use of repair and maintenance facilities as a means of beginning the manufacture of telecommunications equipment,

- Changing technologies from electromechanical to electronic switching systems: problems and options within the African context,

- Design, contracting and management of project in order to enhance local participation in their realization.

- Possibilities for the manufacture of specific components of a telecommunications system, and

- Possibilities of regional cooperation in areas such as standardization, the regional manufacture of equipment and components, and the promotion of manufacturing joint ventures.

The conclusions and recommendations of the Harare seminar were unanimously endorsed by the Third PATU Conference of Plenipotentiaries, Arusha, Tansania, 24 February - 6 March 1986. In following up the progress

already achieved, UNIDO in cooperation with the International Telecommunications Union (ITU) and the Brazilian Government is organizing a technical preparatory meeting on telecommunications industries for the manufacture of telecommunications equipment in Africa from the 8 to 12 May 1989.

This technical preparatory document shall form the basis for discussion and the exchange of experience between African countries and selected non-African developing countries. The paper describes briefly in chapter two the situation of telecommunications in Africa, the factors for the restricted growth of telecommunications and the consequences for the African countries out of this situation. With reference to this chapter some tables about socioeconomic and telecommunications indications are presented in the annex.

Chapter three presents a summary of the present status of the telecommunications industry in Africa based on surveys made by PATU in the last years. After the brief analysis of the problems and constraints on the growth of this sector a strategy is described, which should achieve a higher level of self-sufficiency and a better planned development of telecommunications networks, including:

- the systematic use of existing supply industry
- the development of local know how
- the creation of research and development capabilities and
- the development of industrial co-operation.

With the present situation and future possibilities for local production in mind it is indispensible that priorities are defined, by the Government and P&T Authority. In Chapter four a twofold approach has been elaborated to solve the pressing need on spare parts and telecommunications equipment supply.

Taking the actual operational problems in telecommunications services into consideration special emphasis is laid in chapter five on the status of repair and maintenance facilities as a means of entering into the manufacture of spare parts.

Chapter six presents an approach of strategy for possibilities in the industrial production of specific components and equipment. To realize viable projects important activities from the Government and governmental Authorities

are required. Furthermore changes in the design, contracting and management approach of telecommunications projects shall take place, which may have a strong impact for the establishment of industries.

After the review of components and equipment of a telecommunications network and the analysis of adapted technology finally a proposal of materials and equipment for manufacture is made which shall be most suitable under the specific circumstances in Africa.

2. Situation of Telecommunications in Africa

With a population of more than 500 million and a surface area that is second to Asia, Africa presents one of the biggest challenges for the communications development. Availability of telecommunications in this region is lower than in any other region of the world. Telephone density on the continent averages less than 0.7 per 100 inhabitants, compared to 2.8 per 100 inhabitants in Asia, 5.2 per 100 in Latin America and over 60 per 100 in Europe and North America. Table 1 in the annex presents some basic socioeconomic indications and the number of telephone stations of all kinds connected to the public network for all African countries. For 1985, a total number of about 4,840,000 telephone stations has been estimated for the African continent. There are more telephone stations installed in Mexico (6.8 million), Brazil (10.8 million) or in the Republic of Korea (6.8 million) than in the whole continent of Africa.

Table 2 in the annex presents the telephone density based upon the number of main telephones per 100 inhabitants and total telephones per 100 inhabitants for selected African countries.

The telephone density varies between 0.06 telephones and 2.09 telephones per 100 inhabitants. However, for all these countries the low average penetration figures still present no true picture. The telephone services are mainly provided for urban areas to meet the needs of public administration and commerce. In a number of countries between 80 and 90 percent of total telephone capacity is concentrated in urban areas. Rural areas are not connected to the networks due to various reasons, e.g. long distances, sparce population, difficult terrain, missing infrastructure. This disparity can be illustrated by the telephone density for urban and rural areas of selected African countries (see table 3 of Annex).

A telecommunications network provides not only the infrastructure necessary to support communication and information technology activities, but is also crucial to the whole process of economic development. To expand and improve the telecommunications network huge investment will be required, which represents a large portion of the gross domestic product (GDP) of the African country, but generally the investment is still too small to meet the requirements. In 1982 between 0.01 and 1.03 percent of the GDP was invested in the telecommunications sector. (see table 4 of the annex). Many African

countries operate the telecommunications sector with budgets allocated as part of five-years development plans. On average, 2 to 5 per cent of development budgets are set aside for telecommunications. A few years ago the average of budget allocated to telecommunications was less than 1 percent.

Despite the increased allocations in recent years, African countries still require financial and technical assistance from various resources in order to expand services and maintain existing networks. According to estimates of the ITU it will cost approximately US$50 billion to expand Africa's existing subscriber lines with additional 25 million subscribers to achieve a ratio of three telephones per 100 inhabitants for the year 2000. For most African countries the problem of financing is not simply one of increased investment. Telecommunications require mostly foreign currency, which amounts on average to about 60% of investment. However, foreign exchange is scarce and costly to obtain, as most of the revenues telecommunications earn is in local currency.

2.1. Regional markets for telecommunications equipment

About 12 major corporations account for around 80 percent of equipment sales worldwide. Five of the 12 companies produce more than one million lines p.a., most of the others 800,000 lines or more per year.

The total world market for telecommunications equipment in 1982 has been estimated at almost US$47 billion (expressed in 1979 prices). The level of the world market by 1987 and 1992 has been forecast at $6. billion and $103 billion, respectively (see table 1). According to this forecast, the average annual growth rate between 1982 and .992 will amount to 8.1 per cent. For Africa a total demand of telecommunications equipment of one billion US$ per year may be estimated. This amount should serve as a good basis for the establishment of a viable telecommunications industry.

Concerning the regional distribution of the sales market, table 1 shows that North America accounted for over 42 per cent in 1982, while Europe and Asia

Table 1. Forecasts of the market for telecommunications equipment by region, 1982-1992 (Billions of US dollars, in constant 1979 dollars)

Region	1982		Forecast 1987		1992		Average yearly growth rate
	US$	%	US$	%	US$	%	%
North America	19.9	42.5	29.1		41.9	40.8	7.8
Europe	12.5	26.6	17.2		23.7	23.0	6.7
Asia	11.8	25.2	19.1		31.7	30.9	10.1
Latin America	1.4	3.0	2.0		2.9	2.8	7.7
Oceania	0.9	1.9	1.2		1.5	1.5	6.6
Africa	0.4	0.8	0.7		1.0	1.0	8.2
Total	46.9	100.	69.3		102.7	100	8.1

Source: Original source is Arthur D. Little.

accounted for about 26 and 25 per cent, respectively. As Asia is expected to have a annual growth rate of 10.1 per cent, Asia's share of the world market will have increased to about 31 per cent by 1992, while those of North America and Europe will have decreased to some 41 and 23 per cent, respectively. It is also interesting to note, that Latin America, Oceania and Africa, despite a very low consumption of telecommunications equipment in 1982, are not expected to have increased their market share by 1992. In fact, their share is expected to decrease from about 5.8 to 5.3 per cent.

The telephone industry itself accounts for about 80 percent of the telecommunications equipment sales while telex, telegraph and data transmission share the balance.

Table 2. Share of major product subsystems in World sales 1980 - 1985 Value of World Sales

Equipment	in US$ billions 1980	1985	% of total 1980	1985
Switching (incl. PABXs)	12.6	18.4	31.9	31.7
Transmission	12.2	17.4	31.0	30.0
Terminals	5.8	8.0	14.7	13.8
Private Systems	4.3	6.4	10.9	11.0
Mobile Radio	3.8	4.9	9.6	8.5
Other	0.7	2.9	1.8	5.0
Total	39.4	58.0	100	100

Sources: OECD data

Table 2 shows a summary of the share of sales of telecommunications subsystems. Switching equipment accounts for about 32 per cent of total sales, transmission for about 30 per cent and all other products for 38 per cent.

2.2 Factors o restricted growth

Africa relies on the world market for the purchase of equipment as it has no major indigenous telecommunications industry. Little consensus exists concerning the appropriate technology for use in Africa. A broad range of telecommunications technology is in place, including satellite earth stations, mobile radio, microwave and other radio transmission systems. In average about 80 - 90 percent of automatic switching systems installed are electro-mechanical switching systems - a switching system control using relays and/or electromechanical switches to perform logic. The remaining 10 - 20 percent are electronic switching systems using electronic devices to perform logic.

Most of the electromechanical exchange equipment presently in use in Africa is of Cross-bar type with some semi-electronic units. Since 1984, all the equipment installed for international switching centres in 43 countries has been of digital type.

There are numerous factors responsible for the restricted growth of the communication sector in Africa and the low level of efficiency. The following reasons for the situation can be summarized:

(a) In almost all African countries investment in telecommunications has been effected for the acquisition of equipment that was designed, developed and manufactured outside the continent.

(b) The equipment bought by African countries is mainly designed to meet large markets and to be for use in advanced countries with moderate climatic conditions, high population density, well trained supporting staff and heavily used networks.

(c) Since the Sixties, the telecommunications technology has advanced rapidly and major technological changes have taken

place in the product ranges of suppliers. These changes too, did not take into account the circumstances of developing countries. (See figure 1)

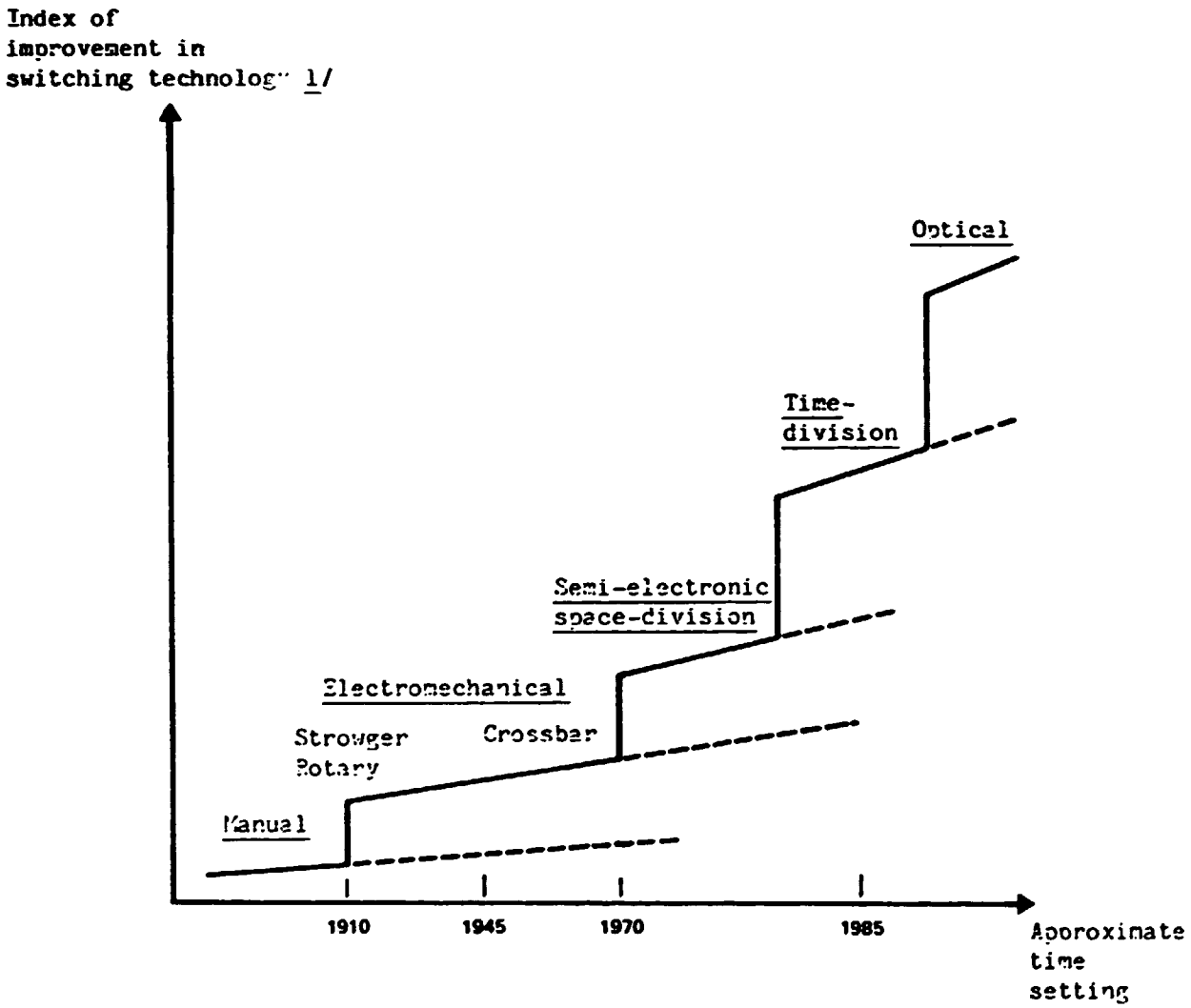
(d) Due to commercial reasons suppliers have stopped to manufacture older systems and particularly spare parts for older systems, which results into the fact that equipment still giving adequate service has to be replaced simply, because the necessary spare parts cannot be obtained.

