TELECOMMUNICATIONS AND DEVELOPMENT

by Hans Von Baeyer

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FOREWORD

This discussion paper on telecommunications and development represents a joint effort by the Department of Communications and the Canadian International Development Agency. In particular, the contribution of Dr. Hans von Baeyer to the drafting of a major portion of the paper is acknowledged. The Department of Communications provided the overall management during the preparation of the paper, as well as contributing considerably at several stages of the research and drafting, in collaboration with various CIDA officials.

The recommendations provided in the paper do not necessarily reflect government positions or policies, but a number of considerations are identified which warrant further analysis in the formulation of Canadian policies and programming in the telecommunications sector. These are related both to Canada's international development cooperation and to domestic and foreign economic, commercial and social goals.

As stated in the paper, the definitive work on pinning down the relationship between teelcommunciations and development remains to be done. In this respect, it is encouraging to note that institutions with greater resources and mechanisms at their disposal are increasingly turning their attention to this relationship. The discussion paper makes a valid contribution, however, to a continuing process of research, policy dialogue and consultation and should assist CIDA and DOC in a further examination of this issue.

EXECUTIVE SUMMARY

TELECOMMUNICATIONS AND DEVELOPMENT

1. Introduction

This study is the result of an effort to document the benefits of telecommunication to a cross-section of social and economic sectors. The paper provides a comprehensive picture for the non-technial reader of studies and recent thinking on the direct and indirect benefits of investment in telecommunications infrastructure, and the relationship between the growth of telecommunication services and socio-economic development in general.

Telecommunication services are defined as any kind of electronic transfer of information from one location to another - telephone, telegraph, radio, television, computer and information systems, navigational aids, satellites, fibre optic systems, and others. This is at variance with some of the extensive literature on the subject where the term "telecommunication" is basically limited to the state of development of the telephone system. Such a restriction places undue emphasis on indicators under urban and inter-urban conditions, neglecting the importance of information flow by broadcasting methods (for example in the fields of remote education, instruction, guidance and training) and disregarding the complementary nature of different modes of "telecommunication".

Common to all of these systems is that they employ electronic equipment; that they are high technology products requiring extensive specialization for their production, planning, operation and maintenance; and that they are components of the dawning information age.

In the absence of quantitative data, descriptive evidence is given of the necessity of some form of telecommunication services wherever there is a problem of organizing or managing a social or economic activity. Because of the interrelationship among the various

types of telecommunications, the paper also points to the need for early consideration of telecommunications in development plans and programmes, in addition to individual projects.

2. Overview of Telecommunications Systems and Services

This section describes the various types of telecommunication systems which are in use (signals, fixed connections, mobile connections, switching, networks, broadcasting and information systems). A number of services could be provided by one network, and in general it is desirable to incorporte in the public system as many telecommunication functions as possible. This widens the scope of the public system and adds to the potential for better financial viability. Too rigid an attitude towards the need for network integration, however, may prevent or retard the development of certain important telecommunication sectors. The planning of telecommunication systems therefore requires an understanding of the needs and priorities of all sectors, of long run versus short run efficiencies, and optimisation of the specific functions telecommunications can perform.

International rules and regulations governing networks extending outside national boundaries have led to a high degree of standardization and uniformity throughout the world. In general, international networks form separate entities from national networks, collecting traffic from the national circuits and delivering to corresponding points in other countries. With the advent of satellites, reliable direct links between any two countries can be established. The presence of a worldwide telecommunication network has raised concerns about the transborder flow of information, but it also enables developing countries to have access to a wide range of information systems.

Conditions for economically viable telecommunication systems are better in urban centres than in rural areas where, at least initially, some financial support is required. Often the solution has been to provide only the most rudimentary functions (radio transmitter/receivers, citizen band facilities, public all offices, community reception centres)

to rural areas. The most advanced technology may, however, also be appropriate because it is aimed at low cost per user, demands less maintenance skill, lower power consumption and greater flexibility in service options.

Satellite systems represent particularly attractive solutions for the telecommunication problems of developing countries because of their service options and their ability to span great distances. A number of pilot projects have demonstrated the multiplicity of roles satellite systems can play in remote regions, mainly in education, health care and agricultural information services. In addition, satellites can also gather useful information on the conditions in the atmosphere and on the surface of the earth, with applications for agriculture, forestry, geology, ocean and water resources, and land use.

Radio broadcasting is widely used as an education tool. Its effectiveness usually depends on listener participation in choice and execution of the programs. Compared to the economically favourable characteristics of radio broadcasting, T.V. broadcasting is considerably more demanding on resources. Declining earth station costs will make T.V. reception in individual homes more practical in the near future, however, and in the meantime, successful experiments in community reception have been conducted.

3. Telecommunication Services as an Element of the Development Process

This section of the paper outlines some of the ways in which telecommunication services support various sectors:

- in the transportation sector, efficiency, effectiveness and safety are ensured;
- in the health sector, remote areas can be linked to health professionals; essential equipment and supplies can be maintained; management of preventive health services can be facilitated; and education presentations can be designed;
- in the agriculture sector, the knowledge and skills of farmers can be upgraded and an information system can be established in order to enhance production and distribution;

- big construction projects require telecommunications for engineering, project management and logistic support;
- communication networks are essential for the protection, operation, maintenance and administration of electric power utilities;
- in the tourism sector, travellers and operators both need reliable information on services and sites;
- in the field of formal education, the problems of overcrowded classrooms, undertrained teachers, inadequate teaching material and lack of access to schools have been solved in various countries through the application of broadcasting services;
- in the fisheries sector, communications can aid the management, protection and identification of resources, and the supporting services;
- in the mining sector, telecommunication needs are of primary concern for administrative, technical, social and safety reasons;
- meteorology, manufacturing and marketing of industrial public administration, the mass mediagoods, all depend on adequate communication facilities.

The impact of telecommunications on the economic sector is fairly well understood. Social and political impacts are less tangible and often depend on the mode of telecommunication which is used; the tariff structure which exists; or a host of other factors. It is perhaps easier to state the disadvantages of not having telecommunications than to describe the advantages of having it.

4. Planning of Telecommunication Services in Developing Countries

This section discusses some of the needs and problems of providing telecommunication services in developing countries, with the understanding that conditions in no two countries are alike. The need for telecommunications is well recognized. There is a growing demand for basic telephone and telex services in urban centres which has outstripped the supply of those services, and communication with remote areas is often impossible. Despite this need, however, there are constraints to

investing in telecommunications. These constraints are a lack of quantification of the benefits of telecommunications; a perception that only a priviledged portion of the country benefits; tariff policies which do not promote efficient allocation of telecommunication resources in the short run; institutional and organizational problems; lack of foreign exchange and technically qualified manpower. Some of these points have already been addressed in the preceeding section.

One of the institutional constraints is fragmentation, or different services being provided by different, unrelated organizations, each investing in its own facilities without reference to the possibility of sharing scarce resources. To avoid inefficiency and fragmentation, national development oriented telecommunication agencies are required. To function effectively, these agencies need to be independent from day-to-day government interference including the necessity of detailed government approval of normal technical procurement and expenditure decisions. Broadcasting presents a particular problem as it is content oriented and therefore subject to a country's information policy, yet the facilities for transmission are basically the same as those for transmission of point-to-point services.

Human resource constraints, such as insufficient local planning, engineering, construction, operation and maintenance personnel, can also cause problems. Considerable progress has been made in solving these problems through telecommunications training centres, but in the poorer developing countries, there is still a strong dependence on foreign personnel and few sources from which to recruit new personnel for training.

One of the financial constraints which developing countries face is the low level at which charges for the users are set, leading to excess demand in relation to supply. An appropriate tariff level should ensure the financial viability of the services and be related to their capacity. Another financial constraint is the amount of foreign exchange needed to pay for the foreign content in equipment, engineering and construction. The telecommunication sector then has to compete with other sectors for scarce foreign funds.

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To some extent these problems can be by-passed by the local manufacture of telecommunication equipment. Only a few countries, however, have the large markets, sophisticated technical and managerial skills, and other conditions necessary to develop a truly indigenous telecommunication manufacturing industry.

A basic element of telecommunication planning is an assessment of present and foreseeable future demands. Demand analysis is a complex task, made more difficult in the developing countries because of the lack of empirical data on growth patterns, user attitudes, economic development, etc. Closely related to demand forecasting is the development of an appropriate tariff structure to influence demand and emphasize certain economic and social priorities. Other factors which have to be taken into account in planning are changes in technology, environmental conditions, and social conditions. The appropriateness of a product must be judged on the basis of reliability, durability, availability of replacement parts, low power consumption, ease of handling and low cost. With that in mind, most of the latest industiral telecommunication products may also be appropriate in the context of the developing countries' needs.

Another aspect of telecommunication planning is the time horizon. Both long-term, or strategic, plans and medium/short-term plans are needed. The planning process therefore requires substantial administrative resources - experienced personnel, continuity of effort and a statistical data base. The setting up of statistical procedures, the development of institutional measures, and the training of personnel are of prime importance in future planning efforts.

5. Canadian Telecommunication Resources Which Could be Applied to Telecommunication Development Programs

Geography, climate and population distribution have made telecommunications indispensable in Canada. This section outlines some of the accumulated experience in practically all fields of telecommunication technology, operation and management which have been gained as a result of overcoming these barriers in Canada. Particular excellence is cited in microwave and satellite technology, modern telephone switching

and digital networks, computer-based information systems, marine and air navigation systems, cable T.V. technology, reaching isolated communities, the interpretation of remote sensing data, and specialized communication networks for electric utilities and for mobile applications.

There are a number of constraints to exploiting all of the existing Canadian know-how in projects outside the country. On the technical side, for certain types of equipment, there is a question of standardization. This is not, however, an insurmountable obstacle, especially with modern digital technology where software modifications can be applied. In the field of engineering services, there may be inadequate provision for trainees or for releasing staff for overseas assignment. Another restriction may occur if a Canadian firm is a branch plant of a foreign company and prevented from exporting. In all cases, an analysis of the available Canadian potential is necessary.

6. Summary and Conclusion

In conclusion, the telecommunications function is an essential supporting element in the process of development and should be examined by both development assistance institutions and national planners in developing countries. Canada's experience and capabilities in the telecommunication field are extensive and the chances for successful assistance programs involving Canadian goods and services are increasing.

BACKGROUND

In 1976 interdepartmental discussions started between CIDA and DOC regarding a joint study of the relationship between telecommunications and development. Recognizing the importance of telecommunication as a support function in practically all sector activities CIDA published in December 1976 guidelines for telecommunication programs as Part A of the Agency's Sectoral Guidelines on Infrastructures and Environment. Specifically, CIDA officers were urged "to regard telecommunications requirements in the wider context of overall national development". In order to strengthen this concept it was felt that the impact of telecommunication on socio-economic development should be documented in a co-operative study to enable the Agency to plan and make decisions on how much and what kind of telecommunication systems are appropriate to the Agency's development programs. (For a description of the extent and nature of CIDA's current project assistance in telecommunications, see Annex I).

Examination of the impact of telecommunications on development was, even in 1976, by no means new. In 1969 the Department of Communications initiated a comprehensive study, under the name of "Telecommission", on the present state and future prospects of telecommunications in Canada, published in the form of over 40 separate studies and a summary report, Instant World (Ottawa 1971). One of these studies (Telecommission Study 3 (b)) was devoted to "Communications and the Canadian Assistance Programs for Developing Countries". It referred to the small amount of assistance funds spent on telecommunication projects, and emphasized the importance of considering telecommunications "in the wider context of contemporary social change, of which development planning and development-assistance planning are important aspects".

Several years later, in June 1978, the Department of Communications sponsored an international workshop on "Special Aspects of Telecommunications Development in Isolated and Underpriviled Areas of Countries". One of the conclusions was that further studies on the measurement of benefits of telecommunication are needed because "if governments and planners are to be convinced of the virtues of investment in telecommunications, they must be shown evidence of its positive effects".

In recognition of this need a large study effort had already been started in 1977 by a joint undertaking of the International Telecommunication Union (ITU)* and the Organization for Economic Cooperation and Development (OECD) aimed at "analyzing the direct and especially the indirect benefits of national investments in telecommunications and to show the way in which a telecommunication system can contribute to economic development". As part of that effort a paper was published by H. Hudson, D. Goldschmidt, E. Parker and A. Hardy on: "The Role of Telecommunications in Socio-Economic Development: A Review of the Literature with Guidelines for Further Investigations" (Keewatin Communications, May 1979) giving a comprehensive picture, though restricted to "basic telephone service and other services that could be offered using a telephone channel". Important other telecommunication applications such as broadcasting, navigational aids, remote sensing satellites are thus outside the scope of that particular literature review.

A recent pursuance of the ITU initiative was a Resolution passed at its Plenipotentiary Conference (Nairobi 1982) regarding Research on the Inter-relationship between Telecommunication Infrastructure and Socio-Economic Development. This Resolution is aimed at "the necessity of providing governments, administrations, decision- makers, economists, financial and other institutions and organizations concerned with development work with the results of comprehensive studies on the direct and indirect benefits of investment in telecommunication infrastructure and the relationship between the growth of telecommunication services and socio-economic development in general, so as to enable developing countries to better assess their own development priorities and give the necessary priority to telecommunications". The complete text of this Resolution is quoted in Annex II, as it illustrates the general thinking on the importance of telecommunications for the development process and because it demonstrates the awareness that the "definitive work" still remains to be done.

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* The United Nations specialised agency for telecommunications.

On an even broader scale, and directed less to the technology of telecommunications than to the general problems of information flow, the International Commission for the Study of Communication Problems (MacBride Commission) published in 1980 its final report Many Voices, One World (UNESCO 1980), in which telecommunication, including broadcasting, is just one of the information-carrying media, besides other media such as books, newspapers, postal services.

These are some examples of the work that has been done over the past few years; the present report, of course, draws on much of this literature. Its main purpose is to introduce to the non-technical reader the perceived relationship between telecommunications and development, a relationship which is increasingly taken as given within the telecommunications community but which is not yet understood or fully accepted outside this community. The paper also tries to present a comprehensive picture, through a sector-by-sector illustration, of the specific support telecommunication provides to the functioning of various economic and social sectors. Apart from occasional references the report does not discuss the wider issues of international information flow, or concerns about media content covered in the MacBride report and discussed in the context of the need for a New World Information and Communication Order. Rather, it is aimed at those considerations which should aid in coming to decisions on the role of telecommunications in Canadian assistance programs for developing countries.

In addition to the existing literature much information for this report has been obtained through interviews, from Canadian industrial, business and government sources. Of further substantial assistance have been discussions with individuals in international lending and aid institutions, in particular the World Bank, the Inter-American Development Bank, and the U.S. Agency for International Development. All this assistance is greatly appreciated.

1. INTRODUCTION

In the context of this report "telecommunication services" include any kind of electronic transfer of information from one location to another, be it the spoken, written or printed word, or pictures or any other signals. This is also the official definition by the International Telecommunication Union describing telecommunication as

> "Any transmission, emission or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electro-magnetic systems."

Far from being restricted to the conventional telephone, telegraph or teletypewriter services, the field of telecommunications then includes broadcasting of radio or TV signals, computer communication and information systems, navigational aid systems such as radar or radio beacon installations, satellite operations for communications and remote sensing, modern fibre optic systems and others. Common to all these systems is that they employ electronic equipment, that they are in the category of "high technology" products, require extensive specialization for their production, planning, operation and maintenance, although their end user may benefit from them with only minimal skill, and that they are components of the dawning of the "information age" where the movement and processing of information become the dominant characteristics in the economic and social fabric of society -- not only in the industrial part of the world but rapidly extending their influence to all other parts.

As indicated in the Background, a large volume of literature has been produced over the last one or two decades aimed at a clearer understanding of the impact of this technology on social and economic development. However, so far a conclusive formulation of this impact has not been possible except in some well defined special applications which would not allow generalization. Are telecommunication services a prerequisite for, or a cause of, social and economic development? Can a case be made for relating directly the magnitude or timing of an investment in telecommunication services to a measurable improvement in a country's economic conditions?

In the absence of satisfactory answers to such questions it remains to give descriptive evidence of the actually encountered role of telecommunication in the various fields of human interaction.

What is attempted here is to show that in the modern world of interdependence wherever there is a problem of organizing, managing, controlling a social or economic activity -- be it developing trade relations, raising agricultural productivity, improving health conditions, aiding the educational level of people -- telecommunication services in some form or other become indispensable and must be considered in the initial planning, funding and scheduling. It is further attempted to show that there is sufficient commonality and interrelationship among the various types of telecommunication applications that planning should proceed as much as possible on a cross-sectoral basis, and not be left entirely to the specific needs of each individual project, thus causing a waste of technical, financial and manpower resources. There is an apparent need, therefore, for early consideration of telecommunication services in development plans, programmes and projects.

Telecommunication is a versatile tool -- in one form it may be mainly to the benefit of a certain group in society, for example the urban population; in some other form, however, its main impact may be on the living conditions and survival in remote and sparsely populated areas. Further, it will be shown that even under the most primitive conditions the most advanced technology may in particular cases provide and sustain the most effective relief, which supports the argument that the most advanced technology may also be the most "appropriate" one to be introduced without having to pass through earlier stages of development. The main problem then is to decide on the appropriate timing for the introduction of a new technology, a decision which must be made in the specific context of a country's social and economic conditions.

Whether the basic aim of a development plan is to stimulate the economic climate, build up trade and industry, or to concentrate on social goals such as the fight against poverty, ill-health, malnutrition etc., judiciously chosen telecommunication methods can support the prime objective, and present more effective alternatives to other modes of communications such as physical transportation.

No part of the world can exist anymore without extensive contacts with other parts, not only in its immediate vicinity but spread all over the globe. This has led to the evolution of all encompassing telecommunication networks for information transfer, networks from which no country can remain excluded and for which the most suitable institutional and organizational structures and procedures are under vigorous discussion. Countries then have to decide on how to react to this development and how to relate in their own national planning to the multitude of systems that surround them.

2. OVERVIEW OF TELECOMMUNICATION SYSTEMS AND SERVICES

Telecommunication services such as telephone, telex, TV, radio etc. are provided through facilities and systems for the generation, transmission, distribution and reception of the signals which are characteristic for a particular service. Such facilities range from buildings, towers, electrical power plants and other supportive installations to all the specific equipments necessary for the type of services provided. In general, such facilities can be utilized, at least in part, in common for a number of services so that costs as well as operation and maintenance expenses can be shared. However, to what extent such joint use takes place in actual systems design depends largely on the existing institutional framework, i.e. the relationship between the various organizations providing individual services. As an example: it is not uncommon that the institution providing interurban, public telephone service is separate from the institution concerned with interurban television program tranmission. As a consequence, in the absence of an overall planning effort, separate systems may be installed in parallel although both services could well be provided by a system with substantial common components.

Since the relationship between systems and services is important in the context of this report, the following sections provide an introduction to the essential technical and organizational factors involved.

2.1. Types of systems and their main technical characteristics

2.1.1 Types of signals

As mentioned in the Introduction, this report is concerned with the electrical transport of information in the most general sense, regardless of whether the information transfer relates to people or machines, and regardless of the purposes the information transfer serves.

Correspondingly, there are many different types of signals to be considered and, in addition, the original signals entering the telecommunication system are often transformed into forms more suitable for the processes of transmission and switching and then re-tranformed into their original form at the receiving end.

There are two main types of signals: analog and digital. The former term describes signals of a continuing waveform, for example the signals emerging from a microphone where changing air pressure is transformed into a continuously varying electrical current, or the signals of a TV camera, where changing light intensity is transformed into a continuously varying electrical current.

In contrast, in the digital mode, signals consist of sequences of electrical pulses, each one in either "on" or "off" condition, where the only variables are the rate at which the pulses follow each other, and the patterns of successive on and off conditions. Any analog signal can be converted into a digital pulse sequence of appropriate pulse rate, and re-converted again into the original analog form. Thus, it is possible in principle to have one single form of signal -- the digital -- for the process of transmitting and switching of any type of information from voice to TV and including, of course, data signals associated with machines and digital computers. Technology is moving towards this kind of integrated approach, where transmission and switching use only one common form of signal: digital pulses.

As a result of historical evolution, the signals for telephony (voice and dial pulses), for facsimile and picture transmission, for telex and similar services, for TV and audio program distribution, are still to a large extent generated, transmitted and received in analog form through equipments specially optimized for each of these services. However, the trend towards introducing digital methods is strong, offering substantial economic benefits and simplified maintenance, particularly when the volume of traffic is high.

2.1.2. Fixed connections

Open wire lines, strung between poles, were the first means for the electrical transport of information from one fixed point to another. At first carrying telegraph signals, later telephone conversations, they remain in use in remote areas. Gradually they are being replaced by cables, with from one or two up to hundreds of individual, insulated pairs of wire within a protective cover, offering the choice of being strung overhead or being buried in the ground. This is a common method for telephone distribution in densely populated areas.

Instead of carrying individual signals (such as telephone conversations) on individual pairs of wire, multiplex methods are used, which, at the transmitting side, convert a number of separate individual signals into a collective signal and at the receiving side split up the collective signal into its original components. This can be done either in analog form, giving each individual circuit a separate band of frequencies, thus collectively forming a wider band signal, or in digital form by interweaving in time the impulses of individual signals, thus forming a higher rate sequence of pulses. For carrying such collective signals the bandwidth capability of the transmission line has to be widened and this can be done by using coaxial cables, which consist of a central conductor surrounded by a tubular metallic shield. To cover large distances, amplifying devices must be inserted at regular intervals to compensate for the gradual weakening of the signal along the line. Such cables are strung overhead like wires, buried in the ground along roads or railways, or laid on the bottom of lakes and oceans (submarine cable).

The wide frequency band characteristics of coaxial cables can be used to transmit instead of, or in addition to multiple telephone conversations, wide band signals such as television programs.

Advancing technology has presented a superior alternative to coaxial cables in the form of optical fibres, using light instead of electrical currents as carrier of the signals. Compared to coaxial cables, the information carrying capacity of such systems is substantially greater, enabling them to carry simultaneously up to hundreds of TV programs or equivalent signals. At this time, however, the state of the art has not yet gone beyond trial installations.

So far only metallic connections (wires or cables) have been described as means for electrical information transfer. An alternative exists in the form of radio systems, utilizing the propagation characteristics of radio waves in the various frequency bands (LF, MF, HF, VHF, UHF, SHF).* Long distance point to point connections across continents and oceans have for a long time been established using radio signals in the LF, MF and HF ranges; however the available bandwidth for the transmission of signals is limited (not exceeding the audio range) and propagation conditions are often sporadic. Most ham operations also fall into this category.

For wider bandwidths, such as multiplexed signals or TV transmission, and for reliable, permanent connections, higher radio frequencies (upwards from VHF) must be used, but coverage range at these frequencies is progressively, as the frequency increases, reduced to line of sight distances.

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* LF 30 - 300 Kilo Hertz
MF 300 - 3000 Kilo Hertz
HF 3 - 30 Mega Hertz
VHF 30 - 300 Mega Hertz
UHF 300 - 3000 Mega Hertz
SHF 3 - 30 Giga Hertz

Thus, on overland routes for fixed wideband connections microwave radio relay systems have become a favoured solution, consisting of a string of repeater stations between two terminals, all stations spaced at line of sight intervals. The capabilities of these systems correspond to those of coaxial cable installations, and they present, depending on circumstances, an economically advantageous alternative. On shorter paths they can be designed for low power consumption so that repeater stations can be powered by batteries and solar energy instead of fuel-driven generators, thus drastically reducing maintenance requirements, which is of great interest in remote areas.

