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TELECOMMUNICATIONS
DEVELOPMENT

Prepared for the
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CHECCHI AND COMPANY
Washington, D. C.

1969

PREFACE

This report is submitted to the National Aeronautics and Space Administration in fulfillment of Checchi and Company's work under Contract NASW-1357.

The report is in two parts. Part One, "Report to Decision Makers," summarizes the significant implications of five studies of improving telecommunications in developing countries which Checchi has undertaken during the last four years. Part Two, "Considerations for the Design of Future Studies," presents the lessons, concepts, and considerations which emerged during the course of these studies, and which merit consideration in the design of future studies.

Philco-Ford Corporation served as subcontractor to Checchi and Company for certain technical portions of the study. The study was directed by Harvey A. Lerner, Vice President of Checchi and Company. The following professional staff members of Checchi and Company and Philco-Ford Corporation made contributions to the report: Mr. William C. Boesman (Checchi), Mr. Richard D. Abbott (Checchi), Mr. Blaine B. Menth (Philco-Ford), and Mr. Robert C. Moore (Philco-Ford).

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PART ONE

REPORT TO DECISION MAKERS

CHAPTER ONE

INTRODUCTION AND SUMMARY

A. INTRODUCTION

In February of 1966, Checchi and Company submitted to NASA a report on the practicality of establishing some minimum form of satellite communications network for Africa by January 1, 1967, or as soon as possible thereafter. This report was based on a "desk-top" survey conducted in Washington during a period of four months. The information available for this report was limited to that available from published sources, from agencies of the United States Government, and from contacts with U. S. telecommunications organizations.

In the intervening years, Checchi and Company has engaged in four additional telecommunications studies dealing with nations in Africa. These studies have included a survey on improving African telecommunications during the next decade and three economic, technical, and financial feasibility studies. The latter studies deal with:

- Improving the telecommunications system of the Republic of Chad;
- Improving international communications among Nigeria, Togo, Dahomey, Ghana, and the Ivory

Coast by means of a microwave trunk route which would connect satellite earth stations in Lagos and Abidjan; and

- Installing a satellite earth station in Ethiopia and a microwave link between Ethiopia's two largest cities, Addis Ababa and Asmara.

Each of these three feasibility studies included field surveys in Africa. Each required a direct assessment of African telecommunications data, facilities, organization, personnel and policies.

It is now possible to return to our earlier work with a number of insights concerning African telecommunications development, the application of satellite communications to the needs of developing countries, and the design of telecommunications studies. This retrospective analysis yields lessons for further study, planning, and action.

Part One of this report summarizes for decision makers the significant implications of the studies of improving telecommunications in developing countries which Checchi has undertaken during the last four years. Part Two of this report sets forth for government officials concerned with telecommunications development those lessons, concepts, and considerations which merit consideration in the design of future studies.

B. SUMMARY OF PART ONE

Part One first examines the impact of Global Comsat on the developing nations. It then summarizes the findings, study methods, and principal lessons learned in five Checchi studies dealing with telecommunications in Africa. Substantive problems requiring further study are identified, and principal policy issues involved in improving telecommunications in developing countries are discussed.

1. The Impact of Global Comsat on Developing Nations

"Global Comsat" is an international communications system employing satellites to relay commercial telephone, telegraph, telex, television, and other services between widely separated locations on the earth. The role of Global Comsat, in the family of international telecommunications systems, is to transmit large volumes of traffic over long distances with a minimal degradation in signal quality.

High frequency radio circuits can fulfill the same role as satellite communications for voice and data transmissions, but are more subject to limitations on reliability, quality, and capacity. Where relatively low volumes of traffic are involved, high frequency

radio facilities can have substantial economic advantages over satellite communications. Thus, for developing countries the selection of a system to carry long-distance international communications can require hard choices between quality and cost.

Telecommunications planners seldom start with a clean slate, even in developing nations. The process of extending satellite communications service into a country is essentially one of superimposing an additional means of communications upon existing telecommunications systems and related legal, financial, operational, organizational, and administrative agreements, which have been developed over a period of many years. This superimposition factor introduces widespread complexities into the process of establishing economically and technically feasible locations for satellite earth stations and for planning other telecommunications improvements.

The prospects for the viability of satellite earth stations often can be improved if groups of developing nations agree to share common earth stations rather than to install international communications systems which are essentially independent of each other. In such cases, high quality international terrestrial links are required to feed international traffic to, and distribute international traffic from, a common earth station.

Introducing an international terrestrial link presents problems not unlike those of initiating fundamental changes in multilateral trade arrangements. In addition, it requires an assessment of the impact which a rapidly changing technology may have on the interests of particular countries. International terrestrial links require agreement of two or more nations, whereas a single nation can ~~purchase an earth~~ station. Given political realities affecting many developing countries, a considerable effort would be required in order to achieve substantial groupings of developing nations in common earth station tributary areas.