(e) Problems may also arise when only small quantities of equipment or spare parts are required which would lead to extraordinary high costs in procurement.

(f) The investment made had only limited impact on the improvement of skills of local experts and no impact on the development of a local industrial capacity, neither national nor regional, mainly due to the practice of turnkey projects.

(g) No efforts have been made to standardize equipment and procedures. This situation has resulted in a mixture of equipment installed, which does not favour standardized operations or maintenance.

Figure 1:
Schematic illustration of various generations of switching technologies and their approximate time setting



1/ Number of channels, speed, costs, size etc.

Source: ECE secretariat

The consequences for the African countries arising out of this situation are manifold:

(a) Low efficiency of the investment due to high unit cost of equipment;

(b) Extended technological dependence from outside;

(c) Large number of different equipment of various levels of technology in use;

(d) Difficulty in controlling the technical planning of networks;

(e) Unstable operation of the systems due to spare part supply problems;

(f) Low impact of the telecommunications sector to the GDP and high impact in the growth of foreign debt;

(g) The introduction of high technology has only small impact on the general technical know-how level of the country;

3. Present status of telecommunications industry in Africa

A few, still not many African countries have started a production of some telecommunications equipment, but these individual national activities remain limited.

Figure 2 shows the countries which have established a modest local production of

- telephone sets and instruments: Algeria, Egypt, Sudan, Kenya, Tunisia, Zambia, Zimbabwe, Cameroon, Nigeria
- cables and wires: Algeria, Cameroon, Egypt, Tunesia Zambia, Nigeria, Senegal, Sudan
- switching equipment: Algeria, Egypt, Zimbabwe
- transmission equipment: Egypt
- accessories like poles: Sudan, Kenya, Nigeria
  PVC ducts: Cameroon

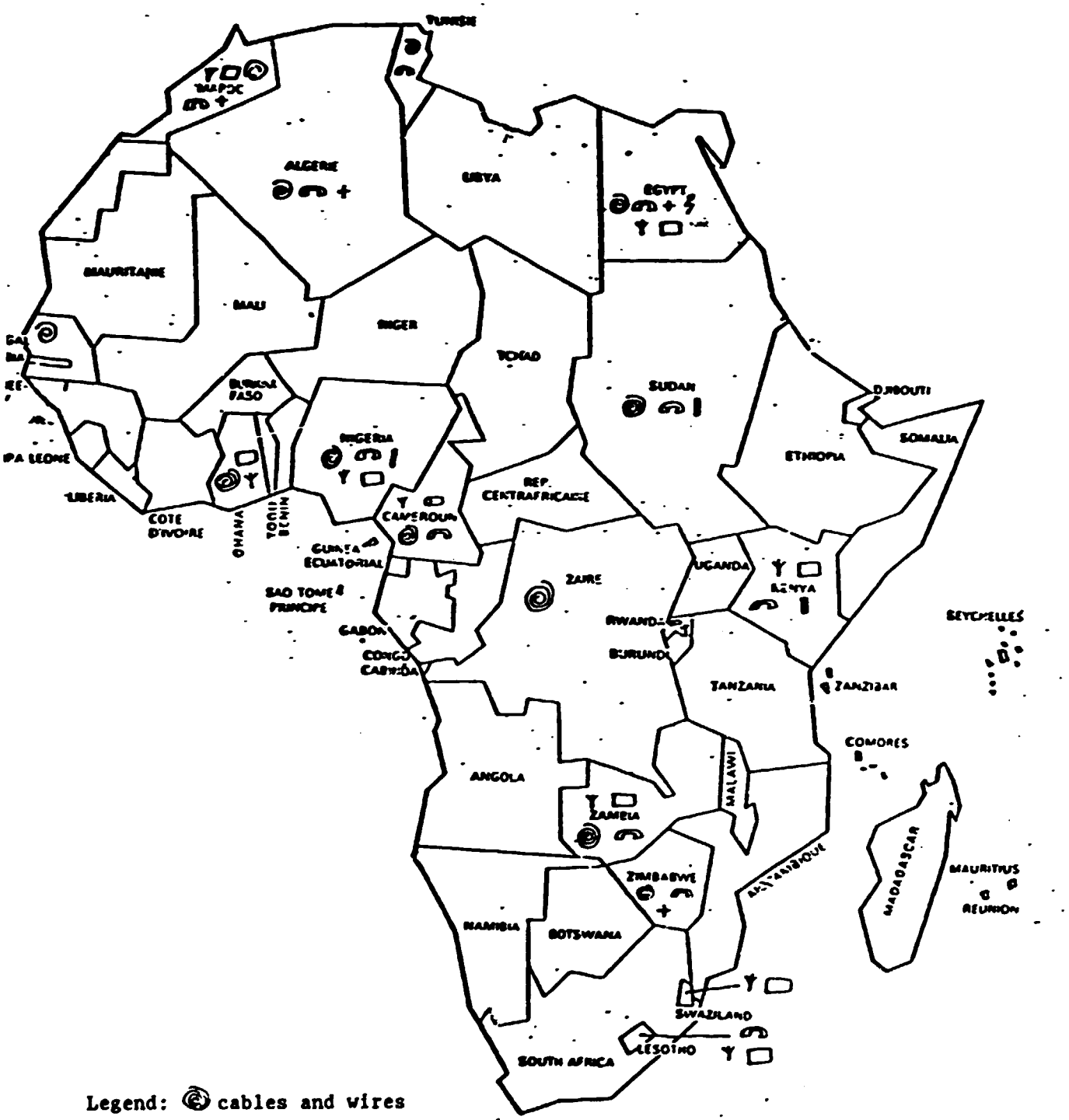
The figure is derived from a PATU-paper on manufacture of telecommunications equipment presented at the African Telecommunications Development Conference in Tunis, January 1987.

As a result of the Harare Seminar on prospects for the manufacture of telecommunications equipment in Africa held in January 1986 the following tables 3-1 to 3-4 were elaborated, showing a summary on the manufacturing activities in the telecommunications sector, as well as training facilities for local P & T staff. Table 3-1 summarizes the countries manufacturing

-cables
-switching equipment
-telephone instruments
-transmission equipment

Table 3-2 lists the countries which have established Design and Development Institutes. Table 3-3 provides information on the training

Figure 2: Telecommunications Industry in Africa



Legend:
- cables and wires
- telephone instruments
- switching equipment
- transmission equipment
- poles
- PVC ducts
- radio sets
- TV sets

The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations Industrial Development Organization

LIST OF MANUFACTURING PLANT

TABLE 1

COUNTRY	TELE CABLE CAPACITY KM	TYPE	WKG	SWITCHING FACTORY CAPACITY LOCAL	TRK	TYPE	TELEPHONE INSTRUMENT CAPACITY	TRANSMISSION EQPT LINE MUX	RADIO
1. ALGERIA		x				x	x		
2. EGYPT		Small Capacity SW-cable		30,000		crossbar-LME ARF102	200,000		x
3. SUDAN							x		
4. CAMEROON		x		x			x		
5. ZAIRE		x							
6. ZAMBIA	300,000	Jelly Filled Solid Polyethilin	YES				x		
7. ZIMBABWE		YES		24,000 TRK lines (non standard)			Repair plant for telephone instrument		

LIST OF MANUFACTURING PLANT

TABLE 1

COUNTRY	TELE CABLE CAPACITY CKM	TYPE	WKG	SWITCHING FACTORY CAPACITY LOCAL	TRK	TYPE	TELEPHONE INSTRUMENT CAPACITY	TRANSMISSION EQPT LINE MUX	RADIO
8. TUNISIA		x					x		
9. MOZAMBIQUE		YES							
10. ETHIOPIA	drop wire open wire jumper wire								
11. MAURITIUS	drop wire plant 1 million meter/year		YES				Asembling Plant 50,000	No	
12. COMOROS									
13. KENYA				All types of Telephone switch Boards 3000 lines per year			x		
14. NIGERIA	Yes								

DESIGN AND DEVELOPMENT INSTITUTES

TABLE 2

COUNTRY	DATE OF ESTAB.	NO. OF ENGRS & TECHS	PROJECTS DEVELOPED
1. ZIMBABWE			
2. MADAGASCAR	1985	4/8	Just started (software for FM)
3. EGYPT	1980	5 ENGRS 10 TECHS	Forsolving network problems
4. MAURITIUS			
5. COMOROS			
6. KENYA	1985	10 ENGRS / 70 TECHNS	Power units for telephone sets and switch Boards.
7. TANZANIA	1978	3-5 ENG. + 360 TECHN/p.a.	- General engineering + basic electronics - Subscriber apparatus, external plant and power plant - Switching, digital switching and transmission

TRAINING INSTITUTES & STANDARDISATION

TABLE 3

COUNTRY	NAME OF THE TRAINING INSTITUTES & TYPE OF TRAINING ENGRS	TECHS	CAPACITY PER YEAR ENGRS	TECHS	TYPE OF COURSE ENGRS	TECHS	FACILITY FOR REFRESHER COURSES
1. ZIMBABWE							
2. ZAMBIA							
3. ALGERIA							
4. KENYA	Central training school Africa regional advanced leveltrg. institute 100	2500	Yes	Yes	Practical Equipm and network planning course	Basic medium advance	all exist
	Kenya regional school	3000	Yes	Yes			
5. UGANDA							
6. NIGERIA							
7. EGYPT	Yes	Yes			all types		

TRAINING INSTITUTES & STANDARDISATION

TABLE 3

COUNTRY	NAME OF THE TRAINING INSTITUTES & TYPE OF TRAINING ENGRS	TECHS	CAPACITY PER YEAR ENGRS	TECHS	TYPE OF COURSE ENGRS	TECHS	FACILITY FOR REFRESHER COURSES
8. ETHOPIA	Ethopian telecom training institue Yes	Yes		50			Yes
9. MADAGASCAR	INTP (National institute for Telecom + Posts) No	only		40			
10. MAURITIUS	Basic skill and techs		20 students		Technicians + basic skills		
11. COMOROS							
12. TANZANIA	University	PTC Training Centre DSM Techn. College	3-5	360			PTC Training Centre

P&T - AUTHORITIES

MANPOWER AVAILABILITY

TABLE 4

SERIAL NO.	COUNTRY	NO. OF MAIN LINES	WAITING LIST	STAFF EMPLOYED ENGRS	STAFF EMPLOYED TECHS
1.	MAURITIUS	40,000 WKG 47,000 Installed	20,000	10	60
2.	COMOROS	1,200	2,000	4	8
3.	KENYA	117,000	71,000	>100	several thousand
4.	TANZANIA	51,142	54,802	3,940 Telecom staff include operators	

institutes in several African countries. Table 3-4 gives information on the manpower availability of P & T activities of some African countries. These tables contain the information which were available at the Harare Seminar in January 1986 and which should be completed during the forthcoming technical preparatory meeting.