Microwave systems of extended range have been built at high cost in the form of over-the-horizon or tropospheric scatter systems, using very high transmitter power, large antenna structures and highly sensitive receivers. However, their use has been overshadowed by the rapidly developing technology of communication satellite links. In particular, the satellite repeater station located in a geo-stationary orbit position (36,000 km above the earth's surface) i.e. in a fixed position relative to a point on earth, has opened the possibility of communicating directly between any points within a coverage area of about one third of the earth's surface. This means that distance and terrain problems are no longer limiting factors. Moreover, by using microwave frequencies (SHF) for the up and down links, the bandwidth capabilities of satellite links correspond to those of coaxial cables and microwave radio relay systems, thus enabling such links to carry any type of signals from slow data and telephone to TV, in analog or digital form.

2.1.3 Mobile connections

If terminal stations are mobile, for example on vehicles or being carried around, metallic connections are of course impractical and radio connections are the only solution.

For long distances, for example in maritime communications, conventional systems make use of the long range propagation characteristics of LF, MF, and HF radio waves. Because of their limitations in bandwidth capability and reliability they are gradually being replaced by specialized satellite facilities for maritime and aeronautical services operating from geostationary orbit positions.

More localized mobile systems in police, taxicab, train, truck, ship, aircraft and similar applications operate in the VHF and UHF bands where, at the expense of range of coverage, better utilization of the frequency spectrum and better immunity from interference can be obtained. Popular radio links of limited range, but unprotected from interference, use walky-talky and CB facilities.

In the category of mobile connections are also the navigational aid systems for position and direction finding of ships and aircraft. They usually consist of fixed transmitting stations emitting regular signals, which are picked up by corresponding receiving sets in the vehicles within a certain coverage range. International and national conventions regulate the design and use of such systems on a worldwide, regional and national basis.

Typical examples are for marine purposes the marine radio beacons, the Decca Navigator and Loran systems, all operating in the LF/MF bands, using chains of stations with, in some of the systems, co-ordinated signal emissions. In the aeronautical field examples are the non directional beacons (LF or MF), the VOR omnidirectional range system (VHF), or the various systems for instrument landing.

Also to be mentioned here are the operations of remote sensing satellites, surveying photographically or by other radiation measuring methods atmospheric and other conditions on the earth surface, sending back to earth via radio links the results of their measurments. Agricultural crops, geological conditions, sea state and weather and many other situations can thus be monitored.

2.1.4 Switching

In a communication system with many participants (subscribers) direct connections between any two users can be established at the exclusion of all others by linking all users to a central switch and providing the switch with instructions for appropriate cross connections. In the simplest case, the switching function can be performed manually by operators on instructions from the message originator (manual exchange). To perform the switching function automatically users send special signals (dial pulses or tones) to the central exchange where automatic switching equipment establishes the wanted connection. Most of the installed automatic switching machines in telephone systems are at present of the electromechanical type, historically first of the "step by step" variety (under direct step by step control by the call originator), later of the "common control" type where the originator's signals are stored and the connection then established according to a fixed program.

The development of the latter type led to electronic telephone exchanges, where a wider range of service options is available (call transfers, call holding when busy, etc), and where "stored program" operation allows greater flexibility. Such electronic exchanges are at present gradually replacing the electromechanical types.

With the introduction of digital technology a new type of exchange is emerging in which the switching function consists of mixing, storing, and unscrambling of digital pulse sequences, similar to the functions of digital computers. With the steadily decreasing costs of that technology and the higher reliability of digital circuitry, substantial economic advantages over earlier methods are expected. But the conversion of the existing telephone plant to digital methods will take a long time, during which hybrid solutions will prevail.

For telephone switching purposes, a direct path between the two communicating subscribers has to be established. For other types of services, such as telegraphy, telex, or data transmission, it is possible to store the messages received from the originator at a central location, and forward them to the recipient, whenever the latter's line is available or at any other convenient time. This type of switching, called "store and forward"or "message switching", was first introduced for telegraph operations, and finds increasing application in digital systems for data communications, particularly in the form of "packet switching" (subdivision of digital sequences into packets of pulses, which are forwarded as separate messages, and then reconstituted for the recipient).

2.1.5 Networks

Transmission, switching and terminal facilities are the elements of networks for the provision of particular services to a community of users. By far the largest of such networks is the telephone system which spreads from local calling areas through interconnection by trunklines with other calling areas throughout cities, countries and the world. National and international agreements on interconnections make it possible that its nearly 500 million subscribers form one large community of users, although its subnetworks serving local areas and individual countries operate autonomously and independently from each other.

Examples for networks for other than telephone services are:

- teletypewriter networks for Telex and similar services
- telegraph networks for the distribution of telegrams
- data communication networks for computer communication systems such as packet switched networks
- teletext and videotex networks for textual and graphic information delivery from data banks to home TV receivers
- cable television (CATV) networks using a coaxial cable system with drops to individual homes
- specialized (dedicated) networks for such functions as the control and operation of electric utility systems, of national and international banking operations, of national and international airline operations, for public administration, or services that are internationally obligatory such as for safety in the air and at sea, and many others.

Depending on ownership conditions and division of responsibility for providing the various services, these networks may exist totally separate from each other, they may be formed by using facilities available on lease from the operators of other networks, or they may be integrated under one or several monopoly institutions. Since the public telephone system is the largest and most widely spread network many other networks utilize facilities that are available from the extra capacity of the telephone system. In countries where one agency (usually the state itself) has a monopoly on telecommunication services, facilities can be integrated to a maximum extent. This however, may have drawbacks in the responsiveness to changing demands and the timely introduction of innovative services. In addition, there are always considerations which require separate networks for technical or operational reasons and, in particular, for security reasons; military systems are a case in point. These aspects are further discussed in section 2.2.

2.1.6 Broadcasting

Any radio communication in which transmissions are intended for direct reception by the general public is called broadcasting. There is broadcasting of sound (speech and music), broadcasting of TV, and also broadcasting of weather information and warning signals for ships at sea and aircraft in the air. Broadcasting from a single station can be arranged to reach receivers thousands of miles away, or only within a limited, small region. The means vary of course with the intended purpose. Conventional sound broadcasting uses amplitude modulated (AM) radio waves in the low, medium and high frequency bands of the radio spectrum, at power levels corresponding to the intended range of coverage. With this technique the transmitted signals are restricted in bandwidth, and propagation conditions are subject to variation, for example differences in day and night reception. For improved reliability and wider bandwidths, the VHF and UHF bands are used as for TV and higher quality sound transmission. In the latter case frequency modulation (FM) with its interference suppressing characteristics is employed. VHF and UHF propagation, however, is resticted to line-of-sight distances, so that coverage of large areas can be achieved only by locating the transmitting antenna on high ground (tall masts or mountains) or on satellites. Instead of covering a large area from a single high power transmitting station, a network of smaller stations can be used, which either pick up their program content from another station (re-broadcasting) or are interconnected by facilities for the distribution of the broadcast programs. Such interconnection facilities may be part of the general public telecommunication network or special UHF, microwave, cable or satellite links, dedicated to the purposes of broadcast program transmission.

Broadcasting includes first the activities for the preparation of the program to be sent, i.e. information content, texts, music and associated hardware (studios, films, tapes); second, the transmission facilities including links for the feeding of programs to the transmitter; and third, the receiving sets, suitable for

translating the received signals into information meaningful to the recipients. The first part, program production, can represent a substantial component of costs and effort that go into the whole operation, often underestimated and misunderstood in their impact on the effectiveness of the information transfer. The second part, the transmitting facilities, require a thorough analysis of the available options regarding centralization or de-centralization of the operations, international implications of reaching across borders, etc. Finally, the third part, receiving facilities, are subject to financial constraints affecting the viability of the whole operation. It is only since transistor technology has led to a drastic reduction in cost, power consumption and size of radio receivers and audio cassettes that wide spread radio systems in low income countries have become practically possible.

Except in industrially-developed countries, TV distribution is far from having reached the level of penetration of sound broadcasting, and is -- particularly as part of satellite systems -- often restricted to community reception with one receiving set serving a whole community. Apart from the costs of receiving sets, TV is of course also considerably more expensive than sound broadcasting in the means for program production, program distribution, and transmission.

The decision on a chosen layout and design of a broadcasting system is by no means a purely technical one; considerations of the degree of centralization or decentralization affect not only the location of transmitting stations but also the dispersal of the program production function. Whether there should be one national program, or many regionally or locally produced programs with different languages, different emphasis in program content, etc, or a mixture of program origins from local to international, can be decisive factors in the ultimate success of the operation.

2.1.7 Information systems

Computer based information systems with remote access from any location inside or outside a country have become important tools in many sectors of the economy. One of the earliest applications was airline reservation services, through which personnel in the airline offices obtain instantaneous information on flight times, availability of seats, prices, etc, enter bookings and issue tickets. Banks are using this kind of system for customer accounts, transport organizations for keeping track of their rolling stock, retail organizations for inventories. Office automation systems are increasingly used in industry, commerce and public administration for filing, word processing, information retrieval, accounting, inventory control. Reference information on scientific/technical documentation, on engineering design, and a host of other subjects of specialized or general interest can be obtained through such systems. Through teletext and videotex services, such as the Canadian Telidon, access to data banks will soon be available to the general public.

Common to all of them is the combination of computer data banks, and input and output devices for updating of the stored information, and for responding to a customer's request. Most of these systems are "interactive" i.e. the customer can enter into a "dialogue" with the data base to narrow down his request and be guided for the best way of obtaining the wanted result. The terminals for input and output messages are either general purpose terminals, such as teletypewriters, CRT (cathode ray tube) terminals, or for home use conventional TV sets; or they are specialized for a particular application (such as bank tellers' terminals). For remote access, connections can be established through dedicated lines leased from the telecommunication organizations, or with special interface equipment through the public telephone system, or through special higher speed data communication networks (see preceding section 2.1.5 on "Networks").

2.2 Networks for public and for dedicated use

The preceding section 2.1.5 has already drawn attention to the dependence of network design and utilization on institutional conditions, more specifically on the question whether services are provided by one or by several different organizations. If a single institution looks after a number of services it has the opportunity of achieving cost savings by using facilities and personnel in common. This may even make certain services economically viable which, by themselves, would be too costly to provide. One may conclude from this that total integration of all services would be the most advantageous solution. However, there are in many cases technical, operational, financial or organizational reasons for keeping facilities and systems separate. This is the subject of the following paragraphs.

The provision of telephone and telegraph services to the general public led to the formation of the first large scale and widely spread networks. In most countries the functions of telephone, telegraph and telex are combined under one authority, usually state operated or at least state regulated, and under the obligation to serve anybody within a given area. Even within this clearly defined concept it is often financially impossible to serve all people in all parts of that area for reasons of remoteness or inaccessibility or low population density, or such service can be implemented only gradually, according to a long term plan. In those cases, private initiative may take over, first to form small, localized, private networks, which at a later date may be interconnected with the main public network and eventually taken over by the central authority.

Another case occurs when services are intended for exlusive use within certain communities of interest; for example, within an industrial or business enterprise or a government department. Then the central telephone authority may be able to meet this or part of the requirement through lease arrangements, using facilities of the network for general public service. However, it may turn out to be more

economical for the respective groups to build and operate their own networks, particularly when the users are located in an area where the public system is not well developed. Internal networks of this kind, dedicated to the use within some widely spread, privately or publicly owned organiztions, are quite common. If properly planned they may later become part of the public system.

The incentives for building facilities separate from the public telephone network are even stronger when the intended service functions are different from those of the standard telephone system, as for example, when special technical or operational characteristics, such as data transfer or television transmission by cable to multiple destinations are required. The question then arises whether the facilities of the public telephone network are sufficiently adaptable for carrying the other types of signals, or technical reasons would preclude joint use. In the latter case separate special function networks such as data networks or TV distribution networks (CATV) may result, at least temporarily, until the main telephone network has been expanded to incorporate these functions.

Another case occurs when requirements on reliability or freedom from interruptions and electrical interference are so different from those prevailing in telephone systems that complete separation is the only practical solution. This can happen in networks for the transmission of remote sensing and remote metering information, as in widely spread electric utility plants where failure or distortion in the transfer of some vital piece of information can have catastrophic effects. Railway and pipeline operations also rely frequently on their own independent networks for various functions.

Finally security, flexibility and mobility criteria may preclude the use of joint facilities, which is the case in military networks.

The trend towards separate networks can also appear to be stronger when the state of development of the public telephone system is low. In the extreme, the situation may even be reversed, when, in the absence of a comprehensive telephone system, industrial or business activities lead to the creation of dedicated networks which apart from their main purpose, offer some telecommunication functions for the general public. Weather and other important information may be carried on these systems, even including some publicly accessible telephone, telegraph or telex channels, thus laying the groundwork for a more comprehensive telecommunications infrastructure.

In spite of the usefulness of, and justification for some separate dedicated or private networks, it is certainly desirable to incorporate in the general public system as many telecommunication functions as possible. Each added function widens the scope of the public system and adds to the potential for better financial viability. In this respect it has been argued (R.J. Saunders and C.R. Dickenson, Telecom Journal IX, 1979) that "widespread fragmentation results in inefficiency in national resource allocation". However, a too rigid attitude towards the need for network integration may prevent or retard the introduction of means for raising the effectiveness and efficiency of certain important sectors. The planning of telecommunication systems therefore requires an understanding of the needs and priorities of all sectors, of long run versus short run efficiencies, and optimization relating to the specific functions telecommunication can perform. This will be further illustrated in Section Three on Sector Performance and Section Four on Planning in Developing Countries.

2.3 International networks

For networks extending outside national boundaries, international rules and regulations must be observed to ensure technical and operational compatibility of the respective systems. Such rules are spelled out in the Recommendations and Regulations of the permanent committees of the ITU (International Telecommunication Union) and other international bodies for specialized services, such as ICAO (International Civil Aviation Organization), WMO (World Meteorological Organization).

Since the rules apply for the entire connection from a user at a location in one country to a user at a location in the other country, they determine the design and operation of not only the border crossing circuitry but also the national networks themselves. This leads to a high degree of standardization and uniformity throughout the world.

Links from a country to its immediate neighbours may be direct extensions of the national trunklines under bilateral arrangements between the two countries. Links to other countries are usually handled through "gateway" stations which collect all traffic and channel it to long distance transmission media such as submarine cables, satellite links, or microwave radio relay systems. Telephone, telex, data services as well as audio and video programme transmission can thus be handled. For telephony special international switching centres perform exchange functions specially adapted to international conditions. Similar arrangements apply to international telex and data traffic which is often carried on transmission lines of the telephone system connected to special telex and data switches. In general, international networks form separate entities from the national networks, collecting traffic from the national circuits and delivering to corresponding points in other countries.

With the advent of satellite technology in combination with submarine cables and microwave systems, it has become possible to establish reliable direct links between any two countries of the world without having to traverse many other countries; before that, the only alternative was to use MF/HF radio links with low capacity and often poor reliability. The satellite earth stations are usually owned and operated by institutions in the countries themselves, whereas the satellites are provided and operated by international organizations such as Intelsat or Intersputnik, or, in some cases by other regional satellite organizations such as the planned Arabsat.

The design and composition of international networks must of course be matched to the national networks that generate the traffic to be carried abroad. A highly developed international system without sufficiently well developed national networks has little value. However,

even when the national network is still in its infancy, interim solutions for international connections can be found. Here again satellite technology has provided flexible and easily adaptable solutions in the form of transportable, relatively small earth stations providing a limited number of circuits to other countries. As and when the national networks expand and the traffic requirements increase, the interim transportable station may then be replaced by a more permanent installation.

Using facilities of the various national and international telecommunication carrier organizations, dedicated industrial networks have been formed for international services exclusively within certain communities of interest. Examples are the worldwide networks of the United Press International (UPI), the Society for Worldwide Financial Telecommunications (SWIFT), the Société Internationale de Télécommunications Aeronautiques (SITA), the World Meteorological Organization (WMO), as well as many networks of large industrial enterprises.

The possibility of easily established direct links between countries has given rise to international debates on the transborder flow of information. The main concern is the flow of data and information between highly developed and developing countries, when the latter have not yet had the opportunities for organizing their own resources and techniques for analysis, production and distribution of information. This applies amongst other things to the distribution of news, television programmes and other cultural exchanges. A more balanced flow is one of the aims of what is debated as a "New World Information and Communication Order" with its cultural, political and economic implications, for which guidelines were proposed by the International Commission for the Study of Communication Problems (MacBride Commission).

On the other hand the presence of a worldwide telecommunication network enables developing countries to have access to information systems, data banks and information based activities wherever they might be located, and to exchange information with other countries, worldwide

as well as regionally. The latter has been emphasized by the United Nations proclamation of a "Transport and Communications Decade for Africa 1978-1988" which has, as one of its principal goals "the promotion of the integration of transport and communications infrastructures with a view to increasing intra-African trade". Also, it is to be expected that the trend in developed countries towards increased use of computer based methods in most sectors of economic activity will extend its influence on the methods used in developing countries, which will give rise to increased international traffic from and to specialized information systems.

2.4 Urban and rural systems

Areas of high population density present ideal conditions for economically viable telecommunication systems with a large number of subscribers. The cost per subscriber and correspondingly the charges to be levied from subscribers can be kept attractively low, difficulties in obtaining operating and maintenance personnel, electrical power and other support services are minimized, and the manifold interactions within the community of subscribers give rise to widespread demand. This explains the rapid growth of public telephone systems in the urban environment.

Conditions outside such areas can be considerably different. Geographic dispersion of the population may require long lines to individual users, climatic or terrain difficulties may make construction and maintenance costly, maintenance personnel may be difficult to be kept in sufficiently close vicinity, electrical power may not be available, or unreliable, the economic capacity of potential users may be low in relation to the high costs of establishing service, and the expressed demand may at least initially be more related to emergencies and special incidents than to regular use. Some of these conditions may of course also exist within certain economically deprived areas in or near population centres, but they are typical rather for the vast remote regions in developing countries. Their main distinguishing feature is in

financial terms: urban type telecommunication systems can be self supporting and profitable from the very beginning, wheras rural type systems require at least initially -- until demand has sufficiently built up -- financial support, either from the urban components of the total network, or through other ways of funding based on considerations of social and indirect economic benefits rather than direct financial profitability. Such benefits may be found in the health services field, in educational and agricultural programmes and information services, in disaster control, safety, national security or in the interest of social cohesion and community affairs. These factors are discussed in greater detail in Section Three of this report.

In view of financial problems and of a -- compared to urban conditions -- much less clearly defined and expressed need for rural services practical solutions are often providing only the most rudimentary functions of telecommunications. Examples are the use of simple HF radio transmitter/receivers, of CB (Citizen Band) facilities or reliance on ham operators in emergency cases. Many of the benefits of a more regular service are thereby, of course, unavailable. A more elaborate solution is that of installing rural public call offices (PCOs), single telephone sets serving a community or parts of a community, and connected to the network in more populated regions. In remote areas this connection may be established through HF radio links or small satellite earth stations as part of a domestic or regional satellite system. The use of PCOs is often complemented by radio broadcasting services for the provision of general information, education and entertainment reaching individuals wherever they may be. This can be done on a large scale by the wide distribution of small battery operated transistor sets. Another option for broadcasting services is that of community reception centres, which, with the help of small satellite earth stations, can be extended to include TV. The satellite earth station may combine TV reception with the provision of the above mentioned telephone channels.

Modern technology, aimed at lower cost per user, less demand on maintenance skill and frequency, lower power consumption, greater flexibility in service options helps to mitigate the cost problems in the establishment of "rural" systems. The main elements in this technology are digital methods in transmission and switching, computer type, solid state compact equipments, small satellite earth stations, low power consumption microwave links and, for radio broadcasting purposes, small low cost transistor radio sets. The most advanced technology is thereby available to solve communication problems in the most primitive environment without imposing undue requirements on the skill of the users.

2.5 Special aspects of satellite systems in the provision of telecommunication services in developing countries

2.5.1 Current and projected capabilities.

The characteristics of satellite systems, particularly those using geostationary satellites, have been mentioned in several of the preceding sections. In short, the main services that are available from them are as follows:

- high capacity international links between gateway stations -- carrying telephone, telex, data, television and sound programs at costs irrespective of distance

- individual telephone or data channels between earth stations either as permanent connections or on a demand basis, the latter enabling the user to utilize -- and to be charged for -- the channel only during the actual message or conversation time. Earth station antennas can be quite small for this type of service and can be transportable for temporary installation. This will eventually lead to antennas of such small size that roof top to roof top connections can be established for links irrespective of length.

- TV and audio broadcast program reception with small sized receiving stations for program distribution from a central transmitting station. At the receiving locations the programms may then be broadcast via ordinary TV and radio broadcasting stations, or fed into a cable distribution system, or directly shown to the public as a community reception service. It is expected that small size and low cost of such earth stations will lead to direct home reception.

- the foregoing services are available commercially from international (e.g. Intelsat) and domestic satellite organizations (such as the domestic systems in Canada, USA, and Indonesia).

- instead of contracting directly for particular services (TV, telephone channels etc) the satellite organizations also make available on a lease basis facilities carried on their satellites for use by the customer for whatever purpose he has in mind. This enables countries to establish domestic satellite systems without having to invest in, and operate their own satellites. Domestic sytems of this kind are numerous; Algeria Mexico, Sudan, Saudi Arabia, Zaire and Nigeria are examples, all leasing portions of Intelsat satellites for their own use.

- it is expected that the business of investment, launch and operation of satellites will become more and more separated from the provision of individual customer services, so that whole satellites will become available on a lease basis, for short and long periods.

It is clear that these service options combined with the fundamental characteristic of satellite systems to span distances up to thousands of miles regardless of terrain and climate, represent attractive solutions for telecommunication problems of developing countries. This applies in particular to the possibilities of reaching remote areas at relatively low cost, and with stations that can be quickly installed and can be moved to

other locations as the need arises for example in disaster situations. Further, the combination of telephone service and the transmission of broadcast programs (including TV) for subsequent distribution by conventional means represents a powerful tool for individual as well as mass communication purposes.

Successfully completed pilot projects (India, Alaska, West Indies, South Pacific) and the experiments with the Canadian domestic satellite system (Anik B) and the Canadian Communication Technology Satellite (Hermes) have demonstrated the multiplicity of functions satellite systems can play in remote areas. Education, health care, agricultural information services are the main fields of application, but once the communication medium is established a host of other not anticipated communication functions can become apparent, as shown, for example, in the Alaska bush communication network and in the Canadian Hermes and Anik B experiments. The United States Agency for International Development (AID) has sponsored a program to assist developing countries in exploring the potential of satellite communications for rural development. Specifically, the program is designed

> "to enable developing countries to apply satellite technology to their own development needs"
>
> and
>
> "to find the most appropriate and effective means to use satellite technology as a development tool".

The program is in particular addressed to solve urgent problems in health and nutrition, agriculture, education and training, community development, and project administration and management. It will be based on commercial satellite systems and will support pilot projects, demonstrations and information exchange.