The installation of a satellite earth station represents a large and complicated undertaking for most developing countries. In the short run, the effort is likely to divert financial, technical, and managerial resources from other undertakings. In the long run, however, it may stimulate a range of domestic improvements including the installation of high quality interurban links and the upgrading of urban service. Once a high quality international communications system has been installed within a country, there is a substantial incentive to achieve high quality service on those portions of the domestic system which serve the users of international services.

International communications are very profitable to developing nations, usually much more so than domestic services. This important consideration cuts two ways in terms of the financial relationships

between a nation's international and domestic systems. If the earth station investment is a well conceived one, it can increase the profitability of international traffic thereby providing a source of additional funds for telecommunications development of all types. On the other hand, if the earth station reduces the profitability of international traffic, it can cut the amounts of internally generated funds available for national telecommunications development.

An economic evaluation of an earth station thus should not stop with a determination that it will "break even" at an early year. The key financial question is not merely whether an earth station will be profitable in itself. Rather, it is whether an earth station will be more profitable than other types of international communications systems, taking into consideration its entire useful life.

2. Telecommunications in Africa: Five Studies in Retrospect

The five Checchi and Company studies reviewed in this report include a survey of improving African telecommunications in the next decade, a survey of the prospects for a minimum program of satellite communications development to be rapidly implemented in Africa, a feasibility study of improving the telecommunications of the Republic of Chad, a feasibility study of improving international communications among five West African nations, and a feasibility study of a satellite earth station and interurban microwave link in Ethiopia. Principal findings and conclusions of these five studies are outlined below.

a. Improving African Telecommunications in the Next Decade (1966)

African telecommunications were found to be characterized by the following significant features:

- Heavy dependence upon high frequency (short wave) radio, both for national and international circuits;
- Heavy dependence upon communications to European capitals--principally London and Paris--for the relay of traffic from one African nation to another;
- Almost total absence of an organized inter-African telecommunications network structure;
- Conspicuous deficiencies in both the availability and quality of telecommunications;
- An enormous shortage of trained indigenous technical personnel in most African countries;
- Chronic lack of internal capital needed to finance the necessary improvements in telecommunications; and
- Dominance of political considerations over economic considerations in decision-making processes in telecommunications planning.

Africa does not thus far have an integrated program for telecommunications development, and although there have

been efforts at continental and regional planning, an over-all network plan has not been developed. Nor has a demonstrably effective means yet emerged for implementing African telecommunications projects in an integrated fashion.

Most international traffic generated in African countries was found to have its origin in relatively few African cities and its destination either in neighboring countries or in Europe. Traffic between countries located in different regions in Africa was found to be relatively insignificant.

On the whole, the interregional features of African telecommunications projects yield the least promise of important payoffs in terms of financial viability and development. It may be anticipated that interregional and even regional communications systems in Africa will develop most satisfactorily as adjuncts to systems which have been designed principally to carry intercity traffic or intercontinental traffic.

b. Minimum Africa Program (1966)

A survey of the prospects for a minimum program of satellite communications development, to be rapidly implemented in Africa on the basis of 1966 funding, found seven locations at which earth stations would break even by 1972:

<u>Station Location</u>	<u>Nations to be Served</u>
Dakar, Senegal	Senegal, Gambia
Abidjan, Ivory Coast	Ivory Coast, Upper Volta, Niger
Lagos, Nigeria	Nigeria, Dahomey, Togo
Brazzaville, Congo	Congo (Brazzaville), Congo (Kinshasa)
Nairobi, Kenya	Kenya, Tanzania, Uganda, Burundi, Rwanda
Khartoum, Sudan	Sudan
Addis Ababa, Ethiopia	Ethiopia

None of these earth stations was funded in 1966, and none is presently in operation. Checchi's subsequent study of the feasibility of a satellite earth station in Ethiopia confirmed that an earth station near Addis Ababa would show a surplus in 1972. However, the study concluded that the earth station should be deferred to the middle or late 1970's because continued use of high frequency radio communications constituted a financially preferable alternative. Substantial shortcomings in ITU international traffic statistics used in the Minimum Africa Program report were found during the course of several feasibility studies.

The intervening years have demonstrated the vast difference between paper planning and tangible accomplishment in

African telecommunications development. Announced dates for future earth station operations may be based upon very little economic and technical analysis. Even where there has been a solid planning effort, political instability or difficulties in obtaining needed financing can push target dates substantially forward in time. Costs are also subject to considerable change as projects move from planning, to initial contract arrangements, to final completion.

c. Improving Telecommunications in Chad (1967)

Checchi's study of the economic, technical, and financial feasibility of improving telecommunications in the Republic of Chad dealt with a landlocked African nation in an early stage of development. Chad is bordered by Cameroon, Nigeria, Niger, Libya, Sudan, and the Central African Republic.