Considering the local production of telecommunications equipment on a regional level the following manufacturing activities are performed:

(i) West Africa:	Small assembly plants for telephone instruments, manufacture of poles, cables and wires;
(ii)Central Africa:	cable manufacturing
(iii)East,Southern Africa:	Manufacturing of poles, cables and wires and telephone instruments
(iv)North Africa:	Advanced production of cables and wires, telephone instruments, switching and transmission equipment.

Beside the existing manufacturing facilities in Africa on this sector, there are also some industrial projects in planning stage like in:

- Cameroon: Industrial project for the manufacture of various materials and equipment for telecommunications and energy:
  - telephone sets
  - cables
  - TV receiver sets
  - Magnetoscope
  - power generators

- Senegal: Based on a sub-regional project the country is planning to produce various kinds of cables for telephony and energy.

- Kenya: There are two industrial projects in this country:

  (a) Manufacture of various materials for telephone sets and open wire systems, planned by the Kenya Post and

Telecommunications Corporation(KPTC)

b) Manufacture of automatic branch exchanges (public and private) of small capacity.

- Zimbabwe: There are a number of industrial projects to manufacture telecom material and equipment:

  - transmission equipment including parabolic antennas for satellite communications
  - digital switching equipment
  - telephone sets
  - overhead line plant involving the provision of copper-weld wire and raw material (PVC, Zinc) for the local manufacture of insulation, arms and spindles as well as the provision for plastic raw materials, creosote and zinc
  - small and large capacity concentrators.

- Madagascar: Workshop and R & D - project for the repair and maintenance of digital equipment.

- Algeria: Joint venture between three local partners and L.M. ERICSSON of Sweden to start production of digital switching equipment for Algeria's telephone network.

- Egypt: Project to start a production of large size digital exchanges.

3.1. Problems and Possibilities in the local manufacturing

Comparing the situation of telecommunications services in Africa to that of other regions and analysing the constraints on the growth of this sector and on the low quality of services offered, it can be concluded that the weakness of the telecommunications system in Africa derives to a greater extent from the weakness in the manufacture of telecommunications equipment. In order to ensure the viability of the sector, there is the need to establish a balance between manufacturing activities and the provision of services.

Most of the telecommunications industry mentioned in the previous chapter, operate below capacity as a consequence of one or more of the following problems:

- insufficient top-level management capacities, technical planning and design skills and know how.
- limited national market size and insufficient promotion of export efforts
- limited foreign exchange
- poor maintenance of production equipment due to lack of spare parts
- rehabilitation of the plant required
- lack of equipment standardization
- limited applied research and development
- inadequate project preparation
- market protection tendencies of industrialized countries

As a result of the Harare Seminar a strategy proposed by UNIDO and PATU was outlined to achieve a higher level of self-sufficiency and a better planned development of the African telecommunications networks. The elements of the strategy include:

(a) The development of structural links between the developing telecommunications industry and other better developed sectors such as the metal-working, plastics, eletrochemical, electromechanical and electronics industries. A dual approach is envisages: On the one side the development of a genuine telecom industry of different levels, which will be presented in chapter 5 and 6, and on the other side the systematic use of already exisiting supply industry. This would help to extent the local production of a number of components, accessories and spare parts for Telecommunications purposes. In the initial and intermediate stages, this approach would help to provide

useful technical support for the establishment of assembly shops in a number of countries, which could later on lead to the set up of indigenous production capacities for complete adapted sybsystems.

(b) The encouragement of the deglobalization of techniques and procedures. Such deglobalization would involve all supplies of both services and equipment. It would eventually lead to a break with the tradition of turnkey contracts and allow the development of local know how, of the design and manufacturing capacity of existing industries in various countries and the involvement of local production supply within the project execution. This should also help to reduce the burden of foreign debt on national economies.

(c) The establishment of a regional research and development (R and D) capacity. This line of activity represents an essential means of supporting industrialization efforts. Initially, regional R and D will be geared towards the adaptation of imported technologies to the different local constraints but it should move on to the modification of equipment and procedures suited to the region. It should also help produce expertise in the different technical and service-related fields.

(d) The promotion of industrial co-operation among states for the establishment of manufacturing and market infrastructures to ensure the economic viability of the industrial projects that will be undertaken.

3.1.1. Systematic use of existing supply industry in Africa

The establishment of telecommunication production for the supply of certain components, items and spare parts needed for the repair and maintenance of telecommunication equipment, as well as providing the technical support for the setting-up of assembly workshops and production facilities should be initiated by the systematic use of existing supply industries in Africa. First of all this approach may take place for already existing telecommunications industry. Taking into consideration the constraints and problems of industrial plants encountered in the previous chapter it would be necessary to rehabilitate the plants and to improve and extent the product range from a local basis to a regional level. Secondly this approach may take place for existing related industries like:

- Metallurgy industry for the fabrication of bays, frames, shelves, cabinets, towers, masts, antennae, containers, stays, manhole covers, cables, wires, drop wires, resistors and capacitors, earthing accessories.
- Ceramics industry for the manufacture of spindles and insulators.
- Plastics industry for the manufacture of ducts, cases, insulators, printed circuit boards and various containers, plates and dials.
- Electro-chemical and electro-voltaic industry for production of cells, batteries and other power supplies, aircondition units
- Electro-mechanical and electronic industry for the manufacture of components, sub-systems, relays, coils, switches, rectifiers, inverters, stabilizers, transformers and actuators.
- woodwork industry for the manufacture of wooden poles and cross arms.
- building construction industry for the manufacture of prefabricated buildings.

3.1.2. Development of local know-how

In order to ensure the orderly transfer of appropriate technology and know-how, there should be systematic increased participation of Africans in projects, through technical assistance and training opportunities. Turnkey projects made up of the following activities should be split into the different procedures and steps to allow maximum local participation:

- Feasibility Studies.
- Preparation of technical specifications and tender documents
- Contract negotiations.
- Manufacture of certain sub-systems and items.
- Supervision of site preparation, civil works, buildings and installation works.
- Commissioning and test-runs.
- Operation, maintenance and repairs.

In collaboration with technologically more advanced countries, technology transfer and technical cooperation programmes should be geared to the gradual introduction of appropriate technologies that correspond or are adaptable to the specific needs and constraints of African countries. The improvement of local know how for the future manufacture of equipment and of items should be promoted in the following areas:

- Public/Private Automatic/Manual switching equipment.
- Transmission equipment especially for the remote and sparsely populated rural areas.
- Solar and wind technologies for electrical energy production.
- Micro-electronic technology.
- Digital technology.

The production of electromechanical systems is a complex and closely integrated task. A large number of specialized component inputs, such as relays, screws, connectors require exact interfacing, mechanical and electrical skills. The large number of moving parts must be engineered precisely to ensure reliability and durability of the system. In contrast to electromechanical technology digital telecom systems require a deep range of new information based skills for the design and development of the aquired software. With the semiconductor based technology there is a sharp reduction in the importance of real manufacture which is reduced to a simple assembly operation.

3.1.3.Creation of Research and Development capabilities

At present only a few advanced developing countries have R & D capabilities of their own. This leads to the situation that equipment designed and developed in industrial countries cannot meet always fully the requirements of developing countries. On the other hand, it is not suitable to develop own equipment in developing countries due to limited resources. This problematic situation was already analysed in the ITU report-"The Missing Link" which concluded in the following statement:

> "The first objective of the R&D establishment in the developing world should, therefore, be to develop equipment which is not available elsewhere. An example would be equipment capable of providing service at more reasonable cost in remote areas which would be suitable for manufacture either on local or on regional basis. There is also a wide range of devices, tools and aids that are not pure telecommunications equipment but whose development and manufacture locally would reduce construction and operation costs. These establishments could adapt designs from the industrialized world to the needs of the countries they serve. In other words, we do not envisage the institutes developing major new telecommunication systems but rather modifying available

systems to their own requirements using modules and components available in the world market."

This would mean that initially the design and development strategies in developing countries either individually or collectively should be to adapt the equipment of the industrialised countries to suit their requirements.

These institutes could co-operate with each other and with other institutes in the developing countries. They could take up subsequently technical and operational problems and develop installation and maintenance solutions needed by telecommunication administrations in the region.

As large resources are required to create an effective R & D establishment it is advisable that wherever it is possible, these establishments should be developed out of an existing entity such as a faculty at a university or an existing research centre.

These institutes are to perform the following functions:

- The adaptation of equipment and techniques of installation and maintenance
- Solutions on particular technical problems
- Dialogue with local manufacturers on telecommunications
- Support for training
- Service and assistance on manufacturing activities.

Based on the results of the discussions of the Harare Seminar, UNIDO approved already the creation of Regional Environmental Centres and Regional Tropicalization Centres for Telecommunications equipment. Such a regional tropicalization centre for telecommunications equipment shall be implemented with UNIDO assistance in Zimbabwe, funded by the Government of Finland. This project is motivated by the fact that environmental considerations in Africa necessitate the application of special design and manufacturing techniques in the manufacture of telecommunications equipment. In particular tropicalization of electromechanical equipment, as they have moving parts, wires and physical connections require heavy isulation from outside environment and ongoing attention. Further, there is a need for a facility which could prepare specifications, devise selection/acceptance tests, undertake design/adaptation and undertake advisory services in the operation

of telecommunications equipment. In order to meet this need, the proposed centres would provide environmental testing (temperature, humidity, salt spray, vibration, shock etc.) facilities for purchased and locally designed and/or adapted telecommunications and other electronic equipment, they would act as focal points for information on environmental specifications, standardization, test procedures, they would offer advice to countries of the region on practical aspects of tropicalization. Finally, they could develop appropriate low-cost tropicalization techniques, materials and processes, and certify equipment according to tropical operating conditions. The costs and technical/technological skills involved in the establishment and operation of such centres justify a regional approach.

3.1.4. Development of regional industrial co-operation

The rapid change of technologies and the difficult conditions in the procurement of equipment lead to the conclusion to look for appropriate means and procedures to establish local manufacturing capabilities in African countries. They should be realized on the basis of technical solutions and economic conditions which could be organized especially through regional co-operation. There are a number of institutional structures for co-operation existing in Africa both at the regional level through institutions such as OAU and PATU and at the sub-regional level through bodies such as ECOWAS, CEAO, CEEAC, UDEAC, CEPGL, PTA, SADCC, etc.

Taking into consideration the Lagos Plan of Action with respect to the communication sector and industrialization for the development of its infrastructure there are a number of technical, financial and economic arguments in favour of regional industrial co-operation:

(i) technical arguments:

- Possibility of standardization of equipment and procedures
- Possibility of association for a common production of equipment
- Realization of greater autonomy with respect to outside technologies;
- Improvement in regular procurement

(ii)financial arguments:

- Savings in foreign exchange requirement
- Use of possible compensation mechanism in trade;

(iii)economic arguments:

- Common utilization of resources and raw materials;
- Utilization and value adding of the local industry for the procurement of basic products;

Taking into account foreseeable requirements and the need to create economically viable industries, the analysis of the regional possibilities for the establishment of local industries showed that:

(a) A small number of eight countries could engage in national production of telephone stations and exchanges;

(b) The other countries (42) should form groups for joint ventures to manufacture equipment;

(c) In general, the economically viable production of cables is possible only through joint ventures by groups of states.

The countries in the first category should act as nucleus around which the countries of the same category should be grouped. This would help avoid economic risks and could promote a better utilization of certain existing infrastructure.

The co-operating organizations may play an important role in the formation of groups, the implementation of common industrial policies, marketing, and so forth.

4. African Priorities, Strategies and Plans

To improve the overall situation on the telecommunications sector in general priorities, appropriate plans and strategies by the Government and the P&T Authority have to take place. The improvement measures should be reflected in national development plans and telecommunications development plans accordingly. And the P&T Authority has to put emphasis on the repair and maintenance of exisiting network to ensure a better quality of services, then to extent the services to rural areas and to standardize equipment.

1. Governmental Priorities

The start of local manufacture in the telecommunication sector requires the active role and strong will of the Government. The Government has to support and co-ordinate the plans and activities of the P&T Authority, parastatal companies, private companies and possible investors for establishing a telecom manufacturing industry through the incorporation of the telecom industrial sector in the national development plan and the classification of this sector as "strategic industry" with highest priority.