Until recently commercial satellite services were not optimized for low cost solutions of telecommunication problems in developing countries, a situation which is changing as technology advances. In recognition of this, a joint ITU/OECD research program includes the study of the design characteristics of a

Global Domestic Satellite System (GLODOM) for rural telecommunications with particular emphasis on low cost, low power consumption, small earth stations. Such a system, if it materializes, would serve all developing countries, providing them with the space segment for their own domestic satellite networks. Thus, in total, many thousands of earth stations are envisaged.

2.5.2 Information gathering and remote sensing applications

Satellite systems have become effective instruments for obtaining current information on conditions in the atmosphere and on the surface of the earth. They have revolutionized weather forecasting and warnings of impending atmospheric storms; they are about to provide vital information in search and rescue operations; they are one of the favoured tools of resource management, particularly in developing countries where the knowledge of land and sea conditions within a country's area of sovereignty is incomplete and resources for organized, systematic terrestrial investigations and monitoring are lacking.

Earth observation satellites are equipped with remote sensing equipment which monitors the electromagnetic radiation reflected, emitted or absorbed by materials on the earth's surface. Sensors can be active or passive; that is, they can transmit radiation and measure the reflected energy or they can simply measure the amount of radiation coming from the earth's surface. Frequency bands are anywhere from ultraviolet to microwave regions of the spectrum, but the visible and infrared regions are most frequently used. The satellites circle the earth at some hundred km altitude in a north-south direction (polar orbit) so that the earth rotates under them, thereby exposing every part of the earth's surface to their observation. Their detailed measurements can be complemented by the larger area coverage from geostationary satellites at much higher altitude (36,000 km). The measured results are transmitted to earth stations usually in form of digital pulse streams, where necessary corrections are applied and a conversion to map displays

may take place, for subsequent analysis and interpretation by specialists in the particular fields of application. Apart from such direct visual analysis computer analysis of the corrected pulse streams may be used, leading to more accurate and more exhaustive results.

Depending on the fields of application (meteorology, land observation, sea observation etc) special satellites have been and are being developed mainly by the U.S.A., Europe and Russia. At present the best known in the earth exploration category is the series of Landsat satellites operated by NASA. Survey data can be obtained either from the organization operating in the country of origin of the satellite or from earth stations in or in the region of the user country itself. As examples, Canada was the first country to build and operate its own Landsat earth stations; similarly Brazil has her own Landsat earth station; the African Remote Sensing Council (ARSC) has agreed on an earth station location for regional pre-processing of data and personnel training, and for subsequent distribution to individual countries; and a large number of other countries obtain Landsat data from the U.S.A. for their own analysis and interpretation.

Main examples of the use of earth observation measurements are:

- Agriculture:
  Soil condition, drainage, moisture content.
  Crop identification and yields forecasting, crop disease, droughts. Livestock estimates.
- Forestry:
  Forest inventory, infestations, fire hazards, burned and flooded areas.
- Geology, mineral and petroleum exploration:
  Surface showings of mineral, oil, salt and brine deposits.
- Ocean information and Glaciology:
  Sea ice distribution; growth and retreat of glaciers.

Surface winds, ocean temperature and sea state (for fisheries).

- Water resources:
  Water quality, quantity and distribution.
  Prediction of run-off, irrigation.
  Pollution.
- Land use:
  Changes in land use and land use practice.
  Urban sprawl, rate of industrialization.
  Mapping of roads, dams, airports.
- Cartography and photogrammetry.

2.6 Special aspects of broadcasting services as an aid in development

In many developing countries, particularly those with large, widely spread populations, audio broadcasting has shown its effectiveness as an educational tool. Technologically this is due to the availability of inexpensive, battery fed transistor radio receivers, and cassette recorders for the storing and replaying of received programs. As a communication medium, radio broadcasting reaches people regardless of their literacy; it can use regional or local languages, and thanks to the transistor technology can accompany the listener wherever his location. It is a source of general information such as news, weather, announcements of any kind, of entertainment and of specific information for educational and job related matters. Moreover, from the point of view of the service provider, audio program preparation can begin with simple and inexpensive equipment, so that the setting up of local program production facilities does not immediately run into severe financial problems.

Extensive tests in developing countries have shown that the effectiveness of radio broadcasting depends in many cases on listener participation in choice and execution of the programs i.e. on the extent of local content. A careful balance must therefore be found between centralized national, and decentralized regional or local production. In some countries there are national networks as well as localized community

broadcast stations, the latter being strictly limited in their coverage area, for example by employing low power VHF/FM transmission. This whole situation is summarized in the Conclusions of a 1979 UNESCO Report ED-79/WS/70, entitled Low Cost Communication Systems for Educational and Development Purposes in Third World Countries:

"- Wide area transmissions from a central point which is characteristic of national broadcasting systems require complementary back-up by small scale systems that can take account of the varieties of need and interest, climate, language and culture.

"- Effective policies for national and educational development need communications support that will arouse response and action by individuals and small groups. Much of the effectiveness of small scale systems comes from the energy released when small teams share roles and tasks among themselves and with volunteers.

"- Local radio has an important but much undervalued role to play and other technology-using systems such as audio-cassettes can make useful contributions both independently and in association with radio.

"- Some of the necessary equipment components of small scale systems (such as VHF receivers) are already within the capacity of Third World countries to manufacture and assemble and others could become so."

Table A illustrates the availability of broadcast facilities in the developed and developing world; Table B provides more detail for one regional example, Africa.

Large scale educational projects such as the agricultural radio broadcasting program in the Philippines have demonstrated that the attitude of a large part of the farmer population towards the introduction of new methods and their willingness to accept a change of practices could be successfully improved, apart from an increase in general knowledge. Similar programs are broadcast in many other developing and developed countries. In Canada, for example, farm information programs are produced by federal and provincial governments,

TABLE A

In developing countries, radio is the only medium that can really be labelled "mass", where a large proportion of the population can be reached by radio broadcasts and possess the means to receive them.

Estimated Number of Radio Receivers in use					
Continent	**Year**	**Total number (million)**	**Continent**	**Year**	**Total number (million)**
Africa	circa 1960	4	Asia	circa 1960	22
	1970	16		1970	58
	1976	30		1976	113
America, North	circa 1960	184	Europe	circa 1960	136
	1970	326		1970	233
	1976	454		1976	284
America, South	circa 1960	14	Oceania	circa 1960	3
	1970	31		1970	8
	1976	58		1976	14

Source: Unesco Statistics on radio and television 1960–1976, Office of Statistics, Publication No. 23

Interesting conclusions are provided by comparing various groups of countries. In the following table, Group A consists of countries with a gross national product per capita of less than $400. Group B consists of countries with GNP per capita between $400 and $2,500; it also includes the oil-exporting states which have a high GNP but whose general development puts them in this middle bracket. Group C consists of developed countries — all of Western Europe except Portugal; USSR, German Democratic Republic, Czechoslovakia, Poland; USA, Canada, Japan, Australia, New Zealand, Israel.

Countries	**Daily Press**	**Radio Receivers**	**TV Receivers**	**Telephone** *	**Cinema Attendance**
	per 1,000 inhabitants				**per inhabitant**
A. With low GNP	19.2	56.0	5.4	1.3	2.7
B. With middle GNP	19.0	57.2	22.5	15.1	1.1
C. Developed	328.0	741.0	338.0	352.0	7.4

* Data about telephones do not include China

Sources: Unesco Statistical Yearbook, 1977; *World Bank Atlas* (for population figures); *World Radio and TV Handbook* 1979; *World Communications*, Unesco, 1977, *Statistical Abstracts*, USA, 1978, *IPC Report*, April 1979, Vol. 4; *Internal Report*, INA, etc.

Source: Many Voices, One World. UNESCO, 1980.

TABLE B

Penetration of broadcasting in Africa

country	radio receivers		television receivers
	number (× 1000)	per 100 inhabitants	number (× 1000)
Algeria	1 020	5.6	450
Angola	116	1.9	—
Botswana	60	8.9	—
Burundi	105	2.8	—
Cameroon	235	3.1	—
Cape Verde	36	13.2	—
Central African Republic	75	3.3	N/A
Chad	70	1.8	—
Comoros	10	2.9	—
Congo	83	6.4	3
Djibouti	15	5.0	3.5
Egypt	5 250	14.4	1 000
Ethiopia	210	0.7	20.5
Gabon	92.5	17.6	N/A
Gambia	61	12.3	8.5
Ghana	1 080	10.8	35
Guinea	120	2.3	N/A
Ivory Coast	210	2.9	101
Kenya	514	3.6	50
Lesotho	23	2.0	—
Liberia	265	17.7	8.9
Libya	110	4.7	150
Madagascar	609	7.2	8
Malawi	130	2.3	—
Mali	82	1.6	—
Mauritania	82	6.2	—
Morocco	1 650	9.0	460
Mozambique	225	2.3	—
Niger	100	2.0	N/A
Nigeria	5 100	7.4	105
Rwanda	70	1.6	—
Sao Tomé and Principe	20	20.0	—
Senegal	290	6.6	2.0
Seychelles	17	28.8	—
Sierra Leone	300	9.0	8.5
Somalia	69	2.1	—
Sudan	120	0.6	70
Swaziland	60	10.7	N/A
Tanzania	300	2.0	—
Togo	52	2.2	—
Tunisia	288	4.9	191
Uganda	250	2.2	71
Upper Volta	105	1.8	1.15
Zaire	108	0.4	7.2
Zambia	110	2.1	22.6
total/average	23 025.5	6.8	2 813.55 0.83

N/A = figures not available

Source: *World Radio & TV Handbook*

stored on tapes, and broadcast daily by local radio stations across the country. The experience has been that program production costs are small compared to the value of the radio stations' air time.

Another example is "The Developing Countries' Farm Radio Network" (DCFRN) produced in Toronto with - at present - seventy participating countries - a project in which all information supplied to local broadcasters has been gathered in developing countries, and where user countries have full control of what they use and how they use it. The function of this project is simply to act as a catalyst in the transfer of "appropriate" technology from one developing country to others.

Compared to these economically favourable characteristics of radio broadcasting, TV broadcasting is considerably more demanding on resources. Transmitting and receiving hardware is more expensive and is more dependent on other services such as electrical power; video recorders are not yet on the mass market, and program preparation requires a substantially higher degree of sophistication and expense regarding equipment, personnel and software preparation. Total expenditures for operating TV systems may be up to 10 times higher than for radio broadcasting services. However, communication satellites, broadcasting TV to small earth stations as mentioned in the preceding section, 2.5.1, have removed the constraints of distance, which formerly made TV distribution in remote areas excessively costly. Even reception in individual homes will become practical in the near future when earth station costs have dropped sufficiently. In the mean time, community reception has shown considerable promise as an economical mass medium for distribution of social, educational and job oriented information. The large scale project in India, using an experimental U.S. satellite, and low cost community earth stations was the first such experiment and achieved considerable success. Its results confirmed the technical feasibility, and pointed towards the institutional, organizational and programming factors that are often neglected but essential in the operation. In Canada, the experimental programs with Hermes and Anik B satellites were successful in demonstrating the possibilities of using satellite technology for remote eduction, tele-medicine, and native programming. In a similar way, the U.S. AID program mentioned in section 2.5.1 is aimed at the further adaptation of this technology to specific development goals.

3. TELECOMMUNICATION SERVICES AS AN ELEMENT OF THE DEVELOPMENT PROCESS

The information presented in this section is based on over forty interviews with knowledgable organizations and individuals in Canada, augmented by literature study; the interviews were held with telecommunication users in each sector. An attempt is made to establish general relationships between social and economic activities, and telecommunication functions, irrespective of special considerations that may apply to circumstances in developing countries. Such special considerations are dealt with in the subsequent Section Four on Planning of Telecommunication Services in Developing Countries.

This section presents, of course, the Canadian perspective - one might regard it as a Canadian case study. It is important to note that in presenting this picture, no claim is being made that this experience is a goal which should be the aim of other countries, developed or developing; rather, in examining as completely as possible the interdependence of telecommunications and other sectors, Canadian material was the most accessible and is therefore used as the base.

3.1 Telecommunication services support of sector performance

3.1.1. Transportation

Transportation as the physical movement of persons and goods, and telecommunication as the rapid, electromagnetic movement of information complement each other, they are used as substitutes for each other, and they support each other. Substitution takes place when sending a letter by mail is chosen instead of a telephone call, or when a conference call replaces travelling to a meeting place. And mutual support is given when telecommunication installations such as radio relay stations are built along roadsides for easy access by maintenance personnel, or when telecommunication facilities provide safety and guidance for aircraft and ships. It is the latter aspect of the role of telecommunications in the various modes of transport activities that is the subject of this section. Common to all modes of transport, whether by sea, air, rail,

road or pipeline is that telecommunication functions have become essential and indispensable when efficiency, effectiveness and safety of the transport undertaking are at stake, which is the case in practically all commercial applications. As a consequence, the benefits of telecommunication investments, as part of transport operations, can often be expressed directly in terms of increased overall efficiency -- in contrast to many other telecommunication applications where benefits are less direct and less amenable to quantitative analysis. For this reason telecommunication services in support of transport activities are often totally integrated in the overall operation, and remain unidentified, although they could also well form a basis for supporting other economic or social programs.

3.1.1.1 Air

Telecommunication in support of air transportation is divided into two separate parts: firstly the national and international arrangements for safety and navigational aids, and secondly the communication requirements of individual airlines for freight and passenger reservations, administration and managment. The first part is the responsibility of governments and international conventions between governments. The second part is handled by the individual airlines and through national and international arrangements between the airlines.

Governments provide all services to aid aircraft to fly, the many radio beacons, direction finding and instrument landing systems, air traffic control and weather information services on the ground and for flying aircraft, flight plan processing and other functions, forming a complex aviation telecommunications environment. For this purpose communication networks are set up linking all airports and related installations, and interconnected with the networks of neighbouring countries. In Canada, for example, an internal automated data interchange system (ADIS) links some 1,000 locations of airports, air radio stations, navigational aid installations, meteorological centres etc, providing information on flight plans, weather, status of navigational aids, air traffic control clearances etc. Internationally

these functions are performed through an aeronautical fixed telecommunication network (AFTN) under the auspices of the International Civil Aviation Organization (ICAO). These networks, though mostly composed of facilities leased from telecommunication carriers are -- in line with ICAO policies -- operated separately from the public telecommunication networks, to ensure immunity from outside influences which might jeopardize the critical conduct of their safety related functions (see section 2.2 on dedicated networks). Special communication satellite systems for aeronautical purposes are expected in the future.

The costs of government telecommunications in support of air transport can be substantial; in Canada they amount annually to some 24% (around $100 million) of the total air administration costs, which include the operation of all major airports, all navigational systems and a substantial fleet of government aircraft. Since these costs are incurred in line with ICAO standards and regulations any country that opens itself to international air traffic must be prepared to accept such expenditures.

In some countries all aircraft operations, regardless of purpose, are controlled by the military authorities in which case, of course, a civil aviation administration does not exist. In other countries there are agreements between the military and civil authorities for mutual support and co-operation, in particular regarding navigational aids and emergency services.

Similar to the extent of government involvement in aid to flying, the telecommunication activities of the airlines themselves are substantial, and considered to be absolutely essential for maintaining regular, efficient and economical air transport. Elaborate point-to-point and ground to aircraft communication networks serve for passenger seat reservations, freight scheduling, information exchange with aircraft in flight and administrative purposes. Owned jointly by the airlines, such networks are operated in North America by Aeronautical Radio Inc. (ARINC); and in non-North American countries by the Société

Internationale de Télécommunications Aeronautiques (SITA). In developed countries the seat reservation and freight scheduling systems are highly automated. Air Canada, for example, has 4,000 terminals in a worldwide system, handling some 160,000 transactions per hour, and spending annually $40 million on telecommunication and information systems, or close to four per cent of total cost of operations. In less developed countries reservations are checked and booked through telephone and telex services, though computer-based information sytems are now extending throughout the world (the SITA network with regional computer centres, services over 200 non-North American member airlines). The transmission facilities of these networks are usually leased from telecommunication carrier organizations but computers and terminals are provided by the airlines.

In combination, the air transport related government and airline activities in the field of telecommunications create a large demand on the availability of appropriate telecommunication facilities and services, spreading nationally and internationally to every location where there is commercial air traffic. This in turn requires a comprehensive telecommunication infrastructure capable of providing appropriate means for the many "dedicated" systems of the air industry. If such an infrastructure does not exist, air transport, particularly international air transport, is severely restricted.

3.1.1.2 Marine

Transportation on water is not far behind air transport in the demands for adequate telecommunication services. The slower speed may, in some respects, reduce the emphasis on the rapidity of information transfer, but it creates more communication problems since the ships' crews and passengers spend more time on board of the moving vehicles. Therefore, the communication system must be able to reach the ships wherever they are located on high seas or near shore.

Safety and navigational aids are provided through internationally standardized systems such as Loran C, Decca, and radio beacons,

distributed throughout the world under specifications of the ITU, IMO (International Maritime Organization) and Safety of Life at Sea Convention, requiring appropriate equipment installations on board ships. They are supported by ship-shore radio communication systems for the transmission of maritime information on weather, ice, gale conditions as well as for public correspondence for the ship's management and operation and also for the benefit of passengers. Medical advice, quarantine messages, pilotage information, emergency and hazard reports of any kind are among the many services provided through these ship-shore systems.

In general all shore installations are government operated, forming a complex infrastructure for maritime communications and navigation. They contain a large variety of radio stations operating at all frequencies and power levels, depending on the intended range and type of service. Among them, specialized communication satellite services for maritime traffic are now becoming internationally available. These systems are of course connected to the public telecommunication systems in the respective countries for direct communications between the ship and any location on land.

For any kind of maritime transportation the availability of telecommunication facilities has become indispensable. The efficiency and effectiveness of all marine activities, from tourist traffic to commmercial transport and fishing industries is critically dependent on appropriate telecommunication services. Even small transport and fishing enterprises are often critically dependent on radio contacts, weather reports and navigational aids.

In Canada the Government's marine administration, operating ice breakers, weather ships, harbours and inland waterways, spends some 12% of its total annual budget on telecommunications; and a typical private shipping organization spends close to one percent of its total operating costs on telephone, telex, data and related services for management and operation. In the latter case, all these services are provided by public telecommunication carrier organizations either in form of regular public services or through leased facilities forming dedicated networks for special purposes.

3.1.1.3 Railways

From the earliest days of the electrical telegraph railways have relied heavily on telecommunications for their operations, particularly for signalling and train dispatch. The wire lines along the tracks, built originally for railway functions only, became the first long distance lines for emerging public telegraph and telephone systems. Basically the situation has not changed, though wirelines gave way to UHF and microwave systems, and mobile radio has been added for communications to and from moving trains. However, the number of telecommunication functions for operational, administrative and customer services is ever increasing.

Because of their safety related operational functions railway telecommunication systems must be designed for the highest possible reliability, and, further, they must serve the multiplicity of stations, check points, signalling locations, switch sections etc. along the routes. For these reasons, what is best for the railways does not necessarily fit the layout and capabilities of a general public telecommunication (telephone) system. The result is that railway systems usually remain "dedicated" and independent of the general public system, although they may be made available for other than railway purposes, such as private line leasing, broadcast program and data transmission or even public telephone service in areas where the public system is not well developed.

Operationally telecommunication systems are indispensable for railways. Safety aspects and managerial control over the rolling stock are main reasons, and it is recognized that the efficiency in the disposition and use of cars and engines is strongly dependent on how well the associated communication system is designed. There is a wide range in the sophistication of these systems, from the rudimentary block system (subdivision of a country's system into individually operated block lengths) to modern centralized traffic control systems.

Operationally the supervision of train movement, car and engine distribution, maintenance of track, cars and engines, crew dispatch and many other functions must be provided. Further, radio systems serve communication needs on trains (end-to-end), between trains and stations, for repair crews, on yards etc. In addition there are the communication services for management and for customer services (freight as well as passengers).

As far as the capital investment is concerned, examples in the United States and Mexico show that communication facilities account for somewhat less than 1% of the total investment in tracks and equipment (the totals being some $36 billion in the U.S. -- 1970 -- and $1.4 billion in Mexico). The example in Mexico also showed that the calculated rate of return on the investment for a modern centralized traffic control system was in the order of 22% in form of cost savings through increased railroad efficiency. Where such an investment is not made the efficiency can be rather low, as an example in Tanzania shows.

Annual telecommunication expenses are typically in the order of 1% of total railway operating budgets, as for example in Canada where sophisticated computer based information and data processing systems for operating control and for traffic reporting and control are employed.

3.1.1.4 Road

As in all other modes of transportation, telecommunication plays an important role also in road transport by cars and trucks. The main applications are related to having contact with drivers while en route, and control over the disposition, time tables and whereabouts of the vehicles. Road transport also, of course, relies on broadcasting services for information on weather and road conditions. Correspondingly, limited range mobile radio installations are used for contact between drivers and central dispatch locations as in the case of taxicab, on-demand bus, delivery and related services. And for freight transportation over long distances fixed telecommunication systems are

used with check points along the route and terminal offices in major centres. Telex or private teletypewriter services are commonly chosen for traffic between terminals, whereas keeping in touch with drivers is usually done by telephone to avoid the need for special driver training in telecommunication methods. In countries with a sufficiently well developed telecommunication infrastructure commercial public telephone and telex services are suitable; however, where this is not the case special fixed VHF or UHF systems may be necessary for access at terminals and intermediate check points.

Investment in telecommunication systems and services is considered well justified by increased effectiveness and efficiency of the transport operation. Central control over car movements, and personnel dispatch and scheduling, customer services, and quick reaction in case of emergencies are main functions. In a typical large trucking company in Canada with monthly operating expenses of over $7 million, telecommunication expenses, exclusive of salaries, amounted in 1979 to about $75,000 per month, or slightly more than 1%. This compares with about 1% in case of railways or around 4% in case of airlines.

3.1.1.5 Oil and gas pipe lines

The most efficient means for the transport of oil and gas over long distances are pipelines. Similar to railway systems they require elaborate signalling, telemetering and remote control facilities to ensure safe operations and to detect quickly danger signals before a catastrophic breakdown can occur. For this purpose all intermediate pump or compressor stations along the lines report to central control stations either automatically or through local personnel, optimum flow and pressure conditions are maintained continuously, and repair crews dispatched as the need arises. As in the case of other transportation systems, safety and efficiency of the overall operation, and reliability of the telecommunication segment are the main criteria. Special fixed VHF or UHF systems may follow the route, or facilities of the general public telecommunication network may be used, if available and if satisfactory from a reliability point of view.

Computer based information systems for display of operating conditions at intermediate points for overall control from main stations, and co- ordination between interconnected pipeline systems are increasingly used.

One large Canadian pipeline enterprise with annual operating costs of $150 million spends $2 million, or 1.3% per year on telecommunication services.

3.1.2. Health Services

The state of health care and medical attention depends greatly on the interaction of many people, at the right time and the right location. Professionals, trained personnel, hospital facilities, supply of materials, food and clothing, pharmaceutical products, ambulance and administrative services are all important in this interaction, oriented towards the individual recipient of health related services. In an urban environment the corresponding need for communications is taken care of by whatever communication system exists, in particular the public telephone systems. However, problems arise where sparse population, remoteness, inaccessible terrain, poor economic conditions or other factors have not yet led to a sufficiently pervasive telecommunication infrastructure -- i.e. under conditions typical for what is called "rural environment" (see section 2.4). In developing countries, as well as in remote parts of highly developed ones, the need for at least basic health and medical services has led to the establishment of community health centres, able to handle routine cases and provide help in emergencies, as well as information and instruction to the public. This was also recognized by the World Health Organization (WHO) which adopted in 1977 a resolution to work toward the goal of primary health care (PHC) for all, defined as a community oriented, community based service directed by health workers native to the community.