All Chad's international communications employed high frequency radio circuits. Access to high quality international communications facilities would have required (1) installation of a satellite earth station in West Africa, and (2) improved high quality national networks in Nigeria or the Cameroon network. Given the magnitude and composition of Chad's international traffic, and the status of communications development in bordering nations, continued use of high frequency circuits represented the only economical means of handling international traffic immediately available.

Improvements in Chad's domestic communications system were found to be necessary and feasible. These improvements included installation of an automatic telephone exchange, improved high frequency radio facilities, and a dual diversity troposcatter link to serve interurban traffic.

Changes in the organization of the telecommunications agency, its functions, and its personnel programs were found to be essential to the success of the proposed technical expansion. These changes included providing additional headquarters staff, establishing regional field staffs, and making needed adjustments in financial practices.

Government agencies and businesses (many of them operated by foreigners) were found to be the principal users of telecommunications services in Chad. Only in the case of domestic telegraph traffic did the general public constitute a significant user. Lack of satisfactory telecommunications services was found to be retarding the growth of the market sector of the Chad economy.

An examination of principal economic activities and development plans provided useful inputs to an econometric traffic forecasting model, which was developed in order to fill gaps in the available data. The study identified the nature of benefits which telecommunications improvement would bring to the Chad economy. However, it was

able to quantify only those benefits which would accrue directly to the telecommunications agency in the form of additional revenues.

d. Improving International Telecommunications in West Africa (1968)

The basic purpose of this study was to determine the economic, technical, and financial feasibility of improving international telecommunications among the five West African nations by providing an integrated, multi-channel network extending along the coastal area from Lagos, Nigeria to Abidjan, Ivory Coast. It was assumed that satellite earth stations would be installed in Lagos and Abidjan to coincide with the availability of the international ground network.

Each of the five countries was found to use high frequency radio circuits for its intercontinental and African satellite candidate traffic. Overhead wire, VHF radio and submarine cable, as well as HF radio, were used for traffic among the five countries.

Organizational responsibility for international telecommunications varied among the five countries. Nigeria's international communications were handled largely by Nigerian External Telecommunications, Limited, an entity jointly owned by the Government of Nigeria and a British public corporation. A French public enterprise owned and operated most of the international facilities in Dahomey, Togo, and the Ivory Coast. All international circuits in Ghana were operated by the External Telecommunications Service in the Ministry

of Communications. In each of the countries, except Ghana, the national telecommunications administration operated some international circuits.

The study revealed international telecommunications constraints of three types: outages on existing telecommunications facilities; lack of circuits to desired locations; and deficiencies relating to the promptness and quality of service. The existence of these constraints and the prospects for the growth of the economic activities which generate telecommunications requirements indicated a need for improved facilities. A dual diversity microwave system extending from Nigeria to the Ivory Coast was found to be feasible.

A number of special problems of methodology were posed by the multinational nature of the study. These included: conflicting international traffic data; nonparallel rate structures; rate splitting arrangements; and selection of the appropriate cost-benefit methodology. It was possible to find suitable solutions for these and other problems, although not without considerable difficulty.

The West African telecommunications study was designed on the premise that it was meaningful to evaluate the international trunk route as a self-contained entity. It was thought that the study need not include any detailed analysis of (1) the domestic telecommunications systems of the five countries involved, (2) the economics of the satellite

earth stations in the Ivory Coast and Nigeria, or (3) international traffic not expected to utilize the trunk route. It was expected that relationships with domestic systems and the satellite earth stations could be limited to estimating traffic requirements at system interfaces, and that the analysis of telecommunications traffic not expected to use the international trunk route was irrelevant to trunk route evaluation.

In retrospect, it appears that the scope of the study was too narrowly drawn for the circumstances found to exist in West Africa. Questions of national telecommunications organization, use of displaced equipment, location of constraints on international systems, and earth station economics were found to have extensive ramifications.

Fortunately, the feasibility of the West African trunk route did not turn out to be a close question. Quite clearly, the project would be an attractive one in terms of its financial viability and in terms of its impact on economic activity. Had the project been more marginal, however, it is doubtful that it could have been properly evaluated without expanding the scope of the study.

A study which attempts to insulate analysis of international services from domestic services runs a danger of producing unbalanced or even misleading results. Rather than attempting "self-contained" analysis, it is believed that studies of this type should

squarely address strategic relationships among the basic elements of each nation's telecommunications structure.

e. Ethiopia Telecommunications Study (1969)

The purpose of this study was to determine the economic, technical, and financial feasibility of two investment projects: a satellite earth station for Ethiopia; and improvements in the existing link between Ethiopia's two largest cities, Addis Ababa and Asmara. The study was based on the assumption that satellite earth stations would be installed in Nigeria, the Ivory Coast, and East Africa by 1972. It was also assumed that representatives of foreign governments in Ethiopia utilizing private international communications systems, would not use an Ethiopian satellite earth station for their traffic.