Due to the rapid technological development in this sector a fierce competition exists between the major telecom suppliers worldwide. Huge amounts of capital are required now to develop new products so that the suppliers can be competitive. Today the real manufacturing of digital equipment requires less people than twenty years ago, when electromechanical systems were manufactured by a high percentage of staff whereas about 10 percent of the company's staff were engaged in the design of new equipment. The electronic industry reverses the equation leading to about 80 percent of company's staff, composed of highly skilled people, which are involved in software engineering and design of new equipment as well as in research and development activities. In the electromechanical technology the material input costs to the switching industry amount to around 20 percent of the value of output. In electronic technology total material input costs, mainly semiconductor components, represent about 70 percent of the value of output.

As a consequence, a new manufacturing industry has to be based upon a well known and controlled market, the large majority being the domestic P&T network.

It is also important to note that a newly created manufacturing industry in a developing country will inevitably lead to delays in supplying equipment, quality problems and probably more expensive equipment, in most cases, at least at an early stage. It will, however, create new jobs, increase the independence of the country and allow for a higher degree of incorporation of local technicians and local staff in various activities.

It is obvious that the P&T therefore is an important agent in industrial development on this sector and without appropriate purchasing policy by the P&T there will never be a local manufacturing industry.

Another major issue which can influence the establishment of telecom industry in developing countries lies in the present trends in telecom management and basic philosophy of the services.

First of all some countries are adopting a deregulation philosophy, allowing for competition in some areas, and trying to offer tariffs to the public strictly linked to the cost of each single service. Secondly, there is also a certain trend towards the separation of the traditional activities of Postal and Telecommunications services.

Basically, the concept of cross-subsidization is part of Telecommunications tariffs in the large majority of countries. Particularly in developing countries cross-subsidization is a fundamental principle, so as to maintain the service in remote areas. Tariffs in straight accordance with costs will inevitably lead to difficulties in developing countries.

Normally there are two important subsidizing flows:

- Within telephony, mainly from international and long distance calls towards the local networks

- From telephony, as a total, to other services, namely telegraphy and postal services.

Deregulation tends to reduce cross-subsidization effects, therefore leaving less room for strategic decisions towards the industrialization. As a matter of fact, industrialization will mainly depend upon the development of local networks as they represent the area where large number of locally produced equipment can be utilized.

2. Priorities of P&T Authority

The quality of services provided by the telecom network and operator is sometimes very low or even deteriorating in some countries. The problems of the low performance of telephone networks can be identified in most cases on the maintenance services, in particular:

- Lack of skills of the maintenance staff
- Lack of spare parts required for the services
- Lack of repair facilities
- Lack of adequate maintenance concepts
- Lack of supervision that maintenance is in fact done.

All these lead to a drop in telephone traffic and thus much less revenues for future investments. A second reason for the poor performance of the networks is the fact, that in the African countries a great variety of different telecommunications equipment of different age and supplied by different companies is in operation which makes the uninterrupted operation and continuous maintenance difficult.

In many countries only urban areas are developed, the rural areas did not reach an adequate telecommunications structure. It is often not possible to make a phone-call form one African state to another without using the telephone connections via Europe.

Whilst the structural problems can only be solved through the extension of the existing networks, the problems of the low performance of the existing networks can be solved by improved maintenance procedures, concepts and training as well as regular and immediate spare part supply. Shortages of spare parts can only be settled by local production. Through the encouragement of maintenance and repair activities, solutions for the identified problems should be found.

3. Conclusion

With respect to the above mentioned priorities and problems a twofold approach is proposed:

- the enlargement and improvement of existing repair and maintenance facilities for spare part production as well as the set up of production units.

- the establishment of industrial units for the production of components and equipment.

Table 4 presents a summary of the twofold approach. The two approaches are explained in the following two chapters in more detail.

Table 4: Approach to industrialization

characteristics	repair and maintenance facilities	industrial units
targets	spare part production multi-purpose production	components and equipment production
users	various endusers like P&T radio and TV broadcasting, electric power authorities, households etc.	P&T
ownership	parastatal,P&T	private, parastatal
level	regional or national	regional or national
extension possibilities	extensive training facilities	
special characteristics	production start with very simple spare parts and small quantities. Step by step shift to higher technologies and larger quantities.	production of larger quantities to enable and ensure viable production units
mode of realization	technical assistance through international organizations and donor countries	investment by national and international investors

5. Operational status of repair and maintenance facilities as a means of entering into manufacture spare parts

It is absolutely essential that regular maintenance of the technical equipment installed in telecommunications networks does in fact take place, this ensures a long life cycle of the installations and thus a good economic investment.

If maintenance of equipment is not carried out regularly in telephone exchanges and repeater stations, and faulty equipment is not repaired, for whatever reason - lack of spare parts or lack of trained personnel, etc. - service then will be affected. The amount of traffic will drop and, amongst other things, revenue will also drop.

From the technical point of view, the equipment will deteriorate to such an extent that the maintenance staff will not be able to cope with the situation, with the result that major overhauls of complete systems have to be carried out. Usually, the original manufacturers are then requested to carry out this work with their own staff, test gear and spare parts. This can be a very expensive business.

It would be much cheaper, if part of this money would be spent on more training of local maintenance staff. On providing more spare parts and, to ensure that regular maintenance would be carried out, on providing more supervision, too.

In many industrialized countries, 30 years old electromechanical telephone exchanges are still giving good service and providing revenues, because they are continuously maintained in a good condition.

5.1 Local production possibilities

In some fields of technology it was already possible to develop local production out of maintenance and repair activities. As a result, knowledge and equipment was accumulated for the purpose of repair work. These repair activities lead first to production of substitutes and/or spares, and later on, to an independent local production of comparable items.

Production started initially in those fields where there was lack of

spares supply. Sometimes, the suppliers of original parts were not in the position to provide the required spare parts because the production of the said equipment had already been stopped.

Appropriate know-how developed in maintenance organizations, and investment made there for tools and measurement equipment, can be made available for production purposes, which would save foreign currency.

It is very difficult or even impossible for developing countries to adopt production models of industrialized countries in the telecom fields, even in case all constraints have been removed.

It is therefore necessary to find structure formulas, capable of activating a telecommunications industry.

One such formula may be the multipurpose production approach, i.e. a multipurpose Production Unit (MPU), manufacturing batches of a variety of spare parts for existing installations.

Such a production unit, however, must be designed and operated to very precise rules. It must be designed and operated in such a way as to enable the developing country to accumulate technical knowledge.

To guarantee this accumulation process, the fields of action of the various types of multipurpose production units must be precisely defined by establishing industrial configurations.

Besides the establishment of MPU's, the following approaches can be taken into consideration:

- A small-scale production with a certain stock of machine tools, at the workshops already existing.

- Assembling, as the very first step to earn basic technical knowledge.

5.2. Multipurpose Production Unit Approach

MPU's benefit most from the versatility of manufacturing in smaller batches and utilizing the minimum acceptable critical unit size, rather than

large production runs, large facilities and high degree of specialization.

In order that the proposed MPU's contribute to the industrialization efforts of a developing country, they should not operate at a higher complexity level than the rest of the capital goods industry. If products of higher complexity levels are selected, MPU's then become a new assembly or semi-assembly operation in which a large accumulation of technical knowledge is not possible.

The various products to be manufactured in a MPU must have some common dominant or homogeneous characteristics. So the MPU can be defined as the manufacturing unit for telecommunications products and other products which are required by different end-users, but may be produced within one multipurpose facility, as these products are characterized by some common dominant and homogeneous features.

5.3. Prerequisites

The following prerequisites are necessary for pursuing this approach to produce telecommunications equipment:

(a) Trained personnel, if possible, initially recruited from existing maintenance staff familiar with the equipment, followed by an intensive training programme for newly recruited staff at the training compound of the MPU.

(b) Access to the raw materials required for production, such as metals, plastics, chemicals, etc.

(c) Utilization of production processes like:
- metal sheet works
- soldering
- welding
- drilling
- lathe-work
- plastic dyecasting.

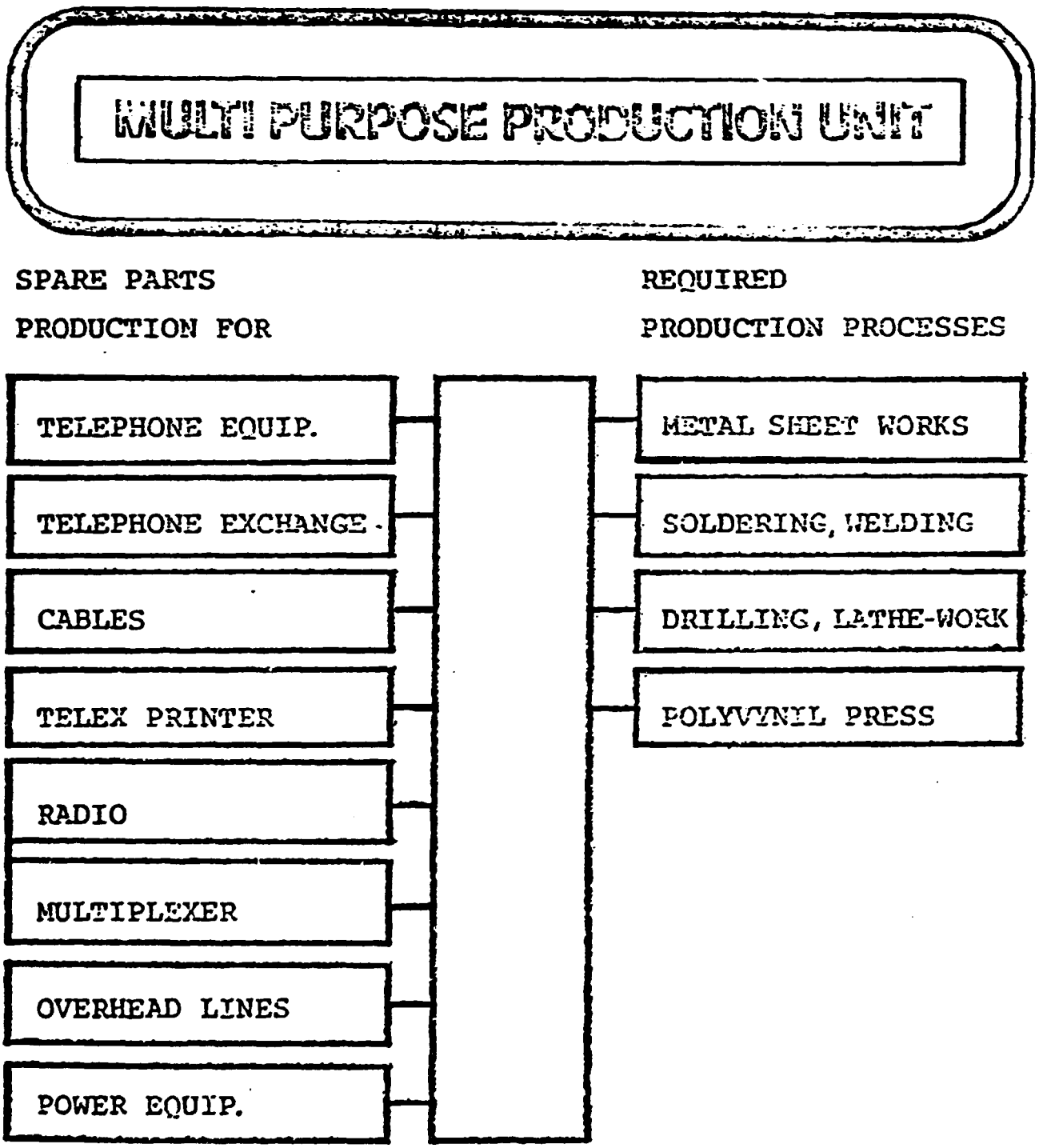
(d) Licences to manufacture, and access to the necessary know-how.