However, the necessary size of such centres, and the necessary training of its personnel are critically dependent on the availability of communication facilities, for contact with better equipped medical and supply institutions -- the easier such contact, the lower is the requirement on the degree of training of the local personnel.

The main functions of such "telehealth" or "telemedicine" arrangements are

- providing a channel for advice and consultation with health professionals concerning questions of diagnosis and treatment of patients

- supplying logistic assistance in maintaining essential equipment and supplies and arranging for transportation of patients and material

- facilitating management and planning of preventive health service

- arranging for educational discussions and presentations.

As far as the utilization of telecommunication channels is concerned, experience in the Canadian North and in developing countries has shown that over 70% of the traffic is devoted to administrative tasks, in connection with supply, personnel, maintenance, financing, concerns of patients, etc. The remainder has to do predominantly with consultation, referencing, monitoring and education.

All the administrative functions can be performed over conventional telephone and, for larger centres, telex channels. The same is true for a majority of medical functions, considering that modern methods of slow scan television and graphic transmission can be applied to send, for example, electrocardiograms (ECG) over telephone channels. Higher resolution picture transmission, for example for the analysis of X-ray pictures, would require either very long transmission times over an often unreliable narrow band channel, or wide band and ultimately TV transmission which, in view of the costs involved and the relatively low frequency of events, is likely to be rejected in favor of other alternatives such as mail service, patient evacuation, visits by doctors, etc. Summarizing this situation, it has been emphasized in a

comprehensive Canadian Government report on Telehealth that "there is no practical substitute for reliable, private telephone circuits as a cornerstone for medical communication...".

How telephone channels in "rural" areas can be established is the subject of earlier sections in this report (sections 2.4 and 2.5.1). As mentioned there, two-way radio sets may be the first steps toward a health services communication system although their range is limited, or in case of using HF systems, their reliability unpredictable. Satellite systems with small, transportable earth stations have proven as for example shown in the Canadian Hermes and Anik B experiments to be well suited regarding flexibility, simplicity and reliability, their costs however -- even using low cost technology -- would commend sharing with other services such as educational, agricultural, public administration and similar programs. For remote regions mixed networks with satellite earth stations connected to local distribution sytems using wire line, cable, or VHF two-way radio extensions, would offer wide area coverage combined with penetration to isolated villages. However such systems would, for economic reasons, have to serve as general purpose telecommunication networks in which health service communication would form only a small part of the total capability. Even then, economic viability on the basis of individual customer charges is unlikely to be possible, so that the costs would have to be born publicly under general social programs related to health, education and medical aid.

Apart from the services so far described, telecommunication channels are needed also for the control of epidemics, monitoring and cambatting of disease carrying insect infestations, public inoculation programs and similar activities. In the presence of an adequate communications infrastructure such requirements are easily met. However, if no general systems are available each activity must have its own telecommunication component with the incumbent problems of cost, maintenance, availability and manpower training.

3.1.3 Agriculture

Preceding sections on rural systems (section 2.4), use of satellites (section 2.5), and broadcasting (section 2.6) have already referred to the role of telecommunications in the field of agriculture. This role becomes the more significant the more the efficiency and volume of farm production is to be raised beyond subsistence levels, and the more the increased farm output is to be distributed to other parts of a country. In other words, as agricultural production becomes a business or an industry, to play its role in the national economy, rapid information transfer through telecommunication becomes increasingly important in a number of different functions.

First, there is the need for raising and maintaining at a sufficiently high level the knowledge and skill of the individual farmer in regard to agricultural practices, innovations, problem areas, etc, as well as providing him with up to date information on changing conditions, such as weather, climatic conditions, insect migration, market opportunities, prices, etc. Both these functions -- education and information services -- can be provided by the use of radio broadcasting methods, as an inexpensive way to reach individual farmers even when scattered over large areas (see "The Developing Countries' Farm Radio Network" mentioned in section 2.6).

Second, radio broadcasting -- a one-way information transfer -- should be complemented by two-way communications to enable the individual farmer to get in touch with local, regional or national information centres from which he may obtain specific advice on his particular problems, such as financial matters, animal health, crop disease, farm management, equipment and material supply, repair services, marketing, etc. A sufficiently well developed telephone network coupled with the availability of agricultural information services meets this requirement. In Canada, for example, with hundreds of government run agricultural district offices and research stations, and with telephones in the proximity of a vast majority of farmers, the number of enquiries reaches many hundred every day, and even planning and accounting for individual

farms is handled through organizations run by farmer co-operatives. The Canadian central farming co-operative, Canfarm, for example, provides computer services to some 5000 farmers, advising them individually on all aspects of farming from diets for dairy cows to market information and income tax data. In this case the computer inputs and outputs -- specific for each individual farmer -- are collected and distributed on printed forms by mail. Where, in other countries, neither adequate mail services nor individual telephones are available direct contacts between individual farmers and central institutions are severely limited at best. Intermediate solutions such as establishing rural public call offices (PCOs) combined with regional or local broadcast programs, as described in section 2.4, are then suitable alternatives.

The establishment of an information service itself requires, of course, a substantial development of the telecommunication network in order to maintain contact between central and district offices and to ensure rapid transfer of information when, for example, test results at a research station have shown that an epidemic or other threatening condition, such as rabies, may be expected. In Canada, teletypewriter connections among the distributed government offices provide rapid, reliable communication with hard copy for further distribution to any area that might be affected.

Such network facilities are also needed for the distribution of information gathered through satellite remote sensing systems, regardless whether a country runs its own remote sensing stations or obtains results from other countries (see section 2.5.2).

In summary, the situation in agriculture is similar to that in the health care field. Broadcasting is an effective instrument to reach the population at large for education purposes as well as the conveyance of timely information. But the effectiveness of broadcasting is substantially enhanced by the establishment of publicly accessible two-way information systems, providing information services through the public telephone network, extending into rural areas. Projects for the

improvement of agricultural production and distribution must therefore be coupled with adequate attention to the telecommunication infrastructure.

3.1.4 Construction

Big construction projects need telecommunications at many levels for engineering, project management and logistic support. The local on-site requirements and communications between the site and local project offices are usually handled as part of the local project administration, employing available means or special arrangements such as two-way radio links. However, project planning and engineering is usually done far away from the project location, in other countries or on other continents. For that purpose national and international telecommunication networks are used extensively, and their reliability is of importance to the project execution. A large Canadian engineering and construction firm, for example, spends between 1% and 2% of its total costs of services on telecommunication (not counting personnel and on site communication costs) for personal and computer contacts with its worldwide local project offices. In these cases telecommunication is actually an instrument to keep scarce engineering and management resources together without distributing them over all the individual project sites, and also to make available to each site the expertise of the whole organization.

In the absence of adequate national and international connections special arrangements have to be included in the project (for example, special radio or satellite links) which may be uneconomical compared to standard commercial services and may be terminated with no further beneficial effect on the country's economy.

3.1.5 Electric Power Utilities

Power utilities provide electricity to a population dispersed over wide areas. High power transmission lines interconnect the various generating stations and the consumer substations for further distribution to customers. Generating stations may be driven by fossil fuel, nuclear

or hydro power. In all these systems communication networks are essential for protection, operation, maintenance and administration. The most critical of these functions is protection of the system components when a failure occurs at some point. Then, signals must be sent at high speed to initiate protective action throughout the system. Because of the possibly catastrophic consequences of a malfunction of the protective arrangements, reliability and freedom from interference are main requirements on the communication service. Similarly, remote control of the operation of stations, and telemetering for the observation of the functioning of the many system components require highest reliability and uninterrupted service.

For these reasons power utilities all over the world are faced with the problem of obtaining telecommunication services of adequate quality and reliability in support of their operations. In some countries with simple utility systems signals that can be sent in limited quantity directly over the high power transmission lines suffice, other countries, for example the U.K., rely on commercially available facilities of the general (BPO) telecommunication network, and others -- particularly for large and complex systems -- use specially built communication networks as part of the overall system. The latter is the case in some of Canada's provinces where dedicated microwave radio relay systems perform functions exclusively dedicated to the requirements of the electric utility. This involves large multi-million dollar telecommunication networks with hundreds of radio relay stations and associated fixed and mobile radio extensions for operation and maintenance purposes. Although Canada has a highly developed general telecommunication network the use of dedicated systems for electric utilities was chosen because it was considered that the existing general telephone network was not designed to meet the exacting requirements of the utility operation, and differed in configuration, particularly in the less populated areas. However, in principle, the functions of a network serving an electric utility are not incompatible with those of a general purpose network, so that the two could be combined if the state of development would allow appropriate planning at the early design stages. Section 2.2 on "Networks for public and for dedicated use" referred already to situations of this kind, and discussed the arguments for and against the formation of dedicated networks.

3.1.6 Tourism

Tourism can be a source of substantial economic benefits to a country, stimulating trade, commerce and various industries, in particular those associated with travelling and transportation. It provides revenue in foreign currency, thus improving the balance of payments. However, to maintain a regular tourist business, it is essential that adequate telecommunication services are available. Such services are needed to provide timely and reliable information to travellers, to let them book reservations for transport and accommodation, and, further to enable the operators of hotels and transport agencies to keep their establishments well utilized and for general management and administration. From the operators' point of view, occupancy rates as close as possible to 100% are desirable -- this, however, makes it more difficult for travellers to find satisfactory arrangements, unless special attention is paid to the availability of adequate reservation and referral services, ready to provide ahead of time and from any location a satisfactory response.

In addition, tourism is greatly aided by general information services, often in form of special broadcast programs, on places to visit, special events, as well as for urgent messages regarding emergencies, disaster warnings, weather reports, conditions of the road system, maritime navigation, etc. Such services are indispensable, and widely provided in national parks and remote regions with tourist attractions, such as mountain ranges, tropical island areas, hunting, fishing and other wild life regions. If such areas are to be opened to larger scale tourism these information and telecommunication services are actual prerequisites to be planned and implemented before business is started.

In Canada many nation-wide, regional and local reservation and information systems are in existence. Some 650 travel agencies, with a large number of branch offices, provide information, and make all necessary arrangements. In this industry telephone and telex are the predominant telecommunication methods, coupled with computer systems for

information and reservation purposes. Expenditures related to these services are high (estimated in the range of 4% of total business). Similarly, hotel and resort operators rely for their management on telecommunication services, mostly conventional telephone and telex; their expenditures (excluding client paid charges) are also in the order of 4% of total business costs (Source: "Trends in the Hotel Business", 1979 international edition).

As in other economic sectors, the provision of all these services is no problem if adequate national and international telecommunication services are available. Without them, however, the chances for promoting tourism on a broader scale are severely limited.

3.1.7 Education

The use of telecommunication as a tool in education is a subject of extensive study, discussion, experimentation and actual application. To describe its social and economic impact one has to distinguish between formal and non-formal education -- formal being traditional classroom schooling, as distinct from non-formal which is extended usually via broadcasting or correspondence courses to the public at large or certain communities of interest. The non-formal methods of instruction and education through telecommunication media have already been discussed in connection with Health Services (section 3.1.2) and Agriculture (section 3.1.3). This section is therefore oriented towards the problems of formal education at its various levels, from elementary to university.

In industrially developed countries such as the U.S.A. and Canada, the problems are mainly economic, related to the steadily increasing costs of education. The introduction of computers into school administration, audio visual aids to teachers, attempts to raise the efficiency of the learning process by computer aided learning (CAL) methods, and modern techniques for the extension of services to the less developed parts of the country are among the measures in which telecommunication techniques play a fundamental role. An example for the

extension of services to remote areas is the Appalachian Education Satellite Program in the U.S., in which teacher training and classroom instruction by TV and multiple audio channels, carrying specially designed courses, are brought into the remote Appalachian region through commercially available satellite channels.

In developing countries the problems are accentuated by the existing conditions of overcrowded classrooms, undertrained teachers, inadequate or sometimes irrelevant teaching material, and lack of access to schools. To overcome this, different approaches have been taken by different countries. Educational TV has been proven (in, for example, Ivory Coast, Korea, El Salvador) to be a powerful medium for raising the educational level, the motivation to learn, and speed of progress, but costs of equipment, tranmission and preparation of course material, as well as the complexities and costs of TV program production are serious constraints. One effective alternative -- as mentioned in earlier sections on broadcasting -- is the use of radio instead of TV. As an aid to local teachers whose role then becomes that of interpreting the received program and stimulating interactive participation by the students, radio broadcasting has proven to be extremely effective, to the point where community para-professionals may be able to perform the teachers' role. This, of course, would reduce the problems of extensive teacher training, teacher recruitment and selection of course material. At the same time radio broadcasting -- as a technique which has been familiar across the country for many years-may, as experience in Indonesia suggests, be less inducive to migration from rural to urban areas than TV which is basically an urban medium promoting metropolitan lifestyles.

Telecommunication in education is bound to play an increasingly important role, as the problems mentioned above tend to become more critical.

For the time being it is mostly the broadcasting medium that may bring some relief (see section 2.6). However, as the development of the

general public telecommunication network progresses, its facilities will become available for the distribution of special education and training programs, as they already do in industrially developed countries.

3.1.8 Fisheries

The establishment of an effective fishing industry raises the problem of providing telecommunication services between shore stations and vessels at sea. The fishing vessels themselves rely on information such as weather forecasts, contacts with their home base, co-ordination of activities, aid in navigation and position finding, etc. This they receive partly through broadcast-type of messages from marine shore stations (see section 3.1.1.2), partly through two-way radio connections with shore installations. Another group of services has to do with the function of sea resource management usually exercised by governments, and executed through patrol boats and remote sensing stations (buoys, special vessels) which report back to government agencies. Licencing and control of fishing operations, matching the supply of fish against the number of licenced operators, compliance with regulations on fishing methods, protection of certain species, control over sales activities, etc, are some of the functions in this category. Reliable and in many cases secure telecommunication methods are indispensable, and, in the future, specialized satellite communication links are expected to be made available for this purpose. This category is closely related to the Search and Rescue systems for safety at sea and other hydrographic, meteorological and navigational activities already mentioned in section 3.1.1.3.

Though of less importance for close-to-shore fishing in which the majority of fishing vessels is engaged, electronic equipment for, and familiarity with, telecommunication and navigation technology are essential in off-shore operations. The availability of trained personnel and of facilities for services as well as for repair and maintenance are part of a country's telecommunication system requirements.

3.1.9 Forestry

The preservation and management of forest resources depend on many telecommunication functions; the areas to be covered are usually vast and remotely located, and conditions are often such that disasters, forest fires, infestations may continue unchecked for months without being noticed, unless there are special systems for monitoring, surveying and protecting these resources. Operationally there are the communication requirements of lumber camps, contacts with vehicles, personnel administration and emergency services, which are usually performed through two-way radio systems as part of the project administration. For the detection of diseases, forest fires, flooding etc, special reporting systems are common, using regular aircraft patrol, remote sensing satellites, watchtower observations which pass the information into the general telecommunication network, or if the latter is not adequately developed, direct by radio to central agencies to initiate protective action. This type of service is usually provided by government agencies or industrial co-operatives. There are further supporting services such as radio broadcasts, to pass information to tourists in national park areas, for weather information, general guidance, wild life protection, etc. Resource management is increasingly recognized by governments as an integral part of economic development, and, accordingly, high priority is given to those measures which are essential for good management, which includes adequate telecommunications as an important component. An example of this trend can be seen in the rapidly spreading technical and institutional development of remote sensing satellite applications, as described earlier in section 2.5.2, where special reference was made to the help satellite technology can give to forest management.

3.1.10 Mining

Mining operations which in the context of this report may include the extraction of all kinds of earth resources, from metal ores to fossil fuels are usually in remote areas where even in well developed countries telecommunication services are either not available at all or of limited scope. In addition, there are usually no population centres in the

immediate vicinity so that the mining personnel and their families have to be settled nearby, which leads to the establishment of new towns, often with thousands of inhabitants. Telecommunication needs then arise for many purposes: for the internal administation and technical operation of the enterprise, for external communications with suppliers inside and outside the local region or country, for the urban communication needs within the settlement and to the outside world, and -- a major reason for substantial investment -- for safety measures and quick reaction in emergencies.

Project managers in setting up new mining operations are acutely aware of the necessity of having adequate local, national and international telecommunication services available even as a prerequisite before starting work. They can then either rely on existing facilities (provided by the telecommunication authorities in the country) or make it a condition that such services must be made available, by the authorities, as the project develops, or if that is not possible, by including in their program the installation of their own telecommunication systems, which may include long range radio or satellite links. Since mining operations generally are set up to last for some 10 to 50 years, such dedicated systems may become permanent components eventually to be integrated with the national or regional network.

Depending on the degree of autonomy of the project manager in relation to the headquarters of his company or state organization, the external telecommunication needs are either predominantly between the location of the project and the company's headquarters, or fanning out directly from the project location to the outside, nationally and internationally. Typical annual costs are in the range of ¼% to 2% of total operating expenses, and may amount to millions of dollars.

Regarding types of services, verbal and written telecommunications (telephone and teletype writer or facsimile transmission) are the main requirements. Added to that is data transmission for process control and information systems which can use telephone lines of sufficiently high grade of quality. For town site communications, standard automatic

telephone systems are common, connected by trunklines to the national network. Also broadcast radio and TV services may be included at the townsite.

In summary, telecommunication needs are of primary concern to mining operators who rely on these services for administrative, technical, social and -- as a matter of high importance -- safety aspects of their activities. Good examples for the vital importance of these services are the drilling and pumping operations for oil and gas at remote islands, or on off-shore floating platforms. There, practically all contacts with the outside world are dependent on the existence of reliable fixed and mobile (marine) telecommunication systems, carrying operational, managerial, administrative and social information from and to the isolated locations. Tropospheric scatter systems (see end of section 2.1.2) are being used in the North Sea drilling operations, satellite links, for example in Canada and Indonesia, microwave and UHF links at the closer-to-shore islands in the Persian Gulf.

3.1.11 Meteorology

Weather reports and forecasts have become an indispensible source of information, distributed by radio, TV and the press, and of vital importance to activities such as air and marine transport, commercial farming, fishing, tourism, construction and many others. The data from which reports are collated and which are processed to result in forecasts and trend projections, originate in hundreds and thousands of weather-stations, from simple observation posts on land and sea to aircraft and satellites, distributed throughout the world, and organized locally, nationally, regionally and internationally to provide a co-ordinated, reliable network to the benefit of everybody. Such co-ordination is of course entirely based on telecommunication systems, able to transmit instantaneously and over long distances first the original data from observation sites to collecting stations, and then after analysis and processing, to distribute the processed information to user organizations and the general public. Since the quality and reliability of the resulting information is the better the more comprehensive the coverage of the collection of observations throughout the world, no country and no area can remain excluded from this process.

Internationally, co-ordination is established through the United Nations World Meteorological Organization (WMO) and its basic World Weather Watch (WWW) programme. An essential element of that programme is the Global Telecommunication System (GTS) which is organized in three levels:

a) the worldwide main trunk circuit and its branches
b) the regional meteorological telecommunication networks
c) the national meteorological telecommunication networks.

National networks are built around National Meteorological Centres in each country which can provide adequate information to the regional and international systems only if the national telecommunication facilities are sufficiently well developed and can meet international requirements. Since so many activities mainly in the transport and agriculture sectors (see the respective sections in this report) depend critically on reliable weather observations, it is in the interest of every country to provide the appropriate telecommunication environment.

Though the technical requirements on branch lines so far have been modest -- in many cases HF radio circuits suffice -- higher quality facsimile and data circuits are increasingly used, as they are mandatory on the main and regional trunklines. As in other sectors which depend on telecommunication facilities, the meteorological requirements can easily be accommodated when the country's general telecommunication network is sufficiently well developed. If not, special arrangements must be made, which are costly in construction and maintenance and cannot match the flexibility and versatility of a general purpose system.

3.1.12 Commerce and Industry

Manufacturing and marketing of goods create a large demand on telecommunication services. In industrially developed countries, specialization of the manufacturing industry, interdependence of different industries, dispersal of manufacturing facilities, centralization of management, increasing automation, etc, require

instantaneous and reliable information transfer, supporting the internal operations and administration of the enterprises. Added to that, and usually exceeding it in volume, are the external requirements for obtaining the necessary raw materials, and for marketing, selling and distributing the manufactured goods. Expressed as a percentage of sales, expenditures on telecommunication services in Canada (not counting computer services) are typically in the order of one quarter of a percent -- not significant as a percentage, but in large corporations substantial in dollar value. Most of these services (telephone, telegraph, teletypewriter, facsimile, data) are provided by the telecommunication common carriers.

As marketing and financial success depend to a large extent on the timely availability of information on demand, pricing, competition, sales opportunities etc, the impact of telecommunication services grows with growing complexity of trade relations and industrialization. Increasing use of telecommunication and computers as a replacement for paperwork and physical transport of documents can be seen in the international moves towards simplifying, and avoiding unnecessary delays of the administrative procedures for trade such as customs declarations, way bills, routing instructions, etc. In Canada, efforts in this direction are under the Canadian Organization for the Simplification of Trade Procedures (COSTPRO) which is working towards a commercial network (Tradex) designed for use by commerce and industry. All national efforts of this kind employ a common format under a "United Nations Layout Key for Trade Documents", the use of which, of course, presupposes sufficiently well developed telecommunication networks in participating countries.

To be mentioned in this connection are also the extensive telecommunication and computer services employed in national and international banking and associated payment systems. Here, also, one part of these services is in support of the internal operations of the respective organizations, another part for external verbal and written communications with suppliers, customers and other institutions.

In Canada each of the main chartered banks has its own telecommunication and computer system through which branch operations are co-ordinated, records kept, credit authorizations verified, routine transactions performed, money transfers made. Transmission facilities are leased from the public telecommunication carriers, but computers and terminals bank owned. Altogether, some five million transactions take place each day, and increasing automation of shopping, pay roll services, etc will further increase this volume at a rapid rate. Similarly, the international transactions betweeen banks in many different countries are executed over a special international telecommunication network SWIFT (Society for Worldwide Financial Telecommunications), already mentioned in section 2.3. International networks of this kind have, of course, a useful function only when the national networks which they connect are at a reasonably advanced stage of development.

In summary, commerce and industry are among the heaviest users of telecommunications, and depend strongly on the availability of reliable, cost-effective and comprehensive domestic and international services. Well developed public networks are essential to meet these needs, regardless of whether facilities are used for communications with the general public or on a dedicated basis within an organization or other community of interest.

3.1.13 Public Administration

Governments are usually the largest single users of public telecommunication services. The daily administrative tasks of the various departments and their branches throughout a territory create a heavy demand on rapid, reliable communications by telephone, telegraph, teletypewriters, data, facsimile and picture transmission to and from centres, and reaching, if at all possible, into the remotest areas. Apart from this, government departments often operate their own dedicated telecommunication networks for operations in their particular sphere of responsibility, for example for the control of air and sea transport, internal security, law enforcement, and others. Not counting such dedicated systems, the Government of Canada spends some 0.6% of its total

budget on administrative communication services, mostly supplied by the telephone and telegraph companies. Including the dedicated systems the figure is close to 1%.