Ethiopia's international telecommunications services were found to be far more profitable than its domestic services. In 1966, international services represented only 27 percent of the revenues of the telecommunications administration, but accounted for approximately 70 percent of its profits. The portion of international services which would be carried by a satellite earth station represented less than 17 percent of the revenues of the telecommunications administration, but accounted for about 46 percent of its profits.

It was found that a satellite earth station could contribute to the administration's net income in the year 1972. However, this contribution would be much smaller than that which would be made by continuing to operate HF facilities. An earth station installation in 1972 would cause the administration to forego well over \$2,000,000 of profit in its early years of operation. Accordingly, it was recommended that the earth station investment be deferred until the middle or late 1970's.

A microwave trunk route which would serve Addis Ababa, Asmara, and principal intervening cities was found to be economically, technically, and financially feasible.

Developing countries are, as a general proposition, in need of improved telecommunications systems. But is it not axiomatic that they require "high quality" communications in all instances. In retrospect, it appears that the very notion of "a satellite earth station feasibility study" for a developing nation is somewhat suspect. The very formulation of the study implies prejudgments as to which portions of a nation's international services are in need of improvement and which technical means are most appropriate for this purpose. An analysis of the economic, technical, and financial feasibility of improving Ethiopia's international high frequency facilities was, strictly speaking, outside the scope of the Checchi study. The HF option could only be explored to the

extent necessary to establish whether the answer to the earth station alternative was "yes" or "no".

A more tentative and balanced approach to earth station studies in developing nations may well be desirable. Such studies could be framed in terms of "improving international telecommunications" or some other formulation which enables the development of any constructive alternatives which emerge from the analysis. Indeed, there would be considerable merit in a study which required the analysis to present in some detail both the best earth station solution and the best high frequency radio solution for a country in an early stage of development.

3. Substantive Problems Requiring Further Study

a. Adequacy of the Telecommunications Data Base

Readily available basic data on international communications in developing countries are far less complete, reliable, and detailed than they could be. First steps toward improvement of the telecommunications data base should include classification of data sources; identification of principal data limitations of each source; compilation of methods of cross-checking, reconciling, and establishing the reliability of data; and recommendations for improvements in those portions of the data base which are most important to telecommunications studies.

b. Rate Structure and Revenue Sharing Problems

There are substantial variations in rate structures and revenue sharing arrangements evident throughout the developing world. Anomalies exist both within the international rate structures of individual countries and in the rate structure patterns prevailing among countries. Rate structure and revenue sharing problems constitute a significant impediment to regional cooperation among developing nations and pose substantial difficulties for telecommunications analysis.

Future study of these problems should include evaluation of principal factors influencing rate structures and revenue sharing arrangements, analysis of cost-price relationships important to negotiations, and identification of techniques for resolving rate structure and revenue sharing problems typically confronted by developing nations.

c. Forecasting Methods

Previous work on methods of forecasting telecommunications traffic in developing nations should be brought together and analyzed in a comprehensive fashion. Additional work is needed on the "impulse jump", the phenomenon which occurs when improvements release suppressed demand for telecommunications services.

Gravity models can be used to predict traffic between population centers in terms of their respective sizes and spatial separation. They are particularly helpful when historical data is incomplete.

The importance of retrospective studies of telecommunications forecasts and traffic patterns cannot be understated. It is important to evaluate just how accurate telecommunications forecasts for developing countries turn out to be and, insofar as possible, to identify the reasons for differences between forecasts and traffic levels which are registered subsequently.

d. Relationships Between Telecommunications Development and Economic Growth

Relationships between telecommunications development and economic growth have not thus far been adequately explored in economic terms. It is particularly difficult to assess the impact of telecommunications development on economic growth. A satisfactory treatment of the subject would require (1) detailed studies of traffic magnitudes, costs, business functions, and cost-savings associated with telecommunications services used by specific industries or other economic activities, and (2) an examination of interindustry relationships. Until substantial efforts along these lines are made, the prospects for comprehensive, meaningful estimates of the impact of telecommunications projects on economic growth are slim.

4. Policy Issues

a. The Information Problem

There is evidence that decision makers are not obtaining information which they need in order to reach fully informed conclusions on proposed telecommunications projects in developing countries. There may in fact be important omissions and unidentified biases in the project and program evaluations which they receive.

The information problem has three principal aspects. First, decision makers may not be fully alerted to the unreliability of data underlying a given evaluation. Second, they may be unaware that the projections of future performance which they have received are strongly influenced by assumptions which can be, but may not have been tested. Third, the basic structure of the analysis may omit considerations which are important to sound decision making, or may give disproportionate weight to considerations which are of limited importance.