Therefore it is essential to have a close liaison with the original telecommunications equipment manufacturers to ensure the provision of adequate training and the raw materials required.

5.4. Production range of the MPU

Taking into consideration the primary objective of the MPU to provide spare parts and components for the telecommunications service the following product ranges can be envisaged. (see also figure 3).

Figure 3: MPU approach



i) Telephone Equipment

One area of repair and maintenance that could be covered by the Multipurpose Production Approach, as a means of entering the manufacture of telecommunications equipment, would be subscribers equipment: i.e. telephone housing, handset with transmitter and receiver, rubber foot, switchhook, ringer, network and base assembly, dials, bells, plugs and sockets, cords,key telephone systems, small PBX's etc.

It is assumed that the local maintenance man on site has replaced the faulty subscribers equipment, and has returned the faulty telephone, etc., to a central repair depot. Here it would be dismantled, faulty parts repaired or replaced. This unit would then be reassembled, cleaned and tested before being stored for reuse.

The above can be done on an individual basis, large numbers of telephones are returned to the central repair depot, a production and assembly line could be started for locally made spare parts. Thus, importation of expensive original parts from industrialized countries manufacturers could be avoided.

ii) Telephone Exchange Equipment

Group and final selectors, relay sets, relays etc., can be similarly dismantled and parts repaired or replaced. These parts can be produced locally at a MPU.

iii)Telephone Cables

Any kind of copper wire, insulated or not, can be manufactured in those countries, which produce copper within Africa, and are able to export to those other African countries not in a position to manufacture their own cables.

In addition to telephone cables, power cable and bus bars of varying capacities could be manufactured, copper wires for relay coils, transformers, and overhead pole routes, too.

In fact, all necessary parts for complete relays, relay sets, could be manufactured with the aim of producing all the necessary components for complete telephone exchanges.

iv) Telex Printer

Cables, terminal connections, paper and ribbon can be produced locally.

v) Radio and Multiplex Equipment

In the initial stages, some simple spare part components for radio and multiplex equipment could also be produced. However, until sufficient trained personnel with the necessary know-how and production capacity are available complete sophisticated transmission systems should not be taken into consideration.

vi) Overhead Lines

These consist of poles, copperwire, dropcable and insulators, which are comparatively low technologies. Poles can be supplied locally and comparatively simple factories would be required to produce insulators.

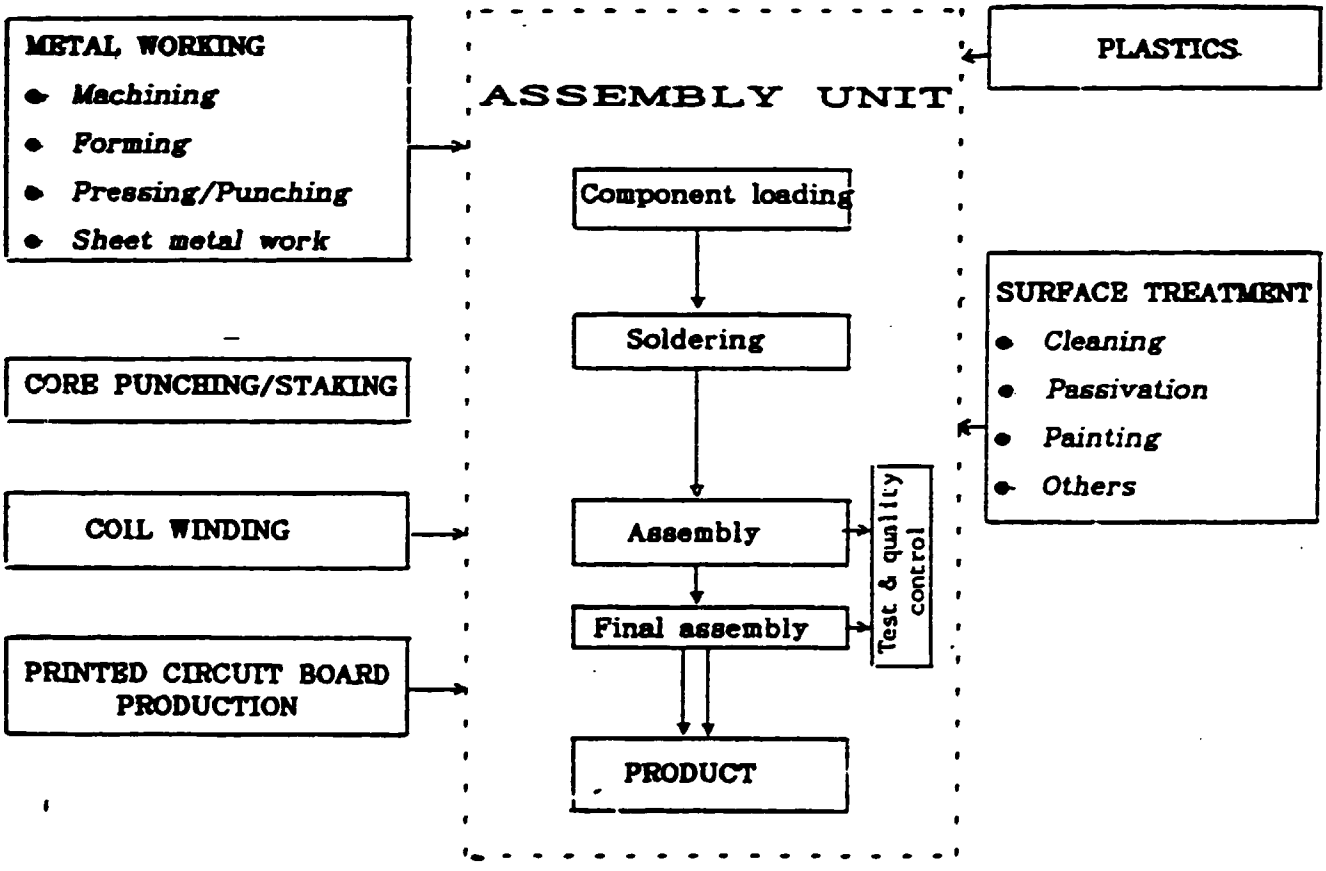
vii)Power Equipment

Cables, transformers, switches, fuses, and lubricants can be produced for repair of power equipment.

5.5 Conclusion

As a result of the Harare Seminar the creation of multipurpose production projects for the manufacture of spare parts and components is proposed. This proposal is motivated on the observation that many developing countries embarking on the manufacture of components and equipment have done so by using the repair and maintenance facilities of existing P&T workshops. These projects would provide practical demonstration facilities and training of African repair and maintenance personnel in the fabrication of spare parts and components. Alternative dominant production routes have been identified: First the electromechanical route, which involves processes such as core punching, coil winding, press work, sheet metal work, some plastic work and relate assembly work. This type of multipurpose workshop, in addition to carrying out electromechanical repairs, can manufacture relays, transformers, high-frequency coils, chokes, motor driven uniselectors, ac voltage stabilizers, etc. Second the electronic route, which can be formed by combining processes such as printed circuit board production, surface treatment, some plastics, some metal working and related assembly work. It can manufacture equipment such as PABX, telephone sets, lightning protectors, battery chargers, intercoms, dc power supplies/adapters, etc. Third the mechanical route, which consists of metal working and surface treatment processes. It can carry out the manufacture of machined parts such as shafts, jigs, fixtures, dies, tools, and sheet and profile work such as racks, cabinets, line attachments.

Figure 4: Manufacturing possibilities offered by MPU's



6. Approach of strategy for possibilities in the industrial production of specific components and equipment

A well defined and comprehensive strategy is required to realize viable industrial projects on the telecommunications sector. The development of a telecommunications industry is not a spontaneous phenomenon. Although a certain number of mechanical workshops manufacturing simple tools appear in many countries on the basis of small-scale industries, the creation of MPU's and other industrial units manufacturing more complex equipment, in most cases, may necessitate the intervention of the Government, as in the following summary:

- Planning of telecommunications industry
- Organized training of manpower
- Financing
- Development of engineering, technical support, research and development of production capabilities
- Creation and development of production units
- Regional cooperation.

For the detailed planning and realizations, the assistance of UNIDO and ITU, development banks, regional organizations, and other sources, like foreign telecommunications industries, will be useful and necessary to successfully establish industrial units.

Besides the tasks mentioned above for the Governments and governmental Authorities, there are some important activities for the successful implementation required, which can be summarised as follows:

i) Evaluation for the needs of components and equipment
The evaluation can be based on the records of faults on technical equipment and the assessment of the demand of components and equipment. This evaluation is essential for the selection of products to be manufactured.

ii) The choice of telecommunications technology and the selection of products
The proper selection of products has to take care of the following factors:

- the results of the evaluation of the needs
- the experience with existing manufacturing procedures and facilities
- The realistic assessment of the local circumstances

New digital technology offers the following advantages in comparison to electromechanical technology:

- solid state
- less susceptible to breakdown
- less maintenance required
- decline in price
- greater speed, efficiency and capacity
- continuous adaptation to traffic conditions

Digital technology requires very little maintenance, it has only few moving parts, and has a self diagnostic system to identify breakdowns through the computer controlled system and the repair usually involves the simple replacement of a circuit board.

iii)The choice of manufacturing technology
This depends on the type and technological level of equipment to be manufactured. Changes in modern technologies will have decisive influences on the entire industrial set up.

Equipment production has shifted to digital, microelectronic technology. Not only the advantages digital technology offers, but also the increasing demand for new information technology services depending on digital telecommunications networks were the reasons for this shift in equipment production. The production of microelectronic equipment is characterized by:

- the modularity of design
- divisibility in manufacture

And the major manufacturing efforts are mainly concentrated in the design and development stages. A small range of information based skills are required, rather than the broad range of mechanical and electromechanical skills.

iv) Relations with original supplier

Continuous relations with original suppliers are required particularly under the assumption to start a production of components and equipment, which are not any longer produced by the original suppliers to ensure a longer life cycle of installed equipment.

v) Relations with national sectoral industries

To maximise the benefits in establishing telecommunications industry in Africa, it is very important to incorporate already existing industrial units in the telecommunications field and related industrial sectors like electronics, plastics, ceramics, metallurgy etc. in the strategy for possibilities to manufacture specific components.

vi) Negotiations on patents and licences

To start a local production negotiations on patents and licenses and the purchase of designs will be required to obtain the know-how.

To establish manufacturing facilities for e.g. telecommunication cable or telephone instruments, various steps have to be considered to implement the industrial units successfully:

- Assessment of the needs and requirement projections for at least 10-15 years,

- Feasibility studies together with economic viability analysis

- Preparation of technical specifications of the product required to be manufactured and finalisation of product mix,

- Discussions with reputated manufacturers of the product with regard to technical and financial conditions for setting up the manufacturing facilities,

- Planning and definition of all logistic requirements for operation

- Preparation of technical specifications for the manufacturing machinery and release of tender papers, evaluation of bids.

- Contract negotiations with the selected supplier and order placements.

- Selection of site keeping in view the infrastructural availability of access roads, land, water and power supply

- Start and execution of civil construction work,

- In deep training of the staff

- Receipt of the machinery, installation, testing and commissioning of the factory and start up production,

- Testing of the indigenously fabricated product within the country as well as at the premises of the original supplier, to ensure compliance with the specification,

- Regular production.

While establishing a manufacturing unit, two important aspects would have to be kept in mind, first, that the price of the equipment or material indigenously manufactured should not be higher than the price of the imported goods and, secondly that it is useful to have equity participation of the foreign supplier at least in the early stages. With respect to telephone cables and telephone instruments a large number of manufacturers would be willing to pass on the technology for manufacturing these items.

The following chapter will deal with some of these aspects to allow a practical approach in realizing a local production.

6.1. Design, contracting and management of telecom projects

Some important prerequisites for the creation of local manufacturing can be summarized as follows:

(1) Important role of the local P & T Authority in:
- selecting and training of new staff
- planning as to define the potential market for a new manufacturing industry through development plans
- organizing the telecom service towards a more dynamic role taking

particular care of technical specifications of telecom equipment, acceptance tests, maintenance etc.
-setting up appropriate policy guidelines, rules and procedures in order to promote local manufacture
-using maintenance workshops as to promote the start of local manufacture

(2) Manufacturing facilities may start with simple items and upgrade the technological level in production gradually.