Telecommunication in this context provides the tools for the internal administration and contacts with the public; it enables authorities to react quickly in situations of disaster, emergencies, crisis of any kind, and to respond to enquiries from anywhere in the country. Associated with it are the various government information services distributed by radio and TV broadcasting, and addressed to the public in general or special interest groups such as farmers, health care units, social agencies, etc.

As an administrative tool telecommunication is of vital importance in centralized as well as in de-centralized systems of management. In the former case it facilitates the exercise of control from a central point, in the latter case it enables co-ordination of the various de-centralized units. Recognition of this dual role can, for example, be seen in recent public policy development in France (Télécommunications, Juillet 70):

"La politique d'aménagement du territoire a pour objectifs permanents d'assurer la meilleure répartition, dans l'ensemble national, des effets du développement économique, de concourir à la résorption des disparités régionales et de valoriser les initiatives locales. .... Une telle politique fait que l'aménagement du territoire se préoccupe des problemes de communication .... Cela se traduit par une action sur les télécommunications (considérées comme un moyen et non pas une fin en soi) .... Pour cette politique les télécommunications sont une condition nécessaire, quoique non suffisante ...."

Of growing importance in public administration are the various specialized computer operations for internal administration and for particular departmental programs. Employment statistics, immigration, the labour market, electoral lists, census material, social services, pensions, taxation, industrial and agricultural statistics, motor vehicle

licensing, police records and a host of other functions depend increasingly on computer based data banks, and on the system that keeps these data banks continuously updated and ready to produce the required output. In many countries the largest concentration of computer systems is in the public domain, and the telecommunication functions associated with this activity often lead to separate data networks interconnecting the various branch and central offices within a particular system (see section 2.2 on dedicated networks).

Related to these activities is the gradual introduction of electronic mail services i.e. the substitution of the physical transport of correspondence and documents by electronic transmission. This involves appropriate input devices at the originator's end, transmission over data networks, and reproduction at the receiving end. Once the electronic "highways" are established in the form of a comprehensive telecommunication network, the transmission function presents no problems. For the other components it is a matter of time for a suitable and cost effective terminal technology to emerge, able to compete economically with the existing increasingly inefficient methods.

Another development in the application of telecommunications technology in public administration is the growing use of "conference calls" i.e. the substitution of individual travel to meeting places by electronic interconnection of all participants. From a simple telephone conference scheme to elaborate closed circuit TV arrangements there is a host of possibilities, increasingly considered as time and cost saving administrative tools.

Finally there is the trend toward office automation by which the mechanical tasks of composing and formating of correspondence and reports, of filing and other office functions are performed by computer based printing, storing and display arrangements, thereby greatly improving the accuracy and accessibility of output as well as reducing the required level of skills of the personnel.

To what extent these modern technologies are applicable in developing countries depends entirely on the particular circumstances. What is highly desirable in one country may be unsuitable in another country. It depends on whether the main problems are encountered in the availability of skilled manpower or transportation, or adequate maintenance facilities for electronic equipments, or other factors highlighted below in Section Four on Planning in Developing Countries.

3.1.14 Mass Media

Broadcasting and the press, though communication media by themselves, also rely to a large extent on telecommunication services in support of their main functions.

In preceding sections frequent reference has been made to the microwave, cable and satellite links that serve as feeder lines of radio and TV programs to broadcast transmitting stations. If these facilities are integrated in the general telecommunication (telephone) network they may, because of their bandwidth requirements (one TV channel equivalent to about one thousand telephone channels), occupy a substantial portion of the total systems capacity. If they are built and operated separately, they form dedicated networks comparable in size to the general network, often constructed directly parallel to the general network routes. Such duplication of facilities and manpower requirements is often considered wasteful and unnecessary, though brought about by prevailing organizational divisions of responsibility.

In addition to these program distribution networks, broadcast organizations use telecommunication services extensively for obtaining the source material for their news reports and documentaries. In this respect they are similar to the operations of the press, which acquires its material through worldwide telecommunication networks, dedicated to the particular needs of news agencies, such as United Press International (UPI), Associated Press (AP), Reuters, Agence France Presse (AFP), Tass. As an example, UPI operates a complex worldwide, private network with switching centres in Brussels, Hong Kong and New York, branches to most large capitals in east and southeast Asia, South America and Europe, and

with inter-connected computer data banks, telephoto and printing systems. In areas where there is no coverage (Africa in the case of UPI), commercial telecommunication services are used as available.

With regard to this kind of private network, and the ease with which broadcast programs can be transported instantaneously anywhere in the world, it was mentioned in section 2.3 that there is growing concern in developing countries about an imbalance in the flow of information with a heavy emphasis on program origination in the industrially developed countries. To counter such an imbalance the aim is to establish stronger national and regional information systems and corresponding telecommunication networks, thereby reducing the dependence of developing countries on the influx of material which they may not consider relevant in their own environment. How this could be achieved within the available financial and manpower resources, for example by co-operative ventures, by appropriate tariffs for international press wire services, and other measures is the subject of vigorous ongoing debate, as documented in the reports of the MacBride Commission referred to in section 2.3. Telecommunication development is in these cases directly linked to questions of cultural sovereignty and self-reliance in the field of information.

On this latter point it is important to consider the financial implications of the choice of a particular system for information distribution. If, for example, comprehensive TV coverage is selected this carries with it the responsibility for creating all the necessary program material -- a commitment which may put excessive strain on the available financial resources and may force the responsible Administration to import cheaper programs from other countries thereby negating initial attempts at avoiding excessive dependence on other countires. A different choice, for example of relying more heavily on radio broadcasting than TV may have different and possibly more favorable ramifications.

3.2 Social and political impact

Whereas in most of the fields covered in section 3.1 the impact of telecommunication is that of improving operational efficiency or of presenting economically feasible solutions to problems that could not be solved before, the social and political impact is less tangible and may in many cases be open to often contradictory interpretation, or altogether ignored. It has been argued, for example, that improved rural telecommunication in a poor, subsistence oriented, remote environment may benefit not so much the people concerned but urban commercial interests ready to exploit more effectively the rural poor. Usually, in such arguments, no differentiation is made between the various possible modes of telecommunication which may have quite different effects. For example, introducing into a rural environment a standard urban-type telephone system with individual subscriber lines and general connectivity has, apart from its cost implications, different effects from those of a system that is designed to meet rural needs, such as (see section 2.4) a radio broadcasting system in conjunction with limited two-way facilities. If the needs are, as for example expressed by the people of the Canadian North (Inuit Tapirisat of Canada, Intervention before the CRTC, 1978), to be able to call for help in emergencies, for advice on medical and legal matters, and to establish contacts between dispersed members of families and friends, then appropriate solutions may consist of the introduction of specially designed and tariffed services, and the organization of information centres to which the people concerned can turn. The technicalities of the communication system are only one component; appropriate organizational and policy matters are of equal importance, as further discussed in Section Four.

The tariff structure of telecommunication services was mentioned above as an instrument of social policy. Some countries that can afford to do so (in the Arab region) provide free telephone service to all its citizens, in conjunction with free education and free health services. Others have specially low tariffs (so called "life line" services for a limited number of calls per month) for the poor, sick and elderly, who cannot afford the regular telephone charges. Differentiation in tariffs between business and private use of the telephone, between intra-city and long distance calls, between daytime use and night time use etc, all

express not only financial and operational aims of the telephone authorities, but also policies in support of social goals.

The effectiveness and perceived value of the traditional point-to-point telecommunication services, such as telephone, telegraph, telex, data, facsimile, depend of course on the particular purposes for which the offered facilities are used by the multitude of different individual customers. In these types of services the message content is entirely at the discretion of the user, outside the control of the service provider whose role is exclusively that of a carrier for whatever the user wants to have carried. This is in contrast to radio and TV broadcasting where the message itself is an essential part of the service, whereas its carriage is only an incidental part of the process of transferring the message to its user. Correspondingly in broadcasting, the service provider has the responsibility for the message content and for producing and paying for the costs of program preparation. It then depends on the service provider whether or not the particular choice of programs has the intended impact on the user community. In this way social and political aims of a country's Government can be pursued directly through appropriate broadcasting policies. The effects of such policies in the fields of health care, education, agriculture, navigation, etc. have been illustrated in preceding sections of this report. Politically, radio and TV broadcasting have their well established role as effective mass media through which prevailing government policies, or the ideas of different factions in a power struggle or election can find instantaneous countrywide distribution. This of course opens up the possibility of abuse by one-sided support of the aims of the political party in power to the detriment of others. In this way control over communications can become a political tool for obtaining or maintaining power by limiting opportunities for open information exchange.

Whether or not such goals as national integration or social and political stability can be achieved through improved telecommunication service, cannot be stated generally; the use of telecommunications may play an important, even decisive role in whatever the outcome in a

particular situation, but the nature of the outcome itself depends on other factors. What had a cohesive and stabilizing effect in one case may lead to the opposite in another case.

As far as the private individual is concerned, telecommunication in the urban environment has come to be taken for granted, and wherever it is not available its lack is recognized as a major deficiency to be remedied as quickly as possible. In the rural environment it is more the long-standing acquaintance with a life without communication, or with only the most primitive ways of communicating, that has prevented a clear statement of need and demand. However, spreading education and familiarization through radio and TV broadcasting is changing the situation. Beginning with the people in remote areas of industrially developed countries (e.g. Canada, Australia, U.S.), the potential benefits of telecommunications are being recognized and demands are expressed. Satellite communications, overcoming all constraints of distance and terrain, have done much to demonstrate the possibilities, as for example, expressed in the following quote about India's development communications (International Institute of Communications, Intermedia September 1981, p.40):

"...we are not seeking to develop our communication network by the use of satellites just for the sake of fashion. Nor do we consider modern electronic media to be merely a tool of entertainment. For us, they are a means to inform, educate and motivate the people. Our urgent task is to improve the quality of people's life; we must immediately create conditions for slowing down the runaway rate of population growth, if not stop it completely. We have to tackle the problem of illiteracy urgently, we have to tell the people about the advantages of adopting improved methods of farming; we have to impress upon the people the importance of health and hygienic living and the benefits of unified social action.... A new social character is what we seek to achieve by the development of communication facilities. And since satellite communication is an instant and direct form of communication, we seek to develop and increase our capability in this sphere."

The growing awareness of the potential benefits of telecommunication is also apparent in the various international technical co-operation programs which encourage the expression and formulation of specific needs in developing countries.

It appears that instead of trying to define positively the social impact of telecommunications, it is easier to state the disadvantages associated with their absence, based on the knowledge of what can be done by a judicious choice of technological and organizational solutions. An important point in such considerations is to recognize that benefits of telecommunication to the individual are not solely economic, but are to a great extent conducive to "well being" i.e. to easing daily life by improving social contacts, being able to make arrangements, obtaining information and entertainment, and generally "participating". This, combined with the direct economic advantages of being able to conduct business without loss of time by moving from place to place, has made telecommunication services hard to miss for all those who have had the opportunity of using them.

On the other hand, the development and spread of telecommunication networks, particularly in conjunction with information systems and automation, has raised questions on undesirable effects such as violation of privacy rights, employment dislocation, problems of the international flow of information as referred to in section 2.3.

3.3 Aggregate sector needs as seen from the services supply side

In the various economic sectors described in sections 3.1 and 3.2, telecommunication services are obtained in part through specialized facilities, serving exclusively the needs of the respective institutions such as transport enterprises, electric utilities, government departments. The majority of services, however, and in particular those of a general nature, are supplied by the telecommunication agencies responsible for operating public networks, of which the telephone network is by far the largest. These agencies, public or private, and

correspondingly owned or regulated by government, form the telecommunication service industry which represents a substantial economic sector in its own right. The performance of that sector is an aggregate measure of the extent to which services are rendered to business, industry, government and the public at large. Since revenues in that sector are predominantly (generally more than 90%) due to telephone service, telephone statistics provide a good measure of performance.

There were in 1981 close to 500 million telephones in the world; some 20% of them in Latin America, Asia and Africa, 50% of them in North America and the balance in Europe, Australia, Japan etc. The telephone density i.e. the number of telephones per 100 population, varies widely from country to country, from less than one per 100 to over 70 per 100. See Table C for a statistical summary of the world's telephones, and Table D for a more detailed analysis of one region, Africa. Further, there is a well established correlation between telephone density and GNP per capita, demonstrating that there is a relationship between telephone density and economic development, (see Table E). As significant as this is, it does not, however, answer the question of whether telephones have an effect on economic development or result from it. Further, telephones are predominantly used in urban areas, with government and business as main users; their extension into sparsely populated rural areas has received increased attention only recently.

The telephone service industry has been described by R. Chapuis (ITU, Oct. 1975) as a "heavy industry". He estimated the worldwide total turnover (gross annual revenues) in 1975 to be between 70 and 75 billion U.S. dollars. This corresponded to a total of some 350 million telephones. Further, he compared telephone revenues with railway revenues and showed that "in most countries with a market economy common carrier telecommunication turnover exceeds that for the sum of both rail passenger and freight traffic, and often by a very large amount". In addition he notes that "in all countries the ratio of common carrier telecommunications service to railway services (passenger and freight) whether its value is still below 1 or much above 1, during the four year period 1970-1973 analysed, showed a steady increase".

TABLE C

International Telephone Statistics

Country	1977 Population (000s) Total	Principal Cities	Rest of Country	TELEPHONES - JANUARY 1980 National Total (000s)	National Per 100 Population	National Percent Average Annual Growth 1969-78	National Automatization (%)	Principal Cities Total (000s)	Principal Cities Per 100 Population	Rest of Country Total (000s)	Rest of Country Per 100 Population	Percent of National in Principal Cities Population	Percent of National in Principal Cities Telephones
WORLD	4,138,000	NA	NA	423,082	10.22	6.6	99	NA	NA	NA	NA	NA	NA
AFRICA	438,000	NA	NA	4,237	12.80	4.3	86	NA	NA	NA	NA	NA	NA
Algeria	18,100	1,991	16,109	298	1.64	7.5	87	176	8.84	122	0.76	10	59
Burundi	4,100	NA	NA	5	0.11	5.5	99	3	0.80	NA	NA	10	100
Egypt	39,845	17,059	21,786	522	1.34	4.1	88	458	7.80	64	0.29	44	88
Ethiopia	28,609	1,855	26,754	79	0.28	9.1	100	60	3.24	19	0.07	6	76
Kenya	14,384	1,385	12,963	144	1.00	9.3	100	116	8.38	28	0.22	10	81
Madagascar	7,995	1,165	6,830	29	0.36	2.0	94	29	2.09	0	0.00	15	100
Mauritius	894	143	751	29	3.24	6.8	100	12	8.39	17	2.26	16	40
Nigeria	79,059	2,139	76,920	128	0.16	6.0	30	71	3.32	57	0.07	3	55
Rhodesia	6,860	1,044	5,816	197	2.87	6.0	94	159	15.23	38	0.65	15	81
Rwanda	4,800	NA	NA	4	0.08	6.5	100	4	0.80	NA	NA	10	100
Seychelles	619	160	459	5	7.37	29.2	100	4	23.73	1	0.17	24	83
South Africa	26,130	8,909	17,221	2,320	8.88	5.8	87	1,703	19.08	617	3.58	34	73
Sudan	18,000	1,971	16,029	62	0.34	3.8	91	56	2.84	6	0.04	11	90
Tanzania	16,132	1,216	14,916	74	0.46	10.1	80	59	0.80	15	0.17	7	80
Zambia	4,067	1,855	2,212	54	1.32	2.9	97	44	2.32	10	0.46	46	82
AMERICAS	577,000	NA	NA	192,789	33.41	5.0	99	NA	NA	NA	NA	NA	NA
Brazil	119,004	26,729	92,275	4,708	3.96	7.9	98	3,597	13.46	1,111	1.20	23	77
Canada	22,943	10,308	12,635	14,506	63.23	5.7	100	7,445	72.73	7,061	55.88	45	51
Jamaica	2,000	823	1,177	111	5.55	6.9	100	97	11.79	14	1.19	41	87
Mexico	66,944	25,477	41,467	3,712	5.54	13.6	98	3,133	12.30	579	1.40	38	85
Trinidad & Tobago	1,067	100	967	75	7.03	4.9	100	46	46.00	29	3.00	9	61
United States	217,000	43,441	173,559	161,448	74.40	4.5	100	36,365	83.70	125,083	72.07	20	23
Uruguay	2,800	1,200	1,600	279	9.90	3.0a/	92	219	18.20	60	3.80	43	78
ASIA	2,319,000	NA	NA	62,877	2.71	9.9	98	NA	NA	NA	NA	NA	NA
Bangladesh	81,800	NA	NA	89	0.01	NA	70	49	NA	40	NA	NA	55
Burma	31,500	9,000	22,500	33	0.10	4.4	69	27	0.30	6	0.03	29	82
China (Taiwan)	16,866	5,340	11,526	1,685	9.99	22.1	100	986	18.46	699	6.06	32	59
Hong Kong	4,567	4,567	-	1,251	27.39	12.7	100	1,251	27.39	-	-	100	100
India	632,099	31,051	601,048	2,247	0.36	8.8	86	1,200	3.86	1,047	0.17	5	53
Indonesia	138,341	15,036	123,305	325	0.23	6.7	68	249	1.66	76	0.06	11	77
Iraq	12,500	11,500	1,000	320	2.56	12.7	96	223	1.94	97	9.70	92	70
Isreal	3,651	1,924	1,727	930	25.47	9.8	100	685	35.60	245	14.19	53	74
Japan	114,620	19,281	95,339	50,626	44.17	10.7	99	11,895	61.69	38,731	40.62	17	23
Korea (South)	35,860	14,643	21,217	1,978	5.20	16.8	97	1,419	12.77	432	0.19	41	71
Malaysia	13,086	1,439	11,647	375	2.86	10.2	99	226	15.70	149	1.28	11	60
Nepal	13,130	303	12,827	9	0.07	6.4	83	8	2.85	1	-	2	92
Philippines	44,980	8,912	36,068	567	1.26	10.0	95	519	5.82	48	0.13	20	92
Singapore	2,325	2,325	-	455	19.57	16.1	100	455	19.57	-	-	100	100
Sri Lanka	13,970	955	13,015	74	0.52	2.8	97	47	4.92	27	0.21	7	64
Thailand	44,273	6,475	37,798	367	0.83	13.8	97	308	4.76	59	0.16	15	84
EUROPE	781,000	NA	NA	154,829	19.82	8.0	99	NA	NA	NA	NA	NA	NA
France	53,183	9,664	43,519	17,519	32.94	10.7	100	7,129	73.77	10,390	23.87	18	41
Germany, Fed.Rep.	16,767	4,216	12,551	2,860	17.06	9.3	100	1,173	27.82	1,687	13.44	25	41
Italy	56,601	20,677	35,924	16,119	28.49	9.3	100	9,236	44.67	6,883	19.16	47	57
Portugal	9,766	1,736	8,030	1,175	12.03	7.4	95	627	36.12	548	6.82	18	53
Spain	36,230	11,203	25,027	9,528	26.30	12.5	95	4,611	41.16	4,916	19.64	31	48
Swedan	8,267	3,598	4,669	5,930	71.73	4.6	100	2,882	80.10	3,048	65.28	44	49
Switzerland	6,292	2,173	4,119	4,145	65.88	5.6	100	1,919	88.31	2,226	54.04	36	46
Turkey	41,758	8,343	33,415	1,379	3.30	13.9	81	924	11.08	455	1.36	67	20
United Kingdom	55,844	17,522	38,322	23,182	41.51	7.5	100	9,064	51.73	14,118	36.84	33	39
USSR	260,000	25,324	234,676	19,600	7.50	8.9	98	5,194	20.51	14,406	6.14	10	26
OCEANIA	23,000	NA	NA	8,350	36.30	5.6	97	NA	NA	NA	NA	NA	NA
Australia	14,074	8,964	5,110	5,835	41.40	6.2	97	4,435	49.50	1,400	27.50	64	76
Fiji	588	87	501	33	5.61	9.5	90	16	18.39	17	3.39	15	48
New Zealand	3,146	2,181	965	1,715	54.51	4.5	96	1,308	59.97	410	42.49	69	76
Papua New Guinea	2,914	250	2,664	38	1.30	9.8	99	33	13.20	5	0.19	9	87

a/ Growth for 1971-78 period.