The information problem can be dealt with in a number of ways. First, there can be an effort to promote a general understanding among decision makers that the problem does indeed exist. Second, decision makers can raise hard and searching questions before accepting the results of a project or program evaluation which has been presented to them as a basis for action.

Finally, an effort can be mounted to improve the reliability of telecommunications studies in the developing nations. Telecommunications statistics can be improved. Methods of analysis can be refined, and a better formulation of the contents of a telecommunications study can be developed. Retrospective studies can check predictions against realities.

It should be recognized that the art of evaluating satellite earth stations and related projects in developing countries is itself in its infancy. Substantial effort will be required before methods of analysis are brought to the point where they can be regarded as both sound and generally understood.

b. The Regional Integration Problem

International telecommunications projects have a potential for contributing to regional integration in developing areas. However, they can encounter substantial difficulties arising from periods of friction between neighbors and from considerations of national interest.

Regional projects can raise hard questions of financial returns, operational capabilities, national prestige and even national security. Moreover, they may impact in significant ways on national communications systems and telecommunications relationships with nations which are not members of the regional grouping.

Telecommunications technology does not necessarily impel regional groupings. Indeed, unless significant countervailing forces are set in motion, the prospects are for a proliferation of satellite earth stations, rather than for substantial regional groupings.

If this trend is to be counteracted, an effective organizational advocate for regional groupings will be required. To be truly effective, such an organization must combine control over substantial funds with significant analytical and negotiating skills.

c. The Uncertainty Problem

Telecommunications technology is a product of an industrial society. It is no simple task to apply this technology to developing nations in a way that is appropriate to their special needs and circumstances. There is no doubt that, properly directed, satellite communications and other modern telecommunications systems can make a very significant contribution to the developing world. There is also a danger that the cumulative effects of entrepreneurial optimism, national pride, and incomplete analysis may lead to the installation of telecommunications systems in developing nations which are, in fact, poor choices from technical, economic, or financial viewpoints. The decision maker is confronted with the need for decisions in an environment that inevitably contains uncertainties and risks. The cause of

development can be harmed just as much by a failure to undertake a needed communications project as it can by the installation of a project which is poorly suited to a country's needs.

Proposed telecommunications projects generally involve fairly sophisticated financial considerations. The danger may not be that a project will stand idle, or will fail to make money. Rather, the choice may be between a prestigious but moderately profitable system, and an alternative which is, although substantially more profitable, also more pedestrian. The consequences of error in choice thus may not be obviously disastrous, but instead may manifest themselves in more subtle forms.

d. The Organization Problem

The structure, management, ownership, and scope of responsibilities of the operating organization can be important ingredients in decision making. The relative success of the pertinent alternatives may be heavily dependent on the technical and managerial capabilities of the organization responsible for the operation of the system. If the responsible organization is operated as a conventional government ministry or agency, the relative success of the project will impact on the revenues and expenditures of the national government. This impact may not be highly visible and indeed may not affect the budget of the government entity involved. It would, of course, affect the

government's financial position and the country's economy. If the organization is an external telecommunications agency partly or wholly owned by foreign interests, the relative success of the project may be expected to impact on external communications only, and thus affect owners in proportion to their ownership shares. If the organization is a financially self-sustaining national administration with responsibility for both international and domestic services, the relative success of the project may impact throughout the national telecommunications structure and have a direct effect on the morale and functioning of the organization itself. In weighing the imponderables implicit in most telecommunications projects in developing countries, it is appropriate for decision makers not only to consider whether a proposed project is a promising one, but also to take into account the nature of the organization on which the project's success or failure will impact.

CHAPTER TWO
THE IMPACT OF GLOBAL COMSAT ON
DEVELOPING NATIONS

A. INTRODUCTION

The purpose of this chapter is to describe what Global Comsat is, how it works, and how it may be expected to impact on the telecommunications systems of developing nations.

Section B provides a brief and nontechnical explanation of the international satellite communications system, the International Telecommunications Satellite Consortium, the Intelsat satellite program, and the status of satellite earth station development.

Section C describes the specialized role of Global Comsat in the family of international communications systems.

Section D examines the impact of satellite communications on the development of international terrestrial links.

Section E discusses the impact of satellite communications on the development of national communications systems.

B. GLOBAL COMSAT

"Global Comsat" is an international communications system employing satellites to relay commercial telephone, telegraph, telex, television, and other services between widely separated locations on the earth.

Each satellite used for Global Comsat is placed in an orbit which is approximately 22,300 miles above the equator. At that altitude, the satellite can communicate with earth stations located as far apart as 10,000 miles on the earth's surface. The satellite's motion is synchronous with the earth's rotation in its equatorial orbit. Consequently, it appears to be stationary in relation to the earth stations whose traffic it relays.