(3) Incorporation of local works, local products and staffs into telecom projects by respective contracting and project management.

These items shall be explained in more detail.

1. The role of the P & T Authority

The creation of local manufacturing of telecommunications equipment and industries in related sectors requires the active role and the strong will of the local P & T Authority. The P&T Authority will be the major customer of the telecommunications industry.

One of the basic criteria to promote the start of local manufacture is the increase of number and skills of staff within the P&T Authority. The increase in skills can not only rely on the fact to send staff members to training courses in specialized schools, to administrations or manufacturing plants overseas. Training includes also the engagement of people in the job so that they can develop their skills by performing various tasks in the organization, e.g. installing, testing and maintaining equipment.

Another important criteria for launching local manufacture is the elaboration of reliable over-all development plans with the forecast of equipment requirements for the next 10 to 15 years and the analysis of fault records of installed equipment to evaluate the needs of equipment. These development plans would form the basis of the production plans of local manufacturers taking into consideration:

(a) which products will be required by the P&T Authority.
(b) which products can be produced locally.

In close context to overall long term plans, short term development plans have to be prepared as well as the definition of technical specifications, equipment standards, quality control standards, etc. which certainly will influence the local production of equipment envisaged.

Furthermore, the P & T Authority has to be committed to the local manufacture development through appropriate policy guidelines taking into consideration that higher costs, delays and quality problems may occur in the beginning of local manufacturing.

Finally, the P & T Authority itself can start the manufacturing process using existing maintenance workshops. Their manufacturing activities can include small accessories like terminal boxes, connecting bars. etc up to higher sophisticated components. On the other hand workshops can easily be turned into test laboratories for acceptance tests.

2. Manufacturing facilities

The manufacturing process may start with very simple items like various installation accessories manufactured in workshops or existing small factories that could be easily reconverted, copper wires in already existing cable factories, poles in the timber industry, etc. In a local network the cables, poles and accessories represent a share of about 50 percent of the investment.

3. Respective project contracting and management.

For implementing a telecom network, two approaches are possible in realizing it:

a) on a turnkey basis through a general contractor
b) on individual contracts by different contractors.

The splitting of a project into individual parts for different contractors requires, however, a very accurate planning of projects and work. All details have to be carefully analyzed, planned, agreed upon and integrated in a plan. On the other hand such a project would allow for the

- higher integration of local products, promoting also related industries like timber and woodwork industry for poles, civil works for buildings and access roads, steel works for towers, structures,

- ceramic industry for insulators, cable works for cables and wires, etc.
- higher participation of local staff, thus enabling the improvement of their skills.
- better adaptation of the system to local requirements.

A good example for the approach would be the local networks. In a local network, buildings and other infrastructural investment represent a lower percentage of the total investments. However, in urban areas the investment into ducts represent about 40% of the cable network. In total, it can be assumed that the investment in non-telecommunications equipment and works represents about 15% of total investment in telecommunications. Taking this percentage into consideration it is advisable to split local network's project into several individual projects to develop and incorporate local manufacturing industries.

4. Long term development plan.

The overall long term development plan is a very important element and should include the following items:

a) Telephone network
Basic scheme of the telephone network including the definition of various types of switching centres (local exchanges, primary exchanges, secondary exchanges etc.)

b) Transmission network
Layout of the transmission network including the definition of various transmission modes (cables, open wire, microwave, satellite systems)

c) Forecasting
Forecasts on the development of telephone stations, telephone lines and long distance circuits should be made for certain periods.

d) Modernization and integration strategy
Taking the technological changes into consideration, a strategy of the modernization of the network should be elaborated together with a strategy of integration of the existing network with the one to be developed

e) Extension of the network

Definition of new routes and extension of the network to offer telecom services to underdeveloped areas

f) Rural areas

Special attention has to be given to the problems of telephone access to rural areas

g) Transmission plan

Careful studies shall be made on the transmission characteristics of the network to allow national and international communication.

h) Technical set-up of telephone systems

Due to the technological change from analogue to digital equipment a reliable strategy for the implementation and operation of analogue, semielectronic and digital equipment shall be defined.

i) Priorities

Priorities shall be established in the implementation of systems paying particular attention to the needs of generating the funds required

j) Other services

A strategy and development of other and new services in telecommunications shall be elaborated analyzing the present and future demand and the possibilities to finance the implementation of these services.

k) Equipment characteristics

Standards are required in order to harmonize the various networks to be installed. Existing equipment specifications shall be revised and new specifications be set up to improve the quality of the network

l) Maintenance

Particular attention shall be laid on the procedures for corrective and preventive maintenance of equipment including tests, measurements, specifications and repair activities.

m) Organizational development and staffing

Telecommunication has to be recognized as a dynamic sector which

requires not only changes on the technical side but also permanent development and improvement of the organization of services.

n) Budgeting

Budgeting procedures shall be defined in order to facilitate the establishment of annual budgets and also its distribution among various projects to be implemented.

6.2. Review of components and equipment for the creation of a telecom industry

Public telecommunications systems consist of four basic sub-systems:

- subscriber terminals
- local line plant
- switching system
- transmission system

The different items in each of these sub-systems are as follows:

i) Subscribers Terminal

- Drop-wire
- Window terminal
- Subscriber house wiring
- Subscribers plug and socket
- Telephone instruments, non-voice service terminals such as facsimile & data modem.

In former times the subscriber terminal was a simple telephone set providing basic vocal telephony. The latest technology trends provide sophisticated terminal intelligence to perform different tasks. Terminals fitted with extensions for other services as text transmission, facsimile and data transfer have become more versatile and flexible.

ii) Local line plant

- Primary cables
- Ducts
- Cabinets
- Distribution points
- Secondary cables

- Concentrators
- Manholes
- Poles

Subscribers terminals are connected to local exchanges by a physical pair of metal conducting wires. These connections account for 30 per cent of the total capital costs for local line plant in urban areas in average. These local networks use either overhead or underground cables of different sizes and distribution points with flexible conductors offering enough available capacity for new subscribers terminals connections to be added. Opposite to urban areas the local distribution in rural areas forms the major problem due to long distances between the local exchanges and the individual subscribers. Connections using physical conductors still dominate with the extendable use of overhead open wire systems. Instead of physical conductors it is possible to use the radiotelephony. Microwave systems in the VHF,UHF and SHF ranges operate along line-of-sight paths allowing the bridging of longer distances. HF systems are used only to a limited extent because frequencies are scarse and interference high.

iii)Switching system

- Exchange Terminations
- Heat coil fuses
- Switching equipment
- Power equipment

Manual or operator circuits in which connections are made by means of jacks and plugs, are still used. As long as staff is available around the clock, these systems can provide a reasonable service with low investment, low energy consumption and moderate maintenance. However, in rural areas, it often happens that they are manned only during day time and that operating costs are high.

In all automatic analogue systems, voice frequencies are converted into an electrical signal of variable frequency and amplitude, and the communications are connected by means of a separate switch within the system. The oldest automatic system is the step-by-step system or Strowger rotary switch consisting of electromagnets and ratchets, which is widely used. Large banks of rotary switches are connected in series. Essential parts are the switches and control section. Direct progressive control and register progressive control are both used in step-by-step switching systems.

Maintenance costs are high, the system has a large number of moving parts, and its capacity is limited, but it can provide a reliable service and many maintenance engineers are familiar with it. It is almost no longer possible to buy a new step-by-step switch, but sometimes such equipment can be obtained in reconditioned form and perfect working order on the world market. Crossbar systems using coordinate or matrix switching operate at higher speeds and are less expensive to maintain. However, these systems are also aged and it is expected that their production is limited to a few countries only for the expansion of existing systems. Crossbar switching systems use the common control method based on relay technology.

The recent generation of analogue systems resulted in semi-electronic space-division switches with stored programme control (SPC). In these systems, the control functions are performed by a programmable computer and the switching matrix can employ solid-state electronic cross-over points. The advantages include extensive possibilities for remote operation and maintenance, integrated test signal units, and an almost total absence of unprotected contact points, which makes these systems less vulnerable to dust. Normally, SPC exchanges are produced in compact form so that air-conditioning is required, particularly in tropical countries.

The next generation were the full electronic time-division switches. In this digital switching system, telephone conversations are converted from an analogue signal into a code consisting of a high speed go/stop pulse, operating completely in digital mode.

The impulses from different conversations are separated from one another by discrete time intervals and are switched in turn by the system (time division switching) so that many conversations can be handled by the same switch. Digital exchanges are cheaper to install and maintain than analogue exchanges, particularly in the larger sizes, and they are becoming less expensive. The advantages of this type of switching include its computer output compatibility and the potential for savings where it is operated in conjunction with digital transmission systems.

The latest generation of switches are based on optical technology, the photonic switches. These switches process and re-route light signals instead of electricity. The introduction of photonic switches might begin in some years from now.

iv)Transmission systems

a) Multiplexing equipment (FDM or TDM systems) including frequency generation.

b) Overhead Lines

* Poles and accessories
* Overhead wires and cables

c) Coaxial Cable

* Line equipment

d) Optical Fibre Systems

* Optical Fibre Cables
* Optical Fibre system equipments

e) Radio Systems

* VHF,UHF equipment
* Microwave Equipment
* Tower, Antennae, Feeder cable

f) Satellite Communication Systems

* Satellite earth station equipment
* Earth station Antennae & Towers

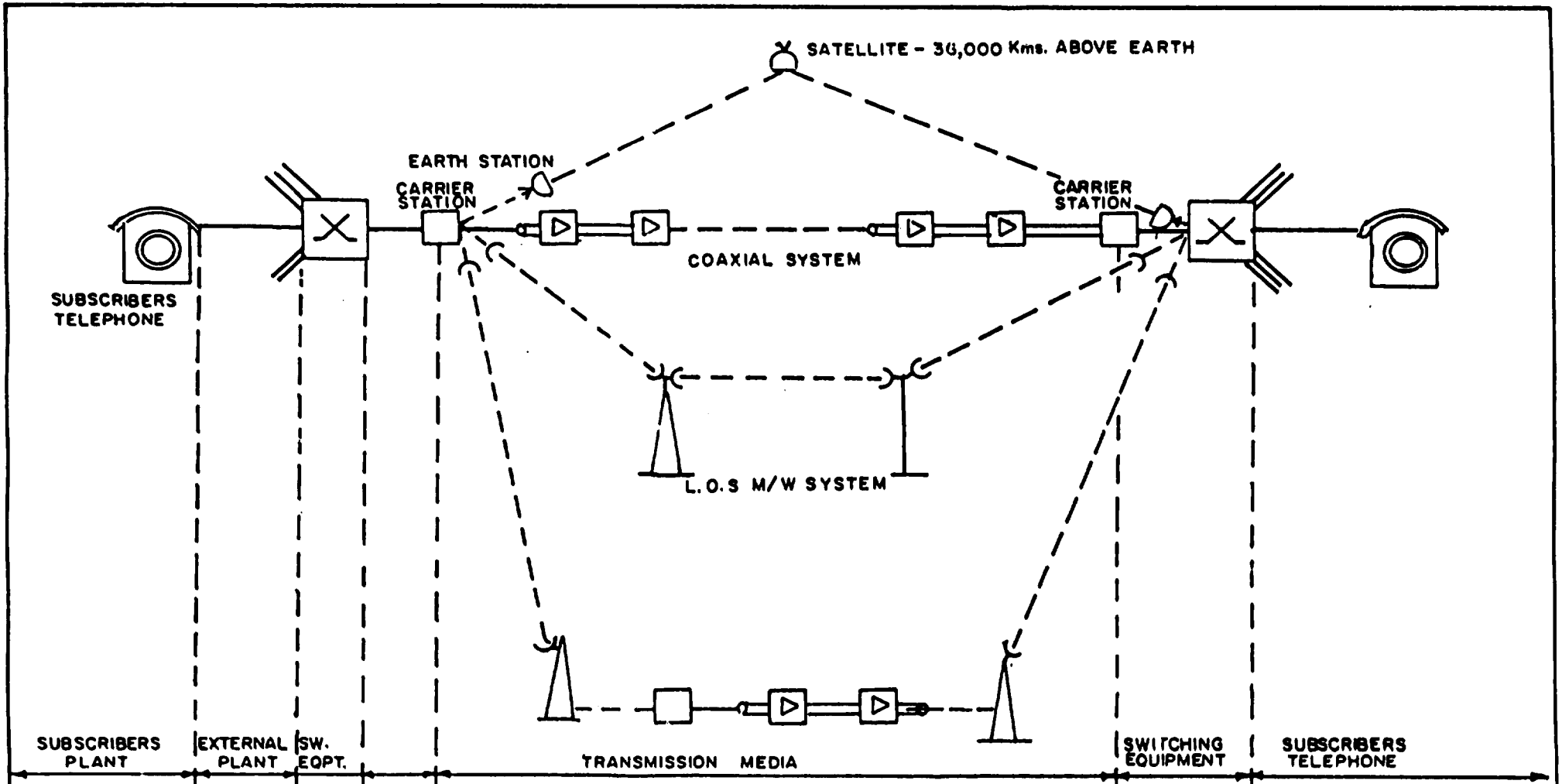
g) Power Plant

* Mains, solar cells, batteries
* Stand-by generators

Communications can be transmitted between exchanges along systematic pair line links, coaxial, or optical fibre cables, or by means of microwave radio system, overland or via satellite. The choice of medium depends on the bandwidth or the volume of traffic to be transmitted, the distance and terrain to be covered, the quality required, the traffic distribution and the cost.