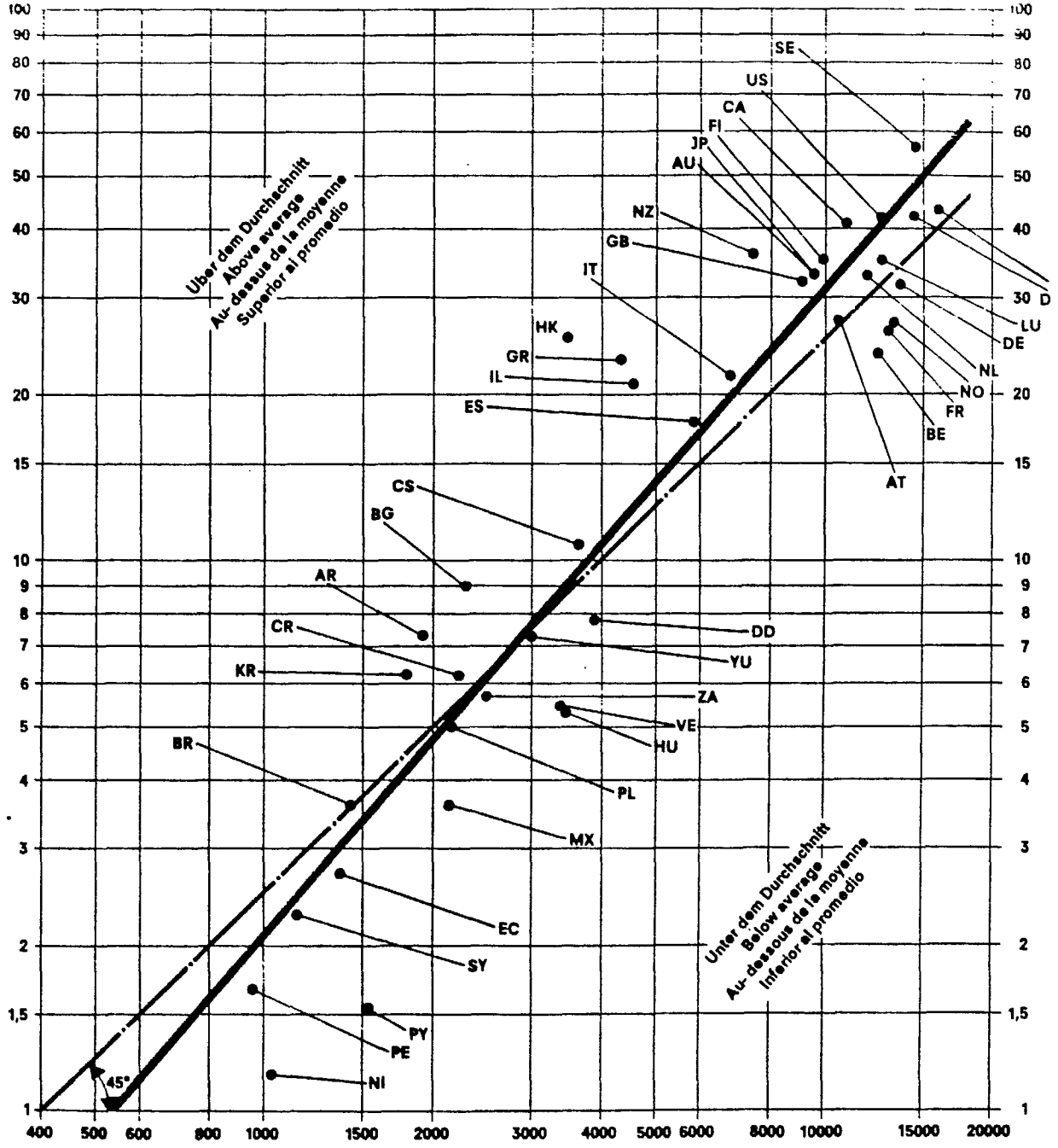
Source: AT&T's "The World's Telephones," a statistical compilation as of January 1978. Data for principal cities for the United States and Japan is in respect of cities with 500,000 or more telephones only.

country (OAU members) (sources)	population (x 1000)	direct exchange lines (DEL)	telephone apparatus	DEL 100 inh. apparatus/ 100 inh.
Algeria [1]	18 500	196 100	346 400	1.06 (1.87)
Angola [4]	6 200	32 300	42 900	0.52 (0.69)
Benin [1]	3 197	5 400	10 300	0.17 (0.32)
Botswana [1]	767	5 900	10 100	0.77 (1.32)
Burundi [4]	3 870	3 389	4 888	0.09 (0.13)
Cameroon [5]	7 664	19 800	39 200	0.25 (0.51)
Cape Verde [1]	273	1 490	1 570	0.55 (0.58)
Central African Republic [1]	2 256	2 200	5 200	0.10 (0.23)
Chad [1]	4 000	2 400	6 500	0.06 (0.16)
Comoros [1]	444	1 400	1 800	0.32 (0.41)
Congo [1]	1 300	6 900	12 800	0.53 (0.98)
Djibouti [4]	300	2 350	3 650	0.78 (1.21)
Egypt [1]	39 200	362 000	473 000	0.92 (1.21)
Equatorial Guinea [4]	310	1 000	1 100	0.32 (0.35)
Ethiopia [1]	30 017	60 000	80 000	0.20 (0.27)
Gabon [3]	526		10 600	(2.02)
Gambia [1]	494	1 470	2 500	0.30 (0.51)
Ghana [1]	10 000	36 100	64 900	0.36 (0.65)
Guinea [1]	5 143	6 600	9 500	0.13 (0.18)
Guinea-Bissau [3]	791		2 200	(0.28)
Ivory Coast [1]	7 188	27 600	66 600	0.38 (0.93)
Kenya [1]	14 875	65 300	156 300	0.44 (1.05)
Lesotho [1, 4]	1 156	1 800	5 300	0.16 (0.46)
Liberia [1, 4]	1 500		7 500	(0.50)
Libya [2]	2 444	100 495	101 600	4.11 (4.16)
Madagascar [1]	8 410	15 100	32 000	0.15 (0.38)
Malawi [1]	5 744	13 400	26 500	0.23 (0.46)
Mali [1, 3]	5 697	3 300	5 700	0.06 (0.10)
Mauritania [2]	1 318	2 677		0.20
Mauritius [1]	910	19 900	32 100	2.19 (3.53)
Morocco [1]	18 906	149 000	216 000	0.79 (1.15)
Mozambique [1]	11 760	29 300	49 300	0.25 (0.42)
Niger [1]	5 246	5 200	7 800	0.10 (0.15)
Nigeria [4]	80 000	58 700	167 300	0.07 (0.21)
Rwanda [1]	4 800	2 700	4 500	0.06 (0.09)
Sao Tomé and Principe [4]	100	750	800	0.75 (0.80)
Senegal [4]	4 436	15 200	38 700	0.34 (0.87)
Seychelles [1]	62	2 470	5 540	4.00 (8.96)
Sierra Leone [4]	3 330	7 000	10 500	0.21 (0.32)
Somalia [2, 4]	3 241	5 076	11 300	0.16 (0.35)
Sudan [1, 2]	18 656	43 541	61 000	0.23 (0.33)
Swaziland [1]	529	3 900	9 900	0.74 (1.87)
Tanzania [1]	17 500	35 020	81 600	0.20 (0.47)
Togo [1]	2 371	5 600	10 400	0.24 (0.44)
Tunisia [1, 2]	5 964	87 200	158 000	1.46 (2.65)
Uganda [4]	11 172	22 000	48 900	0.20 (0.44)
Upper Volta [1]	5 938	4 000	8 600	0.07 (0.14)
Zaire [1]	25 300	26 900	48 000	0.10 (0.19)
Zambia [1]	5 400	29 800	57 200	0.66 (1.06)
Zimbabwe [3]	6 800		196 750	(2.9)
total	416 005 (50 countries)	1 529 728 (46 countries)	2 754 798 (49 countries)	0.38 (0.66)

Sources:
[1] *ITU Year Book 1977*
[2] Middle East survey project
[3] *AUT World Telephones*
[4] Project reports or estimates
[5] IBRD reports

TABLE E

Telephone Density in Relation to GNP



AR	Argentina	EC	Ecuador	MX	Mexico
AT	Austria	ES	Spain	NI	Nicaragua
AU	Australia	FI	Finland	NL	Netherlands
BE	Belgium	FR	France	NO	Norway
BG	Bulgaria	GB	Great Britain	NZ	New Zealand
BR	Brazil	GR	Greece	PE	Peru
CA	Canada	HK	Hong Kong	PL	Poland
CH	Switzerland	HU	Hungary	PY	Paraguay
CR	Costa Rica	IL	Israel	SE	Sweden
CS	Czechoslovakia	IT	Italy	SY	Syria
DD	East Germany	JP	Japan	US	U.S.A.
DE	West Germany	KR	South Korea	UY	Uruguay
DK	Denmark	LU	Luxembourg	VE	Venezuela
				ZA	South Africa

Mittleres Verhältnis
Mean ratio
Rapport moyen
Relación media

Hauptstellen je 100 Einwohner
Main stations per 100 inhabitants
Postes principaux par 100 habitants
Puestos telefónicos principales por 100 habitantes

Bruttosozialprodukt (BSP) je Einwohner in US $ [1]
Gross National Product (G.N.P per capita (U.S. $) [1]
Produit national brut (P.N.B.) par habitant en $ A [1]
Producto nacional bruto (PNB) por habitante en $ USA [1]

From Siemens "International Telephone Statistics" 1980-81

As far as capital investment is concerned, Chapuis referred to "Huntley's Law: ... the invested capital value of the equipment [investment less depreciation] ...of a sophisticated modern telecommunications undertaking run on a strictly commercial basis is roughly three times the gross annual income (turnover) of an undertaking".

Chapuis continues: "This law is fundamental and brings out the structural difference between telecommunications undertakings and ordinary industrial and commercial companies. In the latter case, the situation is just the opposite, capital invested in plant being, more often than not, less than one-third of the annual turnover. In other words, the fixed capital of a telecommunications operating agency is about ten times as great as that of an ordinary industrial undertaking.

"It is the size of the capital invested in the network and installations of a telecommunications operating agency which justifies describing it as a 'heavy industry', while those industries manufacturing consumer goods and equipment (including telecommunications equipment) are correctly designated 'light industry'".

Applying Huntley's Law to the total turnover in 1975 mentioned above, the total worldwide investment by 1975 amounted to some U.S. $220 billion. The average annual growth rate at that time was about 10%. To sustain such a growth rate substantial annual investments are required which -- as Chapuis shows -- are in the range of 30 to 60% of the total turnover. In the example of 1975 this amounted worldwide to at least U.S. $25 billion. In Chapuis' words: "The application of Huntley's Law to the growth rate desired for common carrier telecommunications helps to bring out the vast amounts of capital necessary for network construction and the installation of the equipment of operating agencies. Telecommunications is indeed a heavy industry -- heavy not least in the burden it imposes on the executives of undertakings who have to find the means for financing development!".

Canada, with a population of 23 million at the end of 1975, had around 13 million telephones i.e. 57 per 100 population. With a GNP at that time of around Cdn$ 154 billion, the GNP per capita was around Cdn$ 6700. Total operating revenues of the telecommunication carriers (telephone, telegraph, telex and leased lines) were around Cdn$ 3 billion or about 2% of GNP. Unfortunately, as mentioned above, the leverage of such substantial telecommunication expenditures on operating effectiveness and efficiency i.e. on the economic performance of the users, can only be guessed. The number of employees of the Canadian carriers in 1976 was around 100,000 or about 1% of the total Canadian workforce. Related to the number of telephones (neglecting the small percentage of services other than telephone) this works out to one employee per 130 telephones -- a figure which is attainable only with a high degree of organization, skill and experience. Under less well organized circumstances in developing countries a ratio of one employee to not more than 50 to 70 telephones is more appropriate if adequate operation and maintenance of the system is to be ensured.

Institutionally, telephone service is provided practically everywhere in the world by entities that are given by governments an exclusive franchise in a certain area -- the latter being as small as a village or as large as a whole country. Such service monopolies are a natural consequence as far as the provision of transmission facilities, and the universality of interconnection are concerned. Competition in services within one and the same area would lead to straight duplication, reduced economies of scale, and cause inconvenience to customers. However, the concept of a service monopoly does not necessarily extend to such things as the subscriber's terminal equiment (in some countries the subscriber is free to choose from a variety of competitive telephone sets, provided that these equipments all meet common technical standards). Similarly the monopoly concept does not necessarily extend to other than telephone services, such as teletypewriter, data, facsimile, broadband services, as long as access to them does not have the degree of universality as in the telephone case.

However, in most countries -- main exceptions are the U.S.A. and, to a lesser degree, Canada -- the telephone authorities, usually government agencies, retain a monopoly on all point-to-point services (telephone, data, teletypewriter, facsimile). Non point-to-point services such as broadcasting are under the control of other government agencies (although even here transmission facilities for program distribution may fall under the monopoly of the telephone authority). As far as the utilization of transmission facilities (microwave systems, satellite earth stations, intercity and intracity cable and wire lines) is concerned, joint usage for different services has the advantage of avoiding fragmentation and waste of resources (further discussed in relation to developing countries in Section Four) -- supporting the argument in favour of a monopolistic arrangement. However, from the point of view of provision of services, competition is more likely to lead to innovative solutions and to give customers that service which is most beneficial for them in support of their operations. A combination of the two concepts has led in the United States to so-called value-added services, in which transmission facilities of public telecommunication carriers are leased by an organization and augmented by specialized switching and terminal arrangements to offer a variety of specialized services to customers on a competitive basis (mostly in the computer communication and facsimile fields).

Similar arguments apply on the question of private networks, discussed in section 2.2. Here also, there are different options in solving the needs of particular communities of interest. An industrial, business or government institution may build, own and operate a communication system of its own, or it may lease transmission facilities from the public telecommunications carriers and add to them special equipment according to the particular needs. Taking the latter approach, a non-public network can be operated privately but still remain within the confines of a monopoly on transmission facilities by the public telecommunication agency. An example of the existence of these two options can be seen in the specialized networks for electric utilities which in Canada are totally separate from the public telecommunication

networks whereas in the U.K. they make use of the transmission facilities (leased lines) of the British Post Office.

In each case the choice of the final solution depends on economic analysis but technical and political considerations may have a strong influence.

Many of the considerations in this section may appear to be of little relevance to developing countries where development has not yet led to an integration of telecommunication functions in the society's modus operandi. However, statistics show increasing growth rates of the telecommunication infrastructure in developing countries exceeding those in industrialized countries, and, further, there is considerable encouragement given to developing countries by United Nations Agencies to reduce the gaps in infrastructure development that separate them from the industrialized part of the world, as the UN announcement of a Transportation and Communications Decade for Africa, or the report of the MacBride Commission exemplify.

The subsequent Section Four is devoted entirely to aspects concerning developing countries.

4. PLANNING OF TELECOMMUNICATION SERVICES IN DEVELOPING COUNTRIES

4.1 Introduction

Technology and use of telecommunications evolved in Europe and North America simultaneously with the build-up of industrialization. They grew as an integral part of the industrial world and played a role in shaping the conditions and institutions that are typical for today's industrial countries.

In contrast, developing countries that now endeavour to establish, expand and improve their telecommunication systems are in a totally different situation. They are faced with an enormous variety and sophistication of technical and operational choices which are in no way related to the particular circumstances prevailing in their societies. Therefore, tracing the evolution of telecommunication in industrial countries is of little help in understanding the developing countries' needs and problems in this field.

In trying to portray these needs and problems one must be acutely aware of the fact that conditions in no two developing countries are alike and that speaking of a "typical" developing country would be an oversimplification. With specific reference to the telecommunication sector, Table F illustrates the diversity found among developing countries. More generally, to quote from Wellenius (Telecommunications Policy Sept.77):

> "However large may be the differences between developed and developing countries, the diversity among the latter is even more impressive. Population varies from over 500 million (India) to about half a million (Gabon). Average population density in Bangladesh is almost 50 times as high as in Brazil. The private sector is heavily relied upon in some countries and the public sector in others; the majority of the economies lie between these extremes, but public utilities and heavy industries tend to be state-owned. Some developing countries are heirs to

TABLE F

Developing nations grouped according to telephone density.

Nation	Telephones per 100 population (1979)	GNP perhead($)(1978)
Group 1:		
Cyprus	16.8	NA
Argentina	10.3	1910
Costa Rica	8.9	1570
Yugoslavia	8.5	2380
Trinidad and Tobago	6.6	2910
Mexico	6.4	1973
Jamaica	5.9	1110
Brazil	5.1	1570
Chile	4.9	1410
Tunisia	2.9	950
Average	7.6	1754
Group 2:		
Syria	2.7	930
El Salvador	1.6	660
Philippines	1.2	510
Thailand	1.0	490
Peru	0.7	740
Ghana	0.6	390
Sri Lanka	0.5	190
Tanzania	0.5	230
Madagascar	0.4	250
India	0.4	180
Average	1.0	457
Group 3:		
Uganda	0.3	280
Sudan	0.3	320
Indonesia	0.2	360
Nigeria	0.2	560
Ethiopia	0.2	120
Zaire	0.1	210
Upper Volta	0.1	160
Rwanda	0.1	180
Nepal	0.1	120
Chad	0.1	140
Average	0.2	245
Group 4:		
Hypothetical rural region (population 10 million)	0.01	100

Source: Telephone density: The World's Telephones, 1981: GNP World Development Report, 1981.

long-established and sophisticated cultures, while others contain the world's most primitive peoples. Many have only recently become free of colonialism, while others reached that stage almost two centuries ago. The capacity to absorb political and economic change varies widely with social flexibility, colonial history, reservoir of skilled manpower, and a host of other factors. There are enormous differences in incomes: in 1972, Argentina's [per capita] gross national product was US$1300, about 20 times that of Upper Volta, Rwanda or Burundi; whereas in some countries most of the people live on the brink of subsistence, in others minimum acceptable conditions are - or could be - enjoyed by all. Similarly, there are large differences in economic structure, some countries relying heavily on foreign trade, others on the exploitation of minerals, a few on industry: the great majority, however, depend heavily on agricultural production, which though increasingly directed towards commercial forms is still predominantly a subsistence activity. There are huge differences in economic potential: whereas some developing countries seem to have the physical resources to build a great power, others have virtually no base for sustained growth in the foreseeable future.

"Development problems, then, vary greatly from country to country, and there is a wide range of development objectives and strategies. Despite this diversity, a common purpose emerges in almost all developing countries: to reduce poverty, to ensure minimum levels of education, housing, health and food to every citizen, to increase control over nature by the nation and the individual, and to broaden the opportunity for choice."

Therefore, the following sections on the planning aspects of telecommunication services in developing countries should be understood as highlighting typical situations, components of which may be encountered in one country, others in other countries, in different combinations and with different emphasis. When applied to specific cases the actual conditions must be analyzed before conclusions can be drawn.

Telecommunication is one mode of people for communicating with each other. Other modes are direct face to face contacts which may require means of transportation to bring people together; or mail services for letters, books, newspapers which also depend on transportation systems. If transportation systems by road or railway are lacking, or climatic conditions restrict their use, telecommunication is the only option that can make communications possible. This complementation and substitution of transportation by telecommunication gains in significance as transportation costs rise (fuel and general construction costs) in comparison to telecommunication (electronics) costs, and as advancing technology offers more and more possibilities for making telecommunications practically independent of terrain, distance, climate and conventional electrical power sources. The significance of this for developing countries is evident since mountain ranges, jungle, heavy forest, desert or tundra, island areas and extreme temperature and meteorological conditions are characteristic for many of these countries making conventional transportation and the extension of transportation based public and private services difficult if not impossible, or excessively expensive. These same environmental difficulties may of course present problems also to telecommunications. But there the variety of available options is so great that the chances for finding practical and economically acceptable solutions is greatly enhanced. This naturally presupposes careful planning of not only the technical characteristics but also -- and of equal importance -- of the financial and institutional implications that are connected with the build-up and sustained provision of adequate services. This is the subject of the following sections.

4.2 Special problems affecting the provision of telecommunication services in developing countries

The need for telecommunication services is well recognized in developing countries. In urban business and government centres there is usually a wide gap between limited supply and growing demand for basic telephone and telex services, existing facilities are overloaded in peak hours to the point of total collapse, new subscriber connections may have waiting times of up to ten years, and delays in long distance and international traffic of hours and days are common. Communication with remote, isolated and economically deprived areas is often impossible, and organizations which require telecommunications for their own operations are left to develop their own private systems. Yet, in spite of all this, improvements are slow in coming. There are apparent constraints which tend to retard the response to growing demands and which may affect the willingness of governments to make appropriate investment decisions. R.J. Saunders (World Bank Report TWT-N-1, 1980) discusses the following constraints:

> "(1) a lack of enumeration and quantification of the benefits of telecommunications investment relative to what is done in other sectors;
>
> (2) a perception that telecommunications investments, while profitable in a financial sense, confer direct benefits only upon a relatively narrow -- and privileged -- portion of the population of a developing country;
>
> (3) tariff policies which in the short run do not promote an efficient allocation of telecommunication resources; and
>
> (4) institutional and organizational problems both within and exogenous to the telecommunications operating entities."

and further mentions lack of foreign exchange and of technically qualified manpower as inhibiting factors.

With regard to the above mentioned points (1) and (2), Section Three of this report describes -- although with few exceptions mostly in qualitative terms -- the impact of telecommunication on the various social and economic sectors, and tries to link telecommunication development to a country's general level of development. The subjects of the other points as well as some further considerations are covered in the following sections.

4.2.1 Institutional constraints

Fragmentation of telecommunication systems has already been discussed in earlier sections (2.2) as a possible cause of retarding a country's development of an adequate communications infrastructure. "Fragmentation" in this context refers to a situation in which different telecommunication services are provided by different, unrelated organizations, each investing in its own facilities and building its own systems, often over the same routes, without reference to the possibility of sharing in scarce financial, manpower and technical resources. Saunders (World Bank, Report PUN 48, Sept. 1979) describes this as follows:

> "In some countries, the responsibility for telecommunications is divided among several operating entities on the basis of a differentiation of services (e.g., local telephone, long distance and international telephone, telex and telegraph). In other countries, there are several or many companies, each operating in a limited, although sometimes overlapping, territory. Often there are also important numbers of private or quasi-private systems, operated by government (ministries of health, public works, etc.) or by public or private enterprises. Whereas the existence of some specialized systems may be justified in terms of user requirements, in a developing country context both service-related and spatial framentation frequently result in a higher cost solution for national communication needs, an inability to realize

> potential economies of scale, and significant resource misallocation borne by the country. Examples include excessive variety of equiment types, with associated higher cost of interconnection, training, stocks and maintenance; loss of scale in domestic and international procurement and financing with associated higher costs; duplication of many managerial and professional functions; inability of the smaller entities to build up the full range of expertise required to perform effectively, especially in planning and system engineering functions; and an increased effort required by the operating entitites and government to develop the system as an integrated whole meeting a variety of user and national development needs, and following the country's development principles and strategy."

How this service-related fragmentation affects, in particular, the improvement of communications in isolated areas is brought out in the following quote from E.G. Anany, "Communications in the rural third world," Praeger 1980:

> "At the international level, communication projects often cut across a number of rival bureaucracies -- such as broadcasting, education, agriculture, and health, to mention only the most common. Attempts to get coordination have not worked well in rural education projects in Brazil and Guatemala and in the Ivory Coast. It seems easier to define goals narrowly under the jurisdiction of one institution than to broaden the scope of rural communication and risk the problems caused by shared responsibility and bureaucratic rivalries. Yet the integrated approach to rural development could have important benefits if institutional constraints could be overcome."

In almost all of the developing countries national economic planning offices exist to which major projects of government agencies and autonomous corporations, as well as many in the private sector, must be submitted for approval prior to construction. Potentially this may help to reduce the multiplicity of unrelated telecommunication projects in the interest of building up a more integrated infrastructure. However, the extent to which telecommunication functions are built into the operations of particular undertakings (for example, transport or electric utility or even broadcasting systems) makes it difficult to separate them from the particular sector programs. Further, planning offices have the task to rank projects in relation to national economic development priorities where telecommunication as a support function may become totally submerged in the measures for pursuing the broader aims of fighting poverty, malnutrition, diseases, illiteracy, lack of shelter.

Then, to avoid inefficiency and fragmentation, well managed, cost conscious, national development oriented telecommunication agencies are required. This leads to another institutional problem, namely the structure and regulation of the public telecommunication agencies, in particular their degree of autonomy in financial and management matters. R.J. Saunders, in the above mentioned World Bank Report TWT-N-1, 1980, describes the organizational measures that are essential to enable these agencies -- irrespective of how closely they are tied to the government -- to function as efficient providers of services:

> "Such measures essentially revolve around the telecommunications entity being made independent from day-to-day government interference, and where relevant, eliminating the practice of making changes in the entity's senior operating managers each time there is a change in government. In addition, efficient sector operations require the elimination of the necessity for detailed government approval of the normal technical, procurement, and expenditure decisions which top corporate management, following national government development policy and sector regulatory guidelines, should be able to make.

> Specifically, this could involve the streamlining of the relationships with the various government agencies legitimately interested in influencing the long-run course of telecommunications development, and expediting procedures for investment program approval; the introduction of a management- oriented commercial accounting system; setting tariffs at levels which meaningfully ration demand in the short run and which allow full cost recovery and the generation of funds for new investment; simplifying and expediting the regulatory procedures for the periodic revision of tariffs, especially where general price inflation requires frequent adjustments; giving the operating entities sufficient authority to collect bills promptly from all users including government subscribers; ensuring that internally generated funds are effectively available for investment under approved medium-term telecommunications development programs, the operating companies either retaining these funds or recovering them when required; and giving the operating entities sufficient freedom to set salaries, wages and other benefits so as to develop as a competitive employer, capable of attracting and retaining qualified staff at all levels."