The satellite is chiefly comprised of antennas for receiving the intended signals from properly equipped earth stations, amplifiers for boosting the signal power, and antennas for transmitting the amplified signals back to earth. The radio frequencies utilized for transmission in Global Comsat are in the microwave range, and propagate in substantially straight lines. Thus, effective communications are provided only between earth stations which can "see" the same satellite.

There are preferred locations for the synchronous satellites. One such location is over the South Atlantic Ocean. This satellite provides a relay point for traffic among eastern North America, South America, Europe, and Africa. Another location, over the Pacific, provides a relay point for traffic among western North America, Hawaii, Australia, and eastern Asia. An Indian Ocean satellite will relay traffic among the United Kingdom and Europe, Africa, the Arabian peninsula, the Indian subcontinent, southeast Asia, Japan and Australia.

Earth stations employ dish-shaped antennas for both transmission to and reception from a given satellite. Interference between transmitted and received signals is avoided by the use of a frequency separation band between them. Some earth stations will employ more than one antenna to provide service via two satellites. For example, some stations in Europe will handle traffic to North America via the Atlantic satellite, and will also handle traffic to Asia via the Indian Ocean satellite. However, no satisfactory voice service is possible at present utilizing two satellite links connected in any manner. This means that earth stations communicate directly only with those other earth stations which access the same satellite.

The International Telecommunications Satellite Consortium (Intelsat) is a group of nations organized to define, establish, and maintain an international satellite communications system. The United States has played an important role in the formation and proceedings of this group to date.

Intelsat has employed the Communications Satellite Corporation (Comsat) to manage the system. Comsat's management functions include technological development, satellite procurement, launch and control, satellite usage management, and rate determination. Comsat owns no earth stations outside the United States or its

territories. Stations in other countries are owned by their respective governments, or by internal organizations.

The evolution of commercial communications satellite technology has progressed to the third generation. Intelsat I was launched in 1965, Intelsat II launches were in 1967, and Intelsat III launches began in September 1968.

One Intelsat III satellite is now positioned over the Atlantic, and the other over the Pacific. Each has the capacity of relaying simultaneously 1,200 two-way voice channels, or four television channels. The expected useful life of the satellites is about five years.

Two more Intelsat III launches are planned for 1969. One will place an additional satellite over the Atlantic Ocean because of the heavy traffic in that area, and the other will place a satellite over the Indian Ocean for traffic between Asia, Africa, and Europe.

Intelsat III satellites are utilized with the frequency division form of multiplex operation (FDM), similar to that employed in conventional ground-based commercial microwave relay systems. A number of earth stations may utilize a given satellite simultaneously by means of frequency division multiple access (FDMA). For this purpose, the transmission of each terminal is on a carrier frequency different from those used by other terminals.

In view of projected traffic expansion, Comsat Corporation has a continuing program of development to provide and deploy commercial satellites of increased capabilities. Intelsat IV is under contract. Deliveries will begin in 1971. This satellite will accommodate 5,000 telephone channels and will incorporate a number of technical improvements.

The first group of stations to operate under Global Comsat were located in England, France, Italy, West Germany, and the United States. As of the end of 1968, earth terminals in ten other countries or areas were operating in: Australia, Canada, Chile, Hawaii, Japan, Mexico, Panama, the Philippines, Spain and Thailand. The United States now has six stations in: Maine, Washington, Hawaii, California, West Virginia and Puerto Rico. During 1969, terminals currently under contract are scheduled to become operational in twelve additional countries: Argentina, Bahrain, Brazil, Hong Kong, India, Indonesia, Iran, Kuwait, Lebanon, Morocco, Peru, and Taiwan. Stations in Colombia, Greece, Kenya, Korea, and South Vietnam are under contract.

C. GLOBAL COMSAT AND TELECOMMUNICATIONS
DEVELOPMENT FOR DEVELOPING NATIONS

The role of Global Comsat, in the family of international telecommunications systems, is to transmit large volumes of traffic over long distances with a minimal degradation in signal quality. Normally, the distances must be in excess of 1,000 to 1,500 miles, and the traffic volume must occupy at least eight to ten voice channels. Otherwise, other transmission systems (often microwave systems) may be better choices from a cost-effectiveness standpoint. Thus, in developing countries satellite communications facilities are almost exclusively restricted to the transmission of international and intercontinental traffic between earth stations located at relatively large population centers which have substantial economic significance within their respective regions.

High frequency radio circuits can fulfill much the same role as satellite communications for normal and data transmissions,¹ but are more subject to limitations on reliability, quality, and capacity.² Where relatively low volumes of traffic are involved, high frequency radio facilities can have substantial economic advantages over satellite communications. Thus, for developing

¹ Where television transmission is required, HF radio is not a feasible alternative because of its limited bandwidth.