In the past, trunk transmission systems were analogue, but they are now being gradually replaced by digital systems. The applications of pulse code modulations (PCM) technique to traditional transmission methods has resulted in increased capacity and efficiency.

Technological progress reduced the cost and improved the quality of service. The optical fibre is particularly suited to high capacity routes with longer distances between the signal regeneration points, which reduces costs even more while increasing reliability. Optical fibre systems are going to replace symmetric pair line links and coaxial systems. Compared to other transmission modes fibre-optic systems offer the following advantages:



SUB-SYSTEMS OF A TELECOMMUNICATION NETWORK

FIGURE 5

- a low degree of attenuation and a longer distance between repeaters
- a high information capacity and speed
- use for ISDN and broadband services in particular
- decline in price due to improvement in technology and production process
- small cable size and low weight
- immunity from electromagnetic interference
- absence of crosstalk.

Despite these advantages there are large quantities of copper cables in use, which will not be depreciated for decades and which represent a large amount of sunk investments. In addition copper is a basic raw material which is available in Africa.

Microwave systems are particularly suitable for medium or high capacity routes in the developing countries and over difficult terrain. Submarine optical fibre or coaxial cables can provide an economic solution in many cases for long distance or international transmission. Satellite systems, particularly low traffic systems, are becoming more and more competitive when there are long distances to be covered or where the topography poses problems.

6.2.1 Appropriate equipment configurations for rural networks

The majority of the population of developing countries still lives in rural areas. Table 5 shows the population distribution of developing countries for the years 1980, 1990 and 2000.

Table 5 Population distribution of developing countries

Years	Rural population of developing countries in percentage
1980	70.47
1990	65.29
2000	59.56

Source: World Development Report, World Bank, 1985

Taking now the typical features of a rural area into consideration, as there are:

- large and sparsely populated areas
- small settlements
- mainly agricultural activities
- low level of infrastructural development
- difficult power supply situation

the planning of an equipment configuration has to concentrate on telephony, eventually extended to telegraphy and telex. Other more sophisticated services, implemented in the industrialized world, are not required by the public in rural areas at the moment.

The assessment of the present and future demand is the first activity in the planning process. Normally the demand of private persons in rural areas with low income will be very low. Therefore the planning has to concentrate more on public telephones.

As the next step the sizes of rural exchanges have to be determined. According to studies of the ITU a classification of sizes was elaborated on the relationship between subscriber density and the size of the exchange based on economic considerations.(table 6).

Table 6 Classification of exchanges

Type	Number of Subscribers per km^2	Size of rural area in ha	exchange area	exchange size	Subscriber distances in km
A	>1.5	65	50-130	80-200	5-8
B	0.1-1.5	65-1000	100-140	40-160	7-13
C	<0.1	1,000-10,000	>1,000	<40	65-1,000

Source: Rural telecommunications - GAS 3 manual, ITU, 1979

Seen from the economic point of view, public exchanges with less than 30 subscribers are not attractive. In this case the solution would be:

i) the line collection
ii) drop and insert possibilities

According to table 6 the number of lines for a typical rural network lies between 100 and 1,000.

The next decision is now the selection of the transmission system and the transmission mode. The systems that can be considered are:

1. Open wire carrier systems
2. Cable carrier systems
3. Optical fibre cable systems
4. Radio systems: HF, VHF, UHF, SHF
5. Satellite systems.

Each of the systems has advantages and disadvantages. The choice of a system depends on several factors like transmission capacity, topographic and climatic conditions, human and also financial aspects.

1. Open wire carrier systems:

Advantages:

- Suitable for large, sparsely populated areas with distances up to a few hundred kilometres, where a limit on radio frequency bands exists.
- Repeater sections can be made very long
- Relatively cheap
- Offers drop and insert possibilities.

Disadvantages:

- Limited capacity
- Quality depends on climatic and geographic conditions
- High maintenance is required
- Low reliability
- High risks on theft, sabotage and destruction.

2. Cable systems

2.1 Symmetric pair and coax pair cables

Advantages:

- Large capacity
- Reduced crosstalk
- Independent of temperature and humidity
- Less possibilities of theft

Disadvantages:

- Expensive cable laying
- Expensive fault location
- Shorter repeater sections
- Too large capacity for rural areas

2.2 Glass fibre systems:

Advantages:

- Larger capacity (above 10.000 channels)
- Immunity to electromagnetic interference
- Larger repeater distance (about 10 km)

Disadvantages:

- Too large capacity for rural areas
- Expensive equipment
- Difficult maintenance due to higher sophistication
- Complete foreign technology

3. Radio systems

3.1. HF radio system

Advantages:

- Very long distances can be covered
- Relatively cheap
- Simple technology

Disadvantages:

- Poor voice quality
- Low capacity
- Large antennas required

3.2. VHF/UHF radio systems

Advantages:

- Better quality
- VHF/UHF systems can be used for distribution, toll and trunk systems
- Small and simple antennas

Disadvantages:

- Limited coverage
- Limited capacity

4. Satellite systems

Advantages:

- Satellite system can be installed relatively quickly
- Service to remote areas can be provided easily and in short time.
- Flexible network configuration
- Easily adapatable in operation
- Reliable connections
- Economically feasible for long distances.

Disadvantages:

- Complete system still very expensive
- In tropical zones larger antennas or more power are required.
- Complete foreign technology.

- High need of foreign exchange for procurement and operation.
- Easy jamming of communication
- International agreements required, limiting self-reliance at national level.

Finally comparing the different transmission systems some conclusions can be made which are summarised in table 7.

Table 7: Comparison of transmission systems

System	Open wire	Cable	Glass fibre	HF Radio	UHF/VHF	SCPC[1]
Design Capacity	any	any	any	low	low	moderate
Quality	fair	fair	good	poor	good	good
Installation speed	low	low	low	high	high	high
Maintenance	high	moderate	moderate	low	low	low
Disruption possibilities	low	moderate	low	high	low	low
Flexibility	low	low	low	low	moderate	high
Relative costs	low	high	high	low	moderate	high
Expansion possibilities	limited	limited	high	low	limited	high
Suited for distances < 50 km	+	+	+	-	+	-
50 - 200 km	+	-	+	-	+	+
> 200 km	+	-	-	+	-	+
Suited for distribution	-	+	-	+	+	+
transfer	-	+	+	-	+	+
trunking	-	+	+	-	+	+
digital transmission	-	+/-	+	-	+/-	+
level of foreign technology	low[2]	moderate	high	low	low	high

1) SCPC - Single channel per carrier satellite system
2) Multiplex equipment not included
Source: EUT - report, the impact of telecom on rural areas in developing countries 1987.

At the Eindhoven University of Technology (EUT) in Netherlands a study on the impact of Telecommunication on rural areas in developing countries was made, whereby the following conclusions were elaborated:

1. In a rural area a subscribers density of 1 per 50 km^2 can be expected when people live scattered. In the case of isolated settlements between 50 and some 100 subscribers can be expected with a maximum of 1000 subscribers.

2. From the economic point of view telephone exchanges with less than 30 subcribers are not attractive.

3. For trunk lines with a low to moderate traffic volume over relatively long distances, the open wire carrier systems may be the most cost effective system.

4. Cable systems may be used for subscriber lines for distances up to 25 km. For rural areas carrier cable systems are not very suited.

5. HF radio systems may be suitable for few isolated subscribers in a large area. Half-wave dipole antennas may be the most cost effective antennas.

6. VHF/UHF radio systems may be suited for low to moderate traffic volume. Capacity can be enlarged by frequency re-use, the maximum distance is about 50 km, depending on antenna size.

7. Terrestrial SHF radio systems are mainly suitable for trunking large traffic volumes.

8. Single channel per carrier satellite systems (SCPC) may be suitable for sparsely populated, inaccessible and difficult terrain.

9. The costs per line in rural areas are about five times higher than in urban areas (see table 8)

Table 8: Indicative cost per line in urban and rural areas

	Cost per line in urban areas	Cost per line in rural areas
Subscriber connections and local line plant	40	400
Investment in exchanges	30	60
Investment in transmission	20	20
Investment in building and land	10	20
Total cost per line	100	500

Note: Index 100 = total cost per line in urban areas.
Source: ITU - OECD: Telecommunications for Development 1983.

Conclusion:

Compared to the urban areas, the common characteristics of the rural areas are decentralisation of users and low traffic, which leads to higher costs than in urban areas. Therefore it is important to seek cost reductions through various technological approaches including the development of small-sized equipment, simplification of basic functions and facilititation of operability and maintainability.

6.2.2 Equipment cost comparison

Besides the material and equipment costs also the installation, testing and commissioning costs can have a high impact on the overall costs of a telecommunications system. In table 9 a classification of costs in percentages between material and installation was made.

These are broad percentages which may vary from country to country depending upon several factors such as initial equipped capacity, space and frequency diversity for radio systems etc. However, it can be noticed that in switching and transmission projects the material and equipment costs are higher than the installation costs, but in local line plant project the installation costs which include the cost of duct material are higher than the cable costs.

Table 9: Material and installation costs in percentages

100% Costs		
ITEM	EQUIPMENT/MATERIAL	INSTALLATION, TESTING AND COMMISSIONING
SWITCHING	80%	20%
LOCAL LINE PLANT	(Cables and jointing Material) 40%	60% ducts 20% material installation & commissioning 40%
TRANSMISSION (TERRESTRIAL) RADIO	MUX 20% (50% equipped); Tower Antennae & Power plant 40%; Radio 17%	23%
COAXIAL	Mux 25%; Power plant 20%; LINE 25%	30%

Source: Agarwal: Presentation at Harare Seminar, 1986

The tables 10 and 11 below show the percentage distribution of labour and capital requirements for the manufacture of components and assembly including testing according to CCITT studies:

Table 10: Labour requirements in percentages.

LABOUR REQUIREMENTS	Telephone Stations	Electronic Switching Equipment	Transmission equipment
Manufacture of components	40	20	10
Assembly and tests	60	80	90

Table 11: Capital requirements in percentages

CAPITAL REQUIREMENTS	Telephone Stations	Electronic Switching equipment	Transmission equipment
Manufacture of components	90	70	40
Assembly and tests	10	30	60

Source: CCITT-studies, ITU

6.3 Choice of adapted technology

The 1960's was the decade of the implementation of analogue microwave radio systems for backbone networks. The decade of the 70's was dedicated to the implementation of stored programme control switching equipment for urban areas. The 80's are characterized by the introduction of digital switching and transmission equipment. The 90's will bring the introduction of integrated services digital networks (ISDN).