A particular problem arises in the relationship between the agencies responsible for the traditional point-to-point services (telephone, telegraph, data, etc.) and those responsible for broadcasting. The reason for this difficulty is that broadcasting is content oriented whereas most point-to-point services are concerned strictly with carriage, leaving the message content entirely to the customers. As a consequence broadcasting is subject to a country's information policy -- state regulated or free enterprise, whatever the case may be -- often controlled through a Ministry of Information, whereas telephone and telegraph services lend themselves better to a rate-regulated public or private operating company. As mentioned earlier

in this report, this often leads to duplication of facilities, since the means for program transmission in broadcasting systems are basically the same as those for the transmission of point-to-point services.

4.2.2 Human resource constraints

Planning, engineering, constructing, operating, maintaining telecommunication systems requires skilled personnel at all levels, from university graduates to semi-skilled technicians, as well as for managerial and financing tasks, tariff development, accounting, personnel and many other administrative functions. Developing countries usually encounter difficulties in finding sufficient manpower within their own territory and often depend for extended periods of time on foreign sources which not only compounds the foreign exchange problem but also delays the build-up of indigenous experience with their own systems. Fragmentation of networks as described in the preceding section further adds to these difficulties since it multiplies the manpower requirements.

Considerable progress in solving these problems has been made during the last two decades, although lead times have proven to be long.

In the words of Saunders (World Bank, Report PUN 48, Sept. 1979):

> "Good telecommunications training centers exist in many developing countries, a number of them having been set up over the last 15 years or so with technical assistance of the International Telecommunication Union financed partly by the United Nations Development Programme. Typically, technical personnel up to technician level are trained in national or regional centers, and on the job. In some centers, or in local university programs, junior professional engineers are also educated. Education abroad (other than in regional centers) is resorted to only in some countries for selected professional levels. Normal problem areas generally include inadequate coordination between training centers and the operating

companies, and the fact that training in finance and management generally receives much too little attention. These, however, if acknowledged as problems, can be dealt with relatively easily.

"An especially difficult problem is faced by the poorer developing countries, where there is a strong dependence on foreign personnel, and there are virtually no sources from which to recruit new personnel with an appropriate level of education to undergo training."

B. Wellenius (Telecommunications Policy Sept. 1977) refers to this situation as follows:

"Although telecommunication operations have been successfully started and developed to a considerable extent with expatriate staff, there is a need to transfer all functions to nationals as soon as possible. This localisation process is especially long for the higher engineering and managerial posts. It requires early identification of promising young school students, entering them into an arrangement whereby they are supported in their studies to join the telecommunication company later giving them further education and training within the country (including on-the-job training as counterparts to expatriates) or abroad as may be required, and promoting them as rapidly as possible within the company. A few countries have succeeded in achieving full localisation from very limited conditions in 12-15 years. Some others, however, failed to identify and act upon this need in time, and continued dependence on foreigners became an organizational and political problem leading to staffing crises and sometimes severe programme disruption."

Recognition of the paramount importance of the formation of adequate manpower resources for technology based development has led to many national and international institutions specializing in training methods and associated disciplines. The Technical Co-operation Department of the International Telecommunication Union, for example, conducts regional seminars on all aspects (technical, financial, organizational) of skill development for telecommunication systems, and makes arrangements for the training of personnel from developing countries at institutions in the industrialized nations, such as Canada, USA, UK, Sweden. Another example is the "Foundation for International Training for Third World Countries", a Canada-based international, non-profit organization dedicated to the formation of managerial and technical skills. One of its main objectives is to "mobililze financial and human resources internationally in support of programs leading to the development of human potential in the Third World countries". And one of its essential characteristics is that "needs will be identified by the host organizations who must also participate in the development and conduct of the programs". Examples of that institution's telecommunication related activities are programs for remote education in Egypt and telemedicine in the Sudan.

4.2.3 Financial constraints

Of crucial importance for the financial viability of commercial telecommunication services is the setting of appropriate tariff levels for the charges to be levied from users. In practice, tariffs are set to maintain profitability and an acceptable rate of return on invested capital, while at the same time limiting public and user group reaction, avoiding political repercussions and relating to tariffs in other countries. However, tariffs must also be related to the existing and planned capacity of the network, so that, for example, stimulation of traffic through low rates does not lead to overloading of facilities or to excessive demands on new subscriber connections. The latter is the case prevailing in many developing countries where under existing tariffs demand for services in urban centres exceeds by far the supply, with the resulting effects of congestion, overload, breakdown, excessive waiting

times and delays, whereas at the same time rural areas remain unserved. A judiciously chosen tariff policy adjusted to the various user categories could then be used in the short run to help generate the funds for urban and rural improvement and expansion. For the actual justification of such new investments, however, there appears to be a need for a better awareness of the social and economic costs of perpetrating present unsatisfactory conditions, and a better definition of the specific government objectives and programs for which telecommunication development can provide the greatest benefit.

Telecommunication projects are in general capital intensive, and require large investments, a substantial portion of which in developing countries has to be in foreign currency because of foreign content in equipment, engineering and construction (See Table G for examples of investments in telecommunication infrastructure). Since the revenues of commercial telecommunication agencies are predominantly in local currency, these agencies cannot by themselves generate sufficient foreign exchange, although their operations at least in urban centres may be highly profitable and may be able to create substantial surplus for the benefit of other government programs. The telecommunication sector then has to compete with all other sectors of the national economy for obtaining foreign funds. In this it may receive a low priority for various reasons (some of them indicated in the beginning of section 4.2) although in actual fact telecommunications may help in improving the net balance of payments of a country through savings in other sectors, such as savings in fuel consumption through improved efficiency and substitution in transportation, or through improved conditions in the tourist trade.

The conventional other sources for financing telecommunication imports such as supplier credits and foreign commercial bank loans may involve costs and conditions beyond the capabilities of the less well-off among developing countries. The only other sources, then, are bilateral aid institutions, multilateral development banks, and to a lesser extent the United Nations Development Programme.

TABLE G

INVESTMENTS IN TELECOMMUNICATION INFRASTRUCTURES

	in $ per inhabitant	% out of total investments	in $ per inhabitant	% out of total investments
	1968		1977	
Developed Countries (except socialist countries and FRG)	16.6	3.5	54.4	3.9
Developing Countries (a sample, representing 8% of the total)	1.6	1.8	6.7	2.0

Source: ITU, 1977.

AVERAGE TELECOMMUNICATIONS INVESTMENT PER ANNUM AS A PERCENTAGE OF TOTAL GDP[1]

More developed countries		Less developed countries	
United States	0.83	Venezuela	0.51
Canada	1.07	Upper Volta	0.27
Federal Republic of Germany	0.82	Burma	0.23
United Kingdom	1.23	Chad	0.05
France	0.68	Kenya	0.30
Italy	0.82	Malaysia	0.34
Japan	1.05	Pakistan	0.32
Australia	1.09	Thailand	0.30
Switzerland	1.13	Singapore	0.53
Sweden	0.47	India	0.17
Belgium	0.60	Fiji	0.62
Spain	1.06	Costa Rica	0.60
average	0.90	average	0.35

Source: Many Voices, One World. UNESCO, 1980

4.2.4 Hardware supply constraints

Since most of the equipment used in telecommunication is produced in industrially developed countries its acquisition in developing countries involves foreign exchange funding, which as mentioned in the preceding section usually cannot be generated by the business revenues of the telecommunication agencies themselves. Apart from funding through other government sources, foreign loans or international aid organizations, this problem can be by-passd to some extent by the local manufacture of telecommunication equipment. Besides the conservation of foreign exchange this would have many beneficial effects, such as employment opportunities, lower costs, export potential, familiarity with the equipment. However -- in the words of Wellenius, Telecommunications Policy Sept. 1977:

> "These benefits do not always materialize. Cheap labour may be more than offset by low labour productivity, difficulty in coordinating supplies of raw materials and components (some or all imported), the complexity of production planning in industries involving large number of parts, and the scarcity of skilled industrial managers. The generally weak export organization of developing countries, with very complex and slow procedures and no sources for supplier financing, makes it difficult to break into the highly competitive international markets. Finally, a certain degree of technological independence must be attained, which requires the development of good research and development capabilities closely related to the telecommunication companies that will buy the manufactured goods and the industries that will produce them. Only a few countries have the large markets, sophisticated technical and managerial skills, national and managerial skills, national decision making strength and other conditions required to develop a truly indigenous telecommunications manufacturing industry."

Branch plant manufacturing in developing countries by foreign corporations may provide employment but is dictated primarily by the mother company's interest in low wages, marketing, transportation and related conditions. It may produce products that are used in the developing country itself but these would reflect the originating country's technology i.e. they would have been designed for conditions in the originating country and would not necessarily be best suited for the developing country (climatic conditions, maintenance needs, user habits, service options, choice of raw materials etc). In the future, increasing modularization of equipment may enable developing countries to assemble equipment themselves, according to their own plans and preferences, from components that may be produced in other countries. That, however, would require manpower and institutional measures as indicated above (4.2.2).

4.3 Basic elements of planning

4.3.1 Demand forecasting and systems planning

Telecommunication planning is based on an assessment of the present and foreseeable future demands as expressed by individuals, corporations, institutions, government departments, international agreements, and by statistical analysis of past growth patterns and the likelihood of future changes. In addition, even without overtly expressed demands government may stipulate the need for certain services in order to support certain general objectives. An example for the latter can be seen in the telephone development in South Korea where a government policy aimed at improving the efficiency of the organization of villages and reducing the migration to cities led to a specific plan for the installation of at least one telephone in each village connected to the national network. In pursuing this objective, 2700 rural public call offices (PCOs) were put into operation.

Because of the pervasiveness of telecommunication needs throughout all sectors of the economy, and their impact on social conditions in urban and rural areas, demand analysis is a complex task. However, without such analysis efforts to set specific objectives for the

immediate and longer range future are likely to lead to misallocation of funds and leave the supply of services either continuously short of the demand, or short in one sector while wastefully excessive in others.

C.R. Dickenson (World Bank, Intelcom 1977, Chapter 1) describes the task as follows:

> "It is therefore desirable to plan (telecommunication) development on the basis of the socio-economic needs of the country as a whole. This will require information on the existing administrative, commercial, industrial and social needs and on the likely expansion of economic activities, the exploitation of natural resources (mining, forestry, fishing, agriculture, tourism, etc); the probable time frame of economic and sociological development, the population concentrations, trends (growth and migration), income levels and national goals".

In industrially developed countries the demand for telecommunication services by individuals, business, industry, governments grew from early beginnings, giving an historical base for estimating the likely rate of growth for the immediate future. Also in these countries there is factual experience on how the demand is affected by the introduction of new types of services, for example long distance subscriber dialing, or new service options. Also, statistical information exists on user attitudes, for example call duration and call frequency per installed connection. Such empirical data are not available in developing countries where growth patterns, user attitudes, economic development, changes in government control etc. are more spontaneous, without precedence and often totally unpredictable. Therefore, a typical condition in developing countries is that demand forecasting even for periods as short as five years is usually inaccurate, so that planning for new facilities becomes haphazard and risky. If the inaccuracy is in direction of underestimating the demand, or of underestimating the effect of new service options ("stimulation" effects) the results are

overloading of the installed facilities, leading to a drop in quality and availability of service to the point of total breakdown. This is of particular significance in developing countries where the overt demand for connections in urban areas usually shows a growth rate two to three times the average for industrially developed countries, and where, in addition to that there is likely to be a substantial hidden or suppressed demand from people who as a result of excessive waiting times are discouraged from making their needs known.

If, on the other hand, the inaccuracy of demand forecasting is in the direction of overestimation, facilities will become underutilized, causing financial loss, resulting in gradual deterioration, and reduced quality of service, which further diminishes their use.

The very basis of planning, namely the definition of the systems to be put into operation, is thus handicapped by the difficulties in predicting what the actual demand for services might be. As difficult as this is in urban areas, it is even more elusive in rural regions where people are less vocal in expressing demands on something on which they have no experience yet. This is compounded by the fact that rural systems are usually substantially more costly (on a per user basis) than urban systems so that errors in investment have greater financial repercussions.

Partly as a result of the difficulties in demand forecasting, partly due to financial and institutional conditions, the various components of the overall system often find different degrees of attention. As mentioned in earlier sections (2.2 and 2.3) elaborate long distance facilities are useless unless the local distribution systems are sufficiently developed; and similarly, international links must be related to the national networks into which they connect. If this is not the case a waste of financial resources, manpower and equipment results, distracting from attention to the actual needs of the country.

Closely related to demand forecasting is, of course, the tariff structure for the various public services and user groups. By

differentiating between business and residential rates, urban and rural rates, day time and night time rates, long distance and local rates, or by introducing specially low rates for emergency services, services for the poor or elderly, etc, demand can be influenced and social and economic priorities of the government expressed. Thus the development of an appropriate tariff structure becomes an important planning tool.

For the introduction of broadcast services attention has to be paid to the requirement for continuing program production and the associated costs. In the case of TV these costs may be very high if the aim is to produce indigenous program material rather than obtaining cheaper material from other countries. This may determine the initial choice between radio and TV services, or -- in other words -- once the choice for TV rather than, or in addition to radio has been made, a continuing high expenditure for program production has to be anticipated and included in the financial planning.

Another planning objective is related to changes in technology. In the words of B. Wellenius (IEEE Transaction COM - 24 July 76):

> "Telecommunications is a field of very rapidly changing technology. New techniques appear faster than the capital lives of major parts of a telecommunication system are expended, and, from time to time, genuinely new service and system structure concepts emerge as well. This has a large bearing on system design. Solutions selected today to yield least costs over their expected life spans may soon be found uneconomical to retain in the face of new ones that have become available. Short-term least cost is not equal to long-term least cost: maximizing economic and technical convenience over a long period requires building into system design a capacity to adapt to technological change, and this implies an added short-term cost. In developing countries, this problem comes in addition to the need to build in flexibility to adapt to unforeseen demand and

traffic patterns, as discussed earlier. Yet, solutions typically assume no forecasting error margins and no change in available technology. There is clearly much to be done in dealing jointly with demand forecasting, technological forecasting, and system optimization under uncertainty."

All this is, of course, also subject to the particular environmental conditions under which services are to be provided. It was mentioned above that geographic and climatic factors may present severe difficulties in installing and maintaining telecommunication systems, and require a judicious choice of the methods to be employed. Electrical power may be unavailable and access roads temporarily impassable. Sandstorms and sand movements may make the laying of buried cable impractical; the salt content of the atmosphere and ground may cause excessive corrosion, microwave repeater stations and towers may be exposed to tornados and hurricanes; torrential rainfalls may interupt the propagation of microwaves; rodents may chew through the insulating layers of cables; termites may destroy wooden structures; and added to these, manmade destruction, theft, neglect may lead to the loss of facilities almost as fast as they are being installed. As discouraging as all this may appear there are answers to all these problems, but to find solutions requires an intimate knowledge of the available technology and the particular environmental and social conditions -- a knowledge which is the harder to find the lower the level of development in a country or region. As a consequence many developing countries have turned to institutions such as the ITU or consultant firms for technical assistance and for feasibility studies and pre-investment surveys on telecommunication projects. The Pan-African telecommunication network, for example, which is well advanced in its implementation, has its origin in UNDP-financed ITU studies leading to definitive plans to be implemented by the individual countries. Other examples are the activities of lending institutions such as the World Bank or the Inter-American Development Bank, which assist the countries concerned in obtaining advice in planning and engineering as well as in the final implementation and operation of their projects.

Much has been written about the type of technology that is "appropriate" for a developing country. This has resulted from frequent reports on cases where the transfer of technology from industrial countries to LDCs ended in failure because conditions in the developing country did not allow the absorption of the foreign technology for a variety of reasons such as lack of trained personnel, impossibility of obtaining replacement parts, technical or operational incompatibility, lack of electrical power, or outright rejection and return to established practices. In many cases it was shown that rather primitive labor-intensive methods had a greater chance of being "appropriate" than had the latest, usually capital-intensive and labor-saving, devices of the industrialized world.

In the field of telecommunication the situation is somewhat different. Telecommunication equipment was originally based on electro-mechanical concepts. Then gradually the electro-mechanical devices were -- and are still in the process of being -- replaced by electronic devices with an accompanying dramatic increase in reliability. It was only through the emergence of small, inexpensive, universally available radio receivers (transistor radios) powered by long-lasting small inexpensive batteries that broadcasting could be introduced widely as a means of mass communication in even the poorest countries. Similarly, devices for sound recording (magnetic tapes) had to undergo the evolution of the electronic age to become generally acceptable and emerge as practical means in aid of education and training. The whole telephone technology has also gone in a direction that has enhanced its suitability under the environmental and social conditions of LDCs. For example, the old fashioned electro-mechanical switching systems are being replaced by electronic exchanges where dust, sand, temperature, humidity, necessary maintenance skill, etc. no longer impose severe limitations on their application in LDCs.

It can be said that in telecommunication -- being based on electronic technology -- the latest industrial developments have characteristics which make them more and more suitable in LDCs, although such suitability was not necessarily a design criterion in their

production. The point to be made here is that appropriateness of a product to be used in an LDC must be judged on the basis of reliability, durability, availability of replacement parts, low power consumption, ease of handling, simplicity and, last but not least, low cost. With that in mind, most of the latest industrial telecommunication products may also be appropriate in the context of developing countries' needs.

4.3.2 Time horizons for planning

Concerning the time horizon of telecommunication planning, there usually are two distinct planning periods. One is long-term or strategic planning for the next 10 to 20 years; the other, medium- and short-range planning for the next 5 - 7 years, of which the first 2 - 3 years cover the immediate operational programs. The strategic plan is a long-term development plan in which the goals to be achieved are set, the course of action is projected and the required resources are allocated. Strategic planning is of particular importance in telecommunication since lead times for new projects can be very long, involving such programs as the development of manpower resources, institutional and organizational changes, provisions for the undertaking of research tasks, the possible creation of an indigenous manufacturing industry, financial measures to cover the often large investments and operational costs, gradual education of parts of the population which previously had not been exposed to modern technology, gradual introduction of new types of equipment through extended field trials to ensure reliability and compatibility with existing equipment, and many other time consuming activities.

Medium- and short-term plans represent progressively more detailed programs which form the basis of eventual capital expenditures for specific projects. They turn the strategies into coordinated and definite undertakings, define the details of implementation schedules, financial plans, accounting procedures, training programs, etc., and set up a system of criteria for the control of the progress of implementation.

Both long-term and medium/short-term plans require regular updating to remain valid in view of changing requirements, changing technology, changing financial conditions, and changes in the social, political and economic environment. In particular, for the medium-term plan it is important to have always a program available that is valid and up-to-date, with investments and activities progressively adjusted year after year.

It is clear that the planning process as described above requires substantial administrative resources. Experienced personnel, continuity of effort, access to many different public and private agencies, familiarity with the institutional, political, economic and social framework in the country, including international implications etc. are prerequisites for a successful planning effort. Of particular importance is a statistical data base for economic, social, demographic indicators on which to base expectations for growth patterns, for the most likely pace of development, and for the likely expenditures that may have to be faced. Though well established in industrially developed countries the lack of statistical information is one of the major difficulties in the planning process of many developing countries. Therefore, the setting up of statistical procedures, the development of institutional measures, and the training of personnel in these matters are of prime importance in the preparation for future planning efforts.

5. CANADIAN TELECOMMUNICATION RESOURCES WHICH COULD BE APPLIED TO TELECOMMUNICATION DEVELOPMENT PROGRAMS

5.1 General

Since the beginnings of telecommunications in Canada, geography, climate and population distribution have made telecommunication services an important and indispensable tool in the economic, social and political life of the country.

At first, telegraph lines along the transcontinental railway routes served the railway operations and provided public telegraph services. Then, after the invention of the telephone, these lines became the backbone of the long distance telephone network, to be replaced later by buried cable and microwave radio relay systems. These in turn were augmented by the services of a domestic geostationary satellite system, the first of its kind in the world, thus extending service even to the remotest settlements in the North. With about 66 telephones per 100 population at the end of 1979, Canada's telephone density is among the highest in the world, in spite of vast distances and scattered population. The national telephone network consists of a number of independent but interconnected systems operated by regional, provincial and local telephone companies held together by inter-company agreements. No central authority exists controlling all aspects of telecommunications, and regulatory functions are divided between federal and provincial agencies.

Internationally, Canada at first made extensive use of short wave radio facilities for trans-Atlantic and trans-Pacific service, which were replaced in the 50s and 60s by submarine cables carrying hundreds of telephone, telegraph and data circuits across the oceans. These cables are part of a worldwide cable system circling the earth. After the creation of the International Telecommunications Satellite Organization (Intelsat), Canada, as a founding member, installed several large earth stations at the east coast, west coast and a central location, augmenting the submarine cable system, providing direct links to many countries in the world, and, in addition, accommodating world wide television program transmission.

Bordering on the Atlantic, Pacific, and Arctic oceans and the central Great Lakes region, Canada has extensive marine telecommunication facilities, as well as elaborate air navigation systems reaching into the far north. Increasing interest in the earth resources of the vast northern regions of Canada led to an early participation in the operations of remote sensing satellites, and Canada established its own Landsat earth stations for remote sensing data processing and analysis early in the 70s.

Canada has also developed a number of specialized communication networks for control and operation of its provincial electric power utilities with their extensive transmission networks. The size and complexity of these systems match those of the telephone networks, but the special considerations which they give to reliability and freedom from interference set them apart from the public facilities.

In the field of broadcasting, Canada's system of radio and television stations, interconnected by microwave and satellite links, reaches some 98% of the population. In addition, local distribution by hundreds of cable TV systems, fed off-the-air or by microwave and satellite from broadcast networks, offer a large variety of programs including local productions to some 80% of Canadian households. Current activities extend these services, mainly by means of satellite links, to northern and underserved communities. Pay-TV has been introduced, and computer-based information services are to be shortly. Direct-to-the-home broadcasting from satellites is just around the corner, following Canada's development, through its own Anik B and C satellite program and joint Canada/US experiments (Hermes program), of satellite transmission techniques to very small earth stations.

With all these activities Canada has accumulated experience in practically all fields of telecommunication technology, operation and management. Particular excellence may be quoted in microwave and satellite technology, in modern telephone switching and digital networks, in computer-based information systems, marine and air navigation systems

and their management, cable TV technology and operation, the serving of isolated communities under adverse geographic and climatic conditions, the interpretation of information from remote sensing satellite systems, and specialized communication networks for electric utilities and for mobile applications.

R&D and equipment manufacturing in all these fields have laid the foundation for the present high level of competence of the electronics industry.

R&D in telecommunications is divided among the research laboratories of telecommunication manufacturers, government agencies such as the Federal Government Communications Research Centre, and universities and technical colleges. In some fields, such as digital systems, computer based information systems, research satellites, and survey technology, Canada is in a leading position. There is a number of universities and technical colleges doing research in, and teaching, telecommunication in all its aspects from technical and economic to social.

5.2 Specific Canadian Capabilities

5.2.1 Equipment Manufacturing

5.2.1.1 Telephone switching

All types of telephone switching equipment are produced in Canada, from the obsolescent step-by-step variety to crossbar machines and modern electronic exchanges. Emphasis is given, however, to digital technology where the latest developments in telephone central office and data switching are available. Canada is currently recognized as a world leader in providing electronic exchanges to North American and European standards. There are two major companies, both in the forefront of digital technology, spending large sums on R&D, and producing equipment

from the smallest local exchanges to the largest complete switching systems. Other companies manufacture equipment for special applications such as electronic telex exchanges.