² See International Radio Consultative Committee, Working Group III-A, on An Improved Transmission System for Use Over HF Radiotelephone Circuits (Document III/72-E, October 18, 1968).

countries the selection of a system to carry long-distance international communications can require hard choices between quality and cost.

Submarine cables also can fulfill much the same role as satellite communications, and provide equivalent quality. However, the terminals for such cables are restricted to coastal locations. In addition, at the present time, submarine cable costs are generally higher than satellite communications costs. It is possible that new technology will permit cables to become cost-competitive with satellite links, particularly for very heavy volumes of traffic. However, satellite communications are likely to represent a more economical "high quality" mode for many developing nations for a considerable period of time.

Telecommunications planners seldom start with a clean slate even in developing nations. The process of extending satellite communications service into a country is essentially one of superimposing an additional means of communications upon existing telecommunications systems, and the related legal, financial, operational, ~~organizational~~, and administrative agreements which have been developed over a period of many years. This superimposition factor introduces widespread complexities into the process of establishing economically and technically feasible locations for satellite earth stations and of ~~planning other telecommuni-~~cations improvements. ~~Other factors of particular interest for developing nations are described in the following sections.~~

D. IMPACT OF SATELLITE COMMUNICATIONS ON THE
DEVELOPMENT OF INTERNATIONAL TERRESTRIAL LINKS

The prospects for the viability of satellite earth stations often can be improved if groups of developing nations agree to share common earth stations rather than to install international communications systems which are essentially independent of each other. In such cases, high quality international terrestrial links are required to feed international traffic to, and distribute international traffic from, a common earth station. In many cases, terrestrial links which serve a common earth station can perform other important functions as well. They can carry non-satellite international traffic among the countries which they link together. High quality links can carry domestic interurban traffic among principal cities along the route. They can, in fact, provide a stimulus for a general rationalization and improvement of the national telecommunications systems through which the link passes. In theory, installation of a carefully conceived configuration of earth stations and international terrestrial links could result in truly integrated continental networks.

International terrestrial links are, in many ways, the most complex and problematic ingredients in regional or continental telecommunications planning. They illustrate, perhaps better than does the global system itself, the vast difficulties and opportunities which a revolution in telecommunications technology has posed for developing countries.

Consider the case of a West African international trunk route connecting Ghana, Togo, and Dahomey to satellite earth stations in Nigeria and the Ivory Coast.¹ Such a trunk route would require cooperation among countries whose international telecommunications systems have greatly different rate structures, preferential arrangements, technical capabilities, and organizational practices. For Ghana, Togo, and Dahomey, these nations which would use other countries' earth stations, greater dependence on the performance of their neighbors' facilities and technical personnel would go hand in hand with improving the quality of their international communications. Rates and rate splitting arrangements, which have been largely based upon high frequency radio for long distance communications, would have to be adjusted for the microwave-satellite modes. New arrangements will be required within the countries themselves as to the functions of organizations responsible for domestic and external communications. The West African countries may have to fully reassess their telecommunications relationships with other African countries, Great Britain, France, and other nations, as well as with themselves. The

1 For a discussion of the Checchi study of improving international communications in West Africa, see Section E of Chapter Three.

agreements which must be made among all these groups will necessarily be conditioned by a certain amount of uncertainty concerning traffic volumes, revenues, and technical performance.

Introducing an international terrestrial link presents problems not unlike those of initiating fundamental changes in multilateral trade arrangements. In addition, it requires an assessment of the impact which a rapidly changing technology may have on the interests of particular countries. There are substantial gaps in information concerning telecommunications in developing countries. There is a shortage of indigenous personnel who can confidently evaluate the interests of each country in multilateral arrangements.

International terrestrial links require agreement of two or more nations, whereas a single nation can purchase an earth station. Given political realities affecting many developing countries, the prospects are for a proliferation of earth stations serving single nations or small groups of nations, rather than for substantial regional groupings of developing countries in common earth station tributary areas. A substantial and carefully conceived effort would be required to reverse this trend.

E. IMPACT OF SATELLITE COMMUNICATIONS ON THE
DEVELOPMENT OF DOMESTIC COMMUNICATIONS SYSTEMS

It was suggested in the previous section that international terrestrial communications, which connect a group of developing nations with a satellite earth station, can at the same time serve domestic communications systems. Indeed, installing international links can often stimulate, if not require, a reassessment of the entire domestic communications structure. The installation of a satellite earth station may have much the same effect on a domestic communications system, even where international terrestrial links are not envisioned.