Due to this rapid technological progress it is very difficult for a developing country to choose the best technology for its telecommunications network. The lowest cost and most appropriate technology concerning operations is likely to be based on the high technology of microprocessors and silicon or gallium arsenide semiconductor chips which represent the building block of digital equipment. Older technologies often are not the cheapest ones, have higher power consumption, and less satisfactory technical performance.

Yet the economies of semiconductors manufacturing depend on the availability of global markets, which makes it difficult for developing countries to manufacture them on a national basis. They have to be bought from semiconductor manufacturers. When conventional technology is compared to the latest technology then the following advantages and disadvantages can be summarized.

	Advantages	Disadvantages
Conventional technology	1. Well known technology 2. Foreign exchange component is lower 3. Stimulating self-reliance 4. Better local manufacturing and repair possibilities	1. Relatively lower quality 2. Relatively long implementation time required
Latest technology	1. Relatively higher quality 2. Relatively fast implementation time 3. Simple in maintenance	1. Unknown technology 2. Higher foreign exchange component 3. Dependence from overseas 4. No self manufacturing and repair possibilities

Another problem in choosing the appropriate technology lies in the life cycle of the systems.

In the electronics and telecommunications field, the obsolescense of equipment is getting faster and faster. Technology now changes almost every five years. This was not so earlier as could be seen from the switching technology:

- Step by step systems	50 years
- Crossbar systems with common control systems	20 years
- SPC Analogue systems	10 years
- SPC Digital systems	5 years

The decision has far reaching effects and the consequences of such a decision will be felt for many years. The new technologies now utilise very large scale Integrated Techniques including computer controlled exchanges with time divisions switching and the transmission of information in digital form which makes it possible to transmit voice, data, text and huge quantities of visual information over a single network known as Integrated Services Digital Network (ISDN). Keeping in view the above trends, existing systems and capacity to absorb new technologies, a country's P&T Authority has to choose a proven technology. It should also be capable to sustain the new technology especially to operate and maintain the systems.

6.4 Choice of materials and equipment for manufacture

The establishment of local manufacturing capacities requires manpower, know how, material and finance. Some developing countries have a relatively developed industrial infrastructure and skilled labour - force as well as extensive demand of telecommunications equipment. These countries can, and some already have, set up viable industrial centres. However, for many smaller countries, the creation of industrial units is not economically justified.

Such countries may establish industrial units on joint ventures at regional or subregional level. Branch units may be established in different member countries of a subregional organization in order to improve gradually their industrial base and to consolidate the collective efforts while ensuring a local source of supply.

To offer economies of scale the viability of an industrial project depends on the production of a minimum number of units. It is generally considered that the annual minimum output needed to justifiy the production of telecommunications equipment is approximately for:

- telephone sets:	50,000 - 100,000 sets in assembly
	150,000 - 250,000 sets in production
- public switching exchanges:	100,000 lines in assembling
	-250,000 lines in production
- Private switching exchanges:	1,000 units with capacity of 20 lines
- cables:	500,000 to 1,000,000 pair km in assembly
	2,000,000 pair km in production
- components:	e.g. 1,000,000 telephone relays

Finally the following components and equipment can be taken into consideration for local manufacturing:

1. Electronic switching equipment

The production and modification of small switching equipment for public use seems to be reasonable, for capacities between 50 and 500 lines, up to max. 1,000 lines. Extension possibilities should satisfy especially the needs in rural areas. Also small PABX with a capacity of 10 to 50 lines seems to be

reasonable. The reasons to choose this kind of equipment is especially in the perspective of important markets of private users (trade, commerce, industry, public service) and in the use in rural areas. The less complex software as well as the modularity of design and the divisibility in manufacture are further reasons in favour of this equipment.

2. Electromechanical switching equipment components

The production of electromechanical switching equipment components like relays would be also reasonable, although that can run counter to the technological development trends. But due to the long life cycle of electromechanical exchanges (30 to 50 years) it would be reasonable to produce such components for repair and maintenance purposes for existing equipment, as it would be more and more difficult to find suppliers of such components. Full utilization of existing analogue equipment shall be paramount.

3. Telephone instruments

The production of telephone instruments has already started in some African countries and it is reasonable to extend the production as telephonesets can be considered as a mass product of limited complexity in the production process and low specialization. The product range shall include rotary dial, press-button telephone sets and key telephone systems. However, it should be borne in mind that press-button telephones are over 50 percent more expensive than rotary dial telephones. A developing country with meagre financial resources should carefully weigh the advantages of spending so much more on press-button telephones. Digital exchanges should be able to accept either dial pulses or MF tones and, therefore, the rotary dial telephone might there to stay.

4. Cables, wires and auxiliaries

Cables and wires are also produced in some African countries. Cables can be considered as a very useful local product for the extension of networks, maintenance and repair. The production process requires only limited skills. And the production of telecom cables could be easily combined with the production of electrical cables. The following types of cables can be manufactured locally:

- open wire (copper, copper covered steel, copperweld, aluminium)
- aerial cables
- underground cables
- internal cables
- power cables (open and insulated)

For the production of cables mainly locally available raw materials and resources can be used like copper, aluminium, steel, plastics. The same situation applies for auxiliary equipment needed for open wire carrier systems, consisting of parallel bare conductors, electrical insulators, cross arms and poles. All these components are widely used and of low complexity and simple technology. In addition only low investment costs are required and locally available raw materials like iron, steel, plastics, paper, ceramics and timber can be used. Also cable ducts (plastic or concrete) can be made locally.

5. Multiplex transmission

The production of single channel radio equipment seems also reasonable at a regional level due to the special need for rural areas.

ANNEX

Table 1
Number of telephone stations and basic socioeconomic indications for African countries

Country	Inhabitants in 10^3 (1984)	GDP per capita in US$ (1986)	Telephone Stations (1.1. 1985)
Egypt	47,080	770	800,089
Equatoiral-Guinea	380	343 (2)	(1,500)
Ethiopia	34,350	105	115,833
Algeria	21,200	2,350	707,607
Angola	8,530	806 (1)	(44,000)
Benin	3,830	270 (2)	17,082
Botswana	1,050	812	(18,600)
Burkina Faso	6,710	154 (2)	14,191
Burundi	4,540	217	(6,200)
Djibouti	350	741	7,653
Côte d'Ivoire	9,530	640 (2)	122,600)
Gabon	575	2,393 (3)	(14,000)
Gambia	630	239 (3)	(4,300)
Ghana	13,110	300 (2)	(72,022)
Guinea	5,300	320 (2)	(14,000)
Guinea-Bissau	880	162 (3)	(2,900)
Cameroon	9,370	950	(50,000)
Cap Verde	320	294 (3)	2,384
Kenya	19,400	290 (2)	248,110
Comores	440	250 (2)	2,000
Congo	1,700	600	(18,800)
Lesotho	1,470	480 (2)	11,017
Liberia	2,130	460 (2)	(9,000)
Libya	3,480	5,500	(500,000)
Madagascar	9,630	250 (2)	36,990
Malawi	6,610	167	40,142
Mali	7,720	130 (2)	(9,800)
Marocco	22,800	610 (2)	285,824
Mauretania	1,830	350 (2)	(5,000)
Mauritius	980	890 (3)	53,825
Mosambique	13,710	260 (2)	59,458
Namibia	1,510	755 (3)	(67,900)
Niger	5,930	200 (2)	(10,400)
Nigeria	87,830	735 (2)	(479,200)
Ruanda	5,900	330	(6,700)
Zambia	6,450	340 (2)	77,185
Sao Tome u. Principe	90	291	2,514
Senegal	6,510	440	(50,700)
Seychelles	60	2,286 (1)	10,734
Sierra Leone	3,540	295	(18,700)
Somalia	5,420	270	(8,130)
Sudan	20,950	2,700 (2)	(73,000)
Swasiland	630	597 (3)	16,059
Tansania	21,020	270 (2)	(107,400)
Togo	2,840	236 (2)	(12,500)
Chad	4,900	80 (2)	(7,100)
Tunesia	7,050	1,150 (2)	250,576
Uganda	15,140	280	(56,100)
Zaire	32,080	80 (2)	38,757
Central Afric.Rep.	2,510	258 (2)	6,658
Zimbabwe	7,960	530 (2)	240,962

Note: (1) 1983, (2) 1984, (3) 1985; the figures in brackets are estimations.
Source: UN Publications and ITU Publications

Table 2
Telephone Density by countries

Country	Year	Main tel. per 100 inhabitants	Total tel. per 100 inhabitants
Chad	77	0.06	0.16
Ethiopia	82	0.24	0.31
Mali	82	0.07	0.12
Zaire	82	0.09	0.11
Malawi	79	0.18	0.49
Burkina Faso	78	0.07	0.14
Uganda	82	0.17	0.46
Ruanda	80	0.08	0.09
Burundi	82	0.12	0.14
Tanzania	81	0.23	0.50
Benin	78	0.22	0.47
Cent.Afr.Rep.	81	0.10	0.20
Guinea	77	0.13	0.18
Niger	82	0.12	0.17
Madagascar	81	0.19	0.38
Togo	80	0.23	0.39
Ghana	82	0.32	0.61
Kenya	82	0.55	1.25
Sierra Leone	80	0.37	--
Mozambique	82	0.28	0.44
Sudan	82	0.25	0.35
Senegal	82	0.34	--
Zambia	82	0.63	1.20
Egypt	82	1.09	--
Zimbabwe	82	1.35	3.13
Nigeria	82	0.22	0.71
Marocco	82	0.92	1.28
Cote d'Ivoire	80	0.47	1.10
Congo	81	0.51	1.10
Tunesia	82	2.05	3.24
Angola	81	0.65	0.71
Algeria	82	2.09	3.11

Source: ITU-report: The Missing Link, 1984.

Table 3:
Telephone density in urban and rural areas
in selected African countries

Main telephones per 100 inhabitants

Country	Overall	Largest City	Urban Area	Rural Area
Ethiopia	0.24	3.44	2.84	0.06
Mali	0.07	0.68	0.55	0.015
Ruanda	0.08	--	0.28	0.04
Tanzania	0.23	1.72	1.44	0.09
Ghana	0.32	1.68	1.43	0.10
Kenya	0.55	4.98	3.36	0.15
Sudan	0.25	1.71	1.18	0.04
Senegal	0.34	--	0.64	0.10
Zambia	0.63	1.57	1.4	0.006
Egypt	0.97	--	2.68	0.15
Marocco	0.81	1.8	1.98	0.28
Congo	0.51	1.52	1.42	0.19

Source: ITU-report: The Missing Link, 1984

Table 4
1982 telecommunications investment
in selected African countries

Country	Telecom Invest. (US$ mill)	Invest. Per Capita (US$)	GPD (US$ mill)	Telecom Invest. (% GDP)
Botswana	8.1	9.00	790	1.03
Kenya	35.2	1.95	5,340	0.66
Swaziland	2.6	3.71	590	0.44
Zambia	14.2	2.37	3,830	0.37
Lesotho	1.1	0.79	300	0.37
Senegal	8.1	1.35	2,510	0.32
Ethiopia	12.7	0.39	4,010	0.32
Cote d'Ivoire	22.6	2.54	7,560	0.30
Zimbabwe	13.6	1.31	5,900	0.23
Angola	5.2	0.65	2,741	0.19
Mauritius	1.3	1.44	940	0.14
Congo	2.6	1.53	2,170	0.12
Niger	1.9	0.32	1,560	0.12
Malawi	1.1	0.17	1,320	0.08
Togo	0.5	0.18	800	0.06
Tanzania	2.7	0.14	4,530	0.06
Sudan	5.0	0.25	9,290	0.05
Cent.Afr.Rep	0.1	0.04	660	0.02
Ghana	2.9	0.24	3,122	0.01
Mozambique	0.4	0.03	2,842	0.01
Zaire	0.1	0.01	5,380	0.01

Source: Various World Bank and ITU Reports.

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