Equipment has been successfully supplied overseas to such countries as South Korea, Trinidad, the Federal Republic of Germany, Austria, the UK and Belgium and, in North America, on a large scale to the United States. Canadian off-shore manufacturing plants are planned to be established for the penetration of new markets.

5.2.1.2 Microwave radio relay systems

With several transcontinental microwave systems and a large number of special networks for electrical utilities and broadcast and industrial undertakings, Canada has a long tradition in this field. Several major manufacturers with their own R&D facilities produce microwave equipment for the domestic market but have also been able to penetrate overseas against vigorous competition by Japanese, U.S. and European firms. Accessories such as microwave antennas, towers etc. are available from several experienced suppliers.

Training of foreign personnel on the manufacturer's equipment can be provided by industry, and at least one of the Canadian companies offers total turnkey services including installation and training. Training on complete systems as well as on operation and management can be provided by Canadian operating companies such as some of the telecommunication carrier organizations.

Canadian industry also offers a unique rural telephone system based on a microwave distribution system between central stations and surrounding outstations. Such systems are particularly suited to the needs of previously unserved areas and regions with terrain and accessibility problems.

5.2.1.3 Satellite and satellite earth stations

Canada has produced a number of highly successful scientific satellites and provided subsystems on all the Anik satellites serving the domestic Telesat system. One major Canadian manufacturing firm is competing internationally in the provision of complete satellite systems and is the prime contractor for the Anik D series of Canadian domestic satellites to be launched starting in 1982. That company also built the major spacecraft components of the experimental Hermes satellite which opened the field of direct-to-home satellite broadcasting. More recently it has been involved as a major sub-system contractor in the U.S. space shuttle program, e.g. the supply of the Canadarm or Remote Manipulator.

Regarding satellite earth stations there is one Canadian source for the large Intelsat type A stations and many for smaller stations, a field in which Canada has done extensive pioneering work. So far, some 15 complete foreign Intelsat earth stations as well as electronic subsystems for some 75 foreign stations, have been delivered by Canada. Domestically, over 150 earth stations have been built for Telesat, and the number of smaller receiving stations for broadcast purposes and remote areas is growing rapidly. Industry is now actively seeking foreign markets for earth stations, and can provide training in hardware, operation and maintenance.

In the field of satellite transmission systems Canada is in the forefront of the application of digital technology. Time division multiplex (TDMA) systems for telephone and data transmission, and highly efficient modulation systems for single channel transmission have been developed and introduced in the domestic network.

5.2.1.4 Fibre optic systems

Canada is active in research on fibre optic telecommunication systems and was one of the first countries to apply this technology in extended field trials and practical operations. There are several manufacturers of systems components, including the provision of Canadian optical fibre, and a number of telephone companies and cable TV operators have installed trial systems to gain experience in applications such as

telephone trunk lines, subscriber loops, cable TV service to subscribers, cable TV distribution systems, and experimentally for other purposes. Saskatchewan will soon have the largest fibre optics system in the world with a network 3200 Km long, entirely supplied by a Canadian manufacturer.

5.2.1.5 Mobile telephone systems and mobile radio equipment

Canada has, in Alberta, the world's largest single mobile telephone network with over 20,000 subscribers. The equipment is primarily Canadian.

There are several Canadian hardware suppliers, nearly all exporting worldwide. Some of these provide equipment training, whereas operation training is available from telephone companies.

There are also several companies offering Canadian equipment for mobile radio sets as used in taxicabs, boats, trains, trucks, and airplanes. A special system of simple and reliable radio links, with portable equipment and low power consumption for remote areas, is being developed in government laboratories (Trail Radio).

Nationwide coordination of mobile radio and mobile telephone services through a special satellite system is at present under study.

5.2.1.6 Terminal equipment

In the field of customer terminal equipment for telephone and data networks, Canada has a unique capability for design, development, manufacture and operation. This field is developing rapidly under a regulatory framework which gives the customers considerable freedom in the choice of a system most suitable to their purposes. Canadian-produced Private Automatic Branch Exchanges (PABX) from small analog to large digital systems have gained great reputation worldwide and are exported to many countries; some are manufactured under licence by the larger European telecommunication companies. Telephone key sets and

subscriber sets are manufactured by several firms and new concepts are introduced continuously, such as the recently announced Displayphone, a combination of a versatile telephone set and data terminal with a video screen for displaying messages and information. With equipment of this and similar kinds Canada is moving toward the electronic telephone.

5.2.1.7 Informatics

Canada has a significant number of computer service bureaux offering data processing services which can be accessed locally or through extensive computer communication networks. Consulting services offered either on an independent basis, through equipment vendors or service bureaux are available for applications ranging from geophysical data interpretation to econometric modelling.

Canadian-manufactured computer products include mainframes, peripherals and terminal devices, data entry and retrieval equipment, word processing systems, and micro-processors, to name a few. Many of these products incorporate the most recent concepts in microcomputer design. Canadian companies have produced "intelligent" terminals in such diverse areas as communications, banking and graphics. Canadian companies have designed and developed complete computer turnkey systems for a broad range of applications. Using off-the-shelf micro or minicomputers, specially designed software, and interface circuitry, a total system is developed for such diverse areas as finance, education and business.

In the field of "videotex" services, i.e. computer-based information retrieval services for business and home use, Canada has developed the Telidon system, which because of its superiour technical characteristics has gained world-wide recognition. A number of manufacturers have begun to produce a variety of Telidon equipment and accessories.

5.2.1.8 Radio and TV broadcasting

Canada has a number of hardware suppliers of TV and short wave radio transmitters, and various sources for antennas and towers. In the field of studio equipment Canadian-produced audio-video mixers, consoles and systems for electronic studio control enjoy a global reputation.

Having the world's largest proportion of communities served by cable-TV systems, Canada has extensive experience in the design, manufacture and operation of such systems. In combination with satellite links for program distribution this expertise covers practically all aspects of broadcasting services to small and large communities even in the most remote regions. The Canadian pioneering work in the field of direct-to-the-home satellite broadcasting has already been mentioned in section 5.1.

Recently Canadian industry and broadcast consultants have formed consortia to bid on major broadcast projects. Canadian consultants can provide training in systems planning and layout.

5.2.1.9 Avionics, navigation and detection systems

Canada has several companies specializing in the manufacture of sophisticated avionic systems (ground and airborne). Typical systems are the conventional types of air and marine navigation radio beacons, air traffic control systems, military communications, and radar. Canada also provides emergency locator transmitters, aircraft inertial guidance systems and moving map displays. All suppliers in this field are active exporters, mainly to the U.S.A. Satellite systems for marine navigation, for Search and Rescue and other applications are being developed jointly with other countries.

5.2.1.10 Supervisory control

A number of companies manufacture various types of telemetering/ supervisory systems. Among the areas of expertise are control systems for major microwave networks, electric power transmission, and pipeline

control. Canada is a recognized authority on long distance pipeline applications.

5.2.1.11 Instrumentation for geophysical exploration

Canada has over 20 companies manufacturing instrumentation for airborne as well as ground and marine operations and surveys. This, together with the provision of survey services (see subsection 5.2.2.5) has made Canada a world leader in this field.

5.2.1.12 Earth stations for remote sensing satellites

Canada manufactures Landsat earth stations, of which more have been sold overseas than supplied by any other country. For further details on this field see section 5.2.2.5.

5.2.1.13 Railway communications

Canada has several manufacturers of railway communication equipment and control systems for rolling stock. Systems have been supplied to some developing countries, and there is considerable interest in promoting this line of products.

5.2.2 Engineering Services and Consulting

The Canadian expertise in planning, engineering, constructing, operating and maintaining telecommunication systems is vested in the operating agencies and a number of specialized engineering and consulting firms.

5.2.2.1 For broadcasting, the number of private consultants is high in Canada as a result of the existing regulatory requirements. Consultants are therefore in a position to offer services on planning, engineering, specifications, supplier selection, supervising of installation and acceptance testing for small and large broadcast projects. As mentioned in the preceding section, consortia have been

formed, including manufacturers, for complete package proposals. Some of the most extensive experience in this field rests with the Canadian Broadcasting Corporation.

5.2.2.2 In the field of telephone systems the larger Canadian telephone companies have staffs familiar with all aspects of local and long distance telephone networks from engineering to financial and personnel management.

Training of personnel in all these subjects is an essential part of their activities and some of the companies have separate training establishments for their own staffs as well as for trainees from other countries. Some of the telephone companies have formed separate corporate units to offer consulting services on the technical, financial and operational aspects of telephone systems. An example is the work of Canada's largest carrier in Saudi Arabia. Several independent consultant firms are also active in this field, and consortia have been formed similar to those in the broadcast field. The involvement of private consultants in foreign projects, including route surveys, radio propagation testing, site engineering, etc. is substantial.

5.2.2.3 On the subject of satellites and satellite earth stations, the domestic satellite organization, Telesat Canada, and the overseas telecommunications organization, Teleglobe Canada, have many years of operational experience and are engaged in international consulting. Their satellite links are integrated with the national and international networks through operating arrangements with the telephone and telegraph companies. On special aspects of this technology, independent consultants provide systems engineering, financial analysis and planning services.

5.2.2.4 In the field of transportation, the large railway carriers CN and CP have their own telecommunication departments, and, in addition, have combined their telecommunication resources in a separate organization (CNCP Telecommunications) operating as an independent

telecommunications carrier. Here also, separate corporate units have been formed for consulting services.

In marine and air navigation, the federal Department of Transport has the most comprehensive experience. It operates Canada's air traffic control and airport systems, and the marine and harbour facilities for marine transportation. Through the combination of engineering and manufacturing capabilities, Canada can provide on a turnkey basis complete vessel traffic control systems, monitoring and directing the passage of ocean vessels in congested areas, as it has been done in the Vancouver area.

5.2.2.5 Geophysical exploration

Canada has more than a dozen geophysical consulting firms, most of which depend on foreign contracts as their main business. In addition a major source of technical expertise exists in the Department of Energy, Mines and Resources, which also includes the Canada Centre for Remote Sensing (CCRS), a group with international reputation for its expertise. In the latter field alone there are at least six consulting firms as well as manufacturers for Landsat earth stations, and several companies that provide the systems for image analysis, utilized by users of Landsat data to enhance and correct the data by means of computers. Canada's capabilities in this field extend from equipment supply to complete turnkey installations including training and operations.

5.3 Constraints on the availability of Canadian resources for foreign programs.

So far this section has described Canadian capabilities and expertise in telecommunication without discussing the actual availability of these resources for foreign programs. There is a number of constraints which tend to reduce the possibilities for exploiting all of the existing Canadian know-how in projects outside the country.

On the technical side there is, for certain types of equipment, a question of standardization. North American standards do not in all cases agree with standards in other parts of the world so that equipment supplied for the North American market may not be compatible with other products used in the country of concern. This applies, for example, to certain areas of digital technology such as digital telephone exchanges. Unless the Canadian manufacturer has separate product lines for the North American and the other markets, export chances may thereby be reduced, although the quality of the products may be unquestioned. This, however, is not an insurmountable obstacle at the technical level, in particular regarding the modern digital technology where appropriate software modifications can be applied to meet different requirements.

Another restriction may occur when a Canadian firm which is a branch plant of a foreign company is by company policy prevented from exporting directly to foreign countries. Such a firm can then work only for the Canadian market, or only for certain designated countries.

In the field of engineering services, as mentioned above, some operating agencies have separate units for consulting or for personnel training, open to trainees from other countries. Others, however, may restrict their activities to their domestic purposes and stay away from accepting commitments for foreign personnel or for performing project work outside the country. In certain organizations, for example in some government departments, the policy may not be outright restrictive but there may be a lack of adequate provision in staffing, career development and budgeting for dispatching personnel to other countries even on a contract basis. Therefore, though a substantial pool of expertise may exist, its utilization for the benefit of foreign countries may be limited. This situation is by no means general and is subject to change as time goes on -- in every case a careful analysis of the available potential is necessary before involvement in foreign programs is considered.

6. SUMMARY AND CONCLUSION

As stated in the Background and Introduction sections, this paper is intended to discuss the linkage between telecommunication systems/services and the development process. It was not possible within the terms of reference and resources available for this paper to provide quantitative evidence, in the form of supporting figures or cost/benefit analyses, for example, to prove causality in the relationship between telecommunications investment and economic growth; this report has, however, attempted to show the importance of telecommunication as a supporting element to the various sectors and functions which, taken as a whole, are generally viewed as the development process.

The paper describes the pervasive role of telecommunication in the society of our days, its impact on commercial, industrial, political, social and governmental activities, as well as the institutional characteristics and problems that are encountered as this technology expands into the developing parts of the world. The paper attempts to demonstrate that telecommunication should not be considered as an isolated item, as a facility for transferring electric signals from one black box to another, but should be considered in the context of the overall picture of society's development.

The paper shows how the various forms of telecommunication, from conventional telephone and telegraph services to broadcasting, navigational aids, remote sensing etc., prove their effectiveness in practically all instances where human organization extends beyond the most primitive forms of social cohabitation. As the interdependence among people and countries increases, so increases the organizational complexity, and the proper functioning of the organization demands more and more links of communication. Certain activities, such as air or rail transport depend on telecommunication to such an extent that a lack or loss of facilities can render the whole operation impossible. Similarly, trade and commerce, as well as public administration beyond their most primitive forms, are unthinkable without means for rapid information transfer.

This applies equally to the social field where the provision of health or educational services often depends critically on the availability of adequate means for telecommunication, be it in form of radio or TV broadcast, or of telephone or telex connections. If such facilities are not available as a regular public service, experience shows that either the intended services are simply not provided or, at best, make-shift arrangements and improvisations will be substituted using portable equipment, ham operations, etc., with all their draw-backs of unreliability, inadequacy, lack of continuity and dependability. In this respect, remote or sparsely populated regions present particular problems since here the economics of permanent telecommunication systems are much less attractive for investment than in urban areas.

The identification of what a country needs in telecommunication facilities and services is a complex problem since the purposes for which such facilities and services are used are so diversified and manifold that all sectors of the economy and society must be considered individually and in the aggregate. Also, potential users are often not sufficiently aware of what might be beneficial to them as long as services are not yet available. These difficulties are further compounded by the fact that telecommunication projects usually require long lead times and are capital intensive. Institutional, human resources, financial and hardware supply constraints are discussed in greater detail in Section 4.

The telecommunication authorities of a country have of course their own expectation of future demand and will base any request for financial aid on it. However, institutional constraints often limit the scope of such predictions, and questions involving the planning in fields outside the responsibility of a particular agency may go unresolved, resulting in duplication and possible waste of resources (example: separation of ministerial responsibilities for telephone/telegraph and broadcasting). Thus, needs-analysis and proper planning go hand-in-hand, a fact which is increasingly recognized in developing countries by organizing higher level offices for planning, where demands from the different ministries are consolidated. Telecommunication planning is very much in need of such high level co-ordinating activities.

Canadian know-how and experience in telecommunication is as old as, and probably more diversified than, in any other country of the world. However, Canada has not been particularly well known internationally for its capability of assisting developing countries in this field. One factor is that unlike in many other parts of the world, in Canada the industry (manufacturing as well as services) is largely in private hands and split into many different groups; Government and industry have, so far, not developed a strong and coherent strategy to promote the country's capabilities on the international scene.

This situation is changing, and recent events such as Canada's role in the development of an Australian and a Brazilian satellite system, as well as the international promotion of Canada's Telidon videotex system, indicate that there are co-ordinated efforts under way to stimulate interest in Canadian capabilities. Also, the success stories of certain Canadian equipment (foremost in the digital telephone exchange field) internationally are signs that Canada's reputation is increasing. However, the co-operation of different government departments and industry groups, and strong leadership in project management, is still needed to adapt Canadian abilities to the actual needs and conditions in developing countries.

Conclusion

As stated earlier, this paper is not the first attempt to discuss the linkage between telecommunications and development; neither is it the first to draw the conclusion that the telecommunications function is an essential supporting element in the process of development, and that both international development assistance institutions and national planners in developing countries should therefore recognise the importance of the sector and examine the priority given it in development plans. One pertinent example is the comment of the International Commission for the Study of Communications Problems (MacBride Commission) in its report Many Voices, One World:

> "Given the obvious importance of the telephone, many countries appear to have erred in neglecting to build adequate telephone networks. Unlike the rising costs of some postal services, the decreasing costs for some newer technologies, such as the telephone and electronic data transmittal, will undoubtedly force changes in telecommunication strategies. International and national development assistance institutions will have to consider upgrading the low priority which has hitherto been given to telecommunications projects. Hence, policy decisions on the development and financing of communication services are today a priority for all governments, professional communicators, and the public at large."

It appears to be appropriate, therefore, to conclude that a sufficiently strong telecommunication infrastructure in a country is a valid target to be pursued.

CIDA TELECOMMUNICATION AID PROGRAM - CURRENT PROJECTS

Aid by Region:	($ million)
Africa - Francophone	122.4
- Anglophone	29.5
Asia -	42.0
Latin America -	32.8
	226.7

Title and cost of individual projects:

Key A = Active
P = Being planned
D = Dormant for various reasons.
TBD = To be determined.

Africa

Francophone

		($000)	
1. Cameroun	- Forestry Communications	TBD	P
2. Haute-Volta	- Rural Radio Broadcasting	2,000	A
3. Madagascar	- Air Navigation and Communication	6,000	D
4. Rwanda	- P. and T. Long Haul Transmission	4,950	A
5. Senegal	- Technical Assistance to Fishing Industry	Small	D
6. Sahel	- Panaftel	TBD	P
7. Sahel	- Panaftel Extensions	80,000	A
8. Sahel	- Earth Resource Satellite	29,450	D
		122,400	

Anglophone

1. Kenya	- Remote Sensing	TBD	D
2. Kenya	- Intelsat Station Assistance	8,000	A
3. Swaziland	- General Training Package for P. and T.	3,150	A
4. Swaziland	- Treasury Computerization Assistance	1,030	A
5. Tanzania	- Railway Telecommunication - Phase 1	825	A
6. Tanzania	- Railway Telecommunication - Phase 11	16,500	
		29,505	

Asia

1. Bangladesh	- Intelsat B. Terminal; Technical Assistance	500	A
2. Burma	- 17 Airports Lighting System	4,960	A
3. Indonesia	- Sumatra Coal Railway Telecommunication	25,000	A
4. Indonesia	- Navaids III - VOR and DME	1,100	A
5. Sri-Lanka	- Water Management Project, Communication	500	A
6. China	- Domsat Aids	TBD	P
7. China	- Forest Fire Communications	TBD	P
		32,060	

Latin America

1. Brazil	- Technical Assistance Package	3,000	A
2. Brazil	- Satellite Training Package	8,000	A
3. Colombia	- Fishing Fleet Radio Station	Small	D
4. Guyana	- Timehre Airport Navaids - Phase 1	455	A
5. Guyana	- Timehre Airport Navaids - Phase 11	250	A
6. Guyana	- Technical Assistance and Training	125	A
7. Caribbean	- Emergency Telecommunication System	3,000	P
8. Caribbean	- Airport Improvement Program	10,000	P
		24,830	

N.B. This is the sum total of work in progress and being planned. Some projects may not take place. Many are multi-year duration. Average annual expenditure is not aggregated for the Telecommunication Section but is in the order of $40 million.

RESOLUTION No. 24

Telecommunication Infrastructure and Socio-Economic Development

The Plenipotentiary Conference of the International Telecommunication Union (Nairobi, 1982),

recognizing

that the social and economic underdevelopment of a large part of the world is one of the most serious problems affecting not only the countries concerned but also the international community as a whole;

considering

a) that telecommunication facilities and services are not only the outcome of economic growth, but a precondition of overall development;

b) that the development of telecommunication infrastructure is an essential part of the national and international development process;

c) that the spectacular technological progress achieved during the past decade has made communications faster and more reliable and has reduced operational costs and maintenance requirements;

stresses

the important supporting role played by telecommunications in the development of agriculture, health, education, transport, industry, human settlement, trade, transfer of information for social welfare and in the general economic and social progress of developing countries;

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* Resolution adopted at the Plenipotentiary Conference of the International Telecommunication Union, Nairobi, 1982.

concerned

that the uneven penetration in the world of the two most familiar telecommunication services - telephony and radio-broadcasting - is one of the real obstacles to development in many countries and regions and a barrier to effective communication between the developed and developing world;

recalling

a) that the "International Development Strategy for the Third Development Decade" stipulates, inter alia, the tasks relevant to the ITU in promoting international development and specifies that "special attention should be given to overcome the bottlenecks and constraints of transport and communication facing the developing countries, particularly with a view to strengthening intra-regional and inter-regional links";

b) the decisions made by the United Nations General Assembly at its Seventh Special Session, as well as at its regular annual sessions, relating to the need for international strategies to accelerate progress in social and economic advancement in rural areas and Resolution 34/14 adopted in 1979 inviting the UN specialized agencies to strengthen their participation in the achievement of the above objective;

c) the decision by the United Nations in 1981 to proclaim 1983 as World Communications Year in order to stress the importance of telecommunications infrastructure as both a precondition for and an integral part of economic and social development;

noting

a) that although it is widely recognized that a well developed telecommunication system is a basic requirement of any modern economy, attempts in many developing countries to achieve a higher investment priority for this sector have not, in general, been successful;

b) that one of the main obstacles to the development of telecommunication infrastructure is under-investment in this sector - a situation for which the reasons are manifold but which is in particular due to insufficient research, inadequate dissemination of information, and a lack of understanding within national planning ministries about the relationship between telecommunications and economic and social development;

c) that research carried out so far on the benefits to be derived from telecommunications has generally revolved around analysis of input-output tables and correlation of GNP, telephone density and other variables without, however, explaining the causation;

appreciative

of the Union's initiative in undertaking, in collaboration with the OECD, studies on the contribution of telecommunications to economic and social development, with special emphasis on the problems of integrated rural development, and of the additional voluntary financing for the conduct of such studies;

recognizing

the necessity of providing governments, administrations, decision-makers, economists, financial and other institutions and organizations concerned with development work with the results of comprehensive studies on the direct and indirect benefits of investment in telecommunication infrastructure and the relationship between the growth of telecommunication services and socio-economic development in general, so as to enable developing countries to better assess their own development priorities and give the necessary priority to telecommunications;

decides

that the ITU should continue to organize and carry out such studies, closely integrating this effort with the overall programme for technical cooperation and assistance activities;

invites

the Administrations and Governments of Member States, agencies and organizations of the United Nations system, non-governmental and intergovernmental organizations, financial institutions and providers of telecommunicaion equipment and services to extend their support for the satisfactory implementation of this Resolution;

urges

the UNDP, including its Secretariat and field representatives as well as both donor and recipient Member States, to give greater appreciation to the importance of telecommunications in the development process, with a view to ensuring that an appropriate share of UNDP resources is made available for the telecommunications sector;

requests the Secretary-General

1. to bring this Resolution to the attention of the United Nations General Assembly and to provide the Assembly with regular reports on the progress and results of the research on this matter;

2. to bring this Resolution also to the attention of all other interested parties, in particular the UNDP, the International Bank for Reconstruction and Development (IBRD), regional development banks, and national development funds for cooperation;

3. to report annually to the Administrative Council on the progress made in the implementation of this Resolution;

requests the Administrative Council

1. to review the Secretary-General's reports and take appropriate measures to permit the implementation of this Resolution;

2. to report on the matter to the next Plenipotentiary Conference.