The installation of a satellite earth station represents a substantial and complicated undertaking for most developing countries. In the short run, the effort is likely to divert financial, technical, and managerial resources from other undertakings. In the long run, however, it may stimulate a range of domestic improvements including the installation of high quality interurban links and the upgrading of urban service. Once a high quality international communications system has been installed within a country, there is a substantial incentive to achieve high quality service on those portions of the domestic system which serve the users of international services.

International communications are very profitable to developing nations, usually much more so than domestic services. This important consideration

cuts two ways in terms of the financial relationships between a nation's international and domestic systems. If an earth station investment is a well conceived one, it can increase the profitability of international traffic, often providing a source of additional funds for telecommunications development of all types. On the other hand, if an earth station reduces the profitability of international traffic, it can cut the amounts of internally generated funds available for national telecommunications development.

An economic evaluation of an earth station thus should not stop with a determination that it will "break even" at an early year. The financial question is not merely whether an earth station will be profitable in itself. Rather, it is whether the station will be more profitable than other types of international communications systems, taking into consideration its entire useful life.

In countries where international communications are handled by a separate and/or foreign organization, the installation of an earth station affords a good opportunity to raise the question of national telecommunications organization. If domestic and international communications are combined in a single organization, it should be possible to operate telecommunications services on an independent and self-sustaining basis in developing countries. In countries where this approach has not been adopted, it should be considered in connection with earth station installation.

CHAPTER THREE

TELECOMMUNICATIONS IN AFRICA:

FIVE STUDIES IN RETROSPECT

A. INTRODUCTION

The purpose of this chapter is to summarize the results of five studies of African telecommunications development which were performed by Checchi and Company during the years 1965 through 1969. Each of the five studies is described briefly and its principal findings are set forth. Study methods are then summarized and retrospective comments are made on significant study elements.

Section B examines the survey of the future of African telecommunications development¹ performed for the Agency for International Development in 1966.

Section C discusses the Minimum Africa Program report.² The report represented a portion of the study of the application of satellite communications to the needs of developing countries performed for the National Aeronautics and Space Administration and the Agency for International Development in 1965-66.

1 Improving African Telecommunications During the Next Decade (PIO/T 698-6-6121066) Washington: AID; July, 1966. This study is discussed first for purposes of exposition.

2 Study of the Application of Satellite Communications for Under-Developed Nations, Interim Report (NASW-1357) Washington: NASA; February 25, 1966.

Section D summarizes an economic, technical, and financial feasibility study of improving telecommunications in the Republic of Chad.¹ This study was performed for the Agency for International Development in 1966-1967.

Section E discusses a study of the economic, technical, and financial feasibility of an international microwave trunk route in West Africa.² This study was performed for the National Aeronautics and Space Administration and the Agency for International Development in 1967-1968.

Section F examines the study of the economic, technical, and financial feasibility of a satellite earth station and microwave trunk route for Ethiopia.³ This study was performed for the Agency for International Development in 1967-1968.

B. IMPROVING AFRICAN TELECOMMUNICATIONS DURING THE NEXT DECADE (1966)

This report surveyed African telecommunications systems and set forth a ten-year program of telecommunications development for Africa.

1. Principal Findings

African telecommunications were found to be characterized by the following significant features:

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- 1 A Study of the Economic and Technical Feasibility of Improving Telecommunications in the Republic of Chad, (AID/AFR-433) Washington: AID, May, 1967.
 - 2 A Study of the Economic and Technical Feasibility of Improving International Telecommunications in West Africa (NASW-1357) Washington: NASA/AID, October, 1968.
 - 3 The Ethiopia Telecommunications Study (AID/AFR 522) Washington: AID, May, 1969.

- Heavy dependence upon high frequency (short wave) radio, both for national and international circuits;
- Heavy dependence upon communications to European capitals --principally London and Paris--for the relay of traffic from one African nation to another;
- Almost total absence of an organized inter-African network structure;
- Conspicuous deficiencies in both the availability and quality of telecommunications;
- An enormous shortage of trained indigenous technical personnel in most African countries;
- Chronic lack of internal capital needed to finance the necessary improvements in telecommunications; and
- Dominance of political considerations over economic considerations in decision-making processes in telecommunications planning.

Most international traffic generated in African countries was found to have its origin in relatively few African cities and its destination either in neighboring countries or in Europe. Traffic between countries located in different regions in Africa was found to be relatively insignificant.

The most promising prospects for development of African communications lie in systems whose principal revenues are derived from intercity or intercontinental traffic, but which also have the capacity to transmit traffic among regions of Africa. Satellite earth stations fall into this category.

A telecommunications program amounting to some \$430 million for the next decade was proposed as an alternative to the ten-year, one billion dollar program formulated in 1964 by a joint committee of the Economic Commission for Africa (ECA) and the International Telecommunication Union (ITU).

The Checchi study found that achieving an integrated African telecommunications network, as distinguished from piecemeal development, would be very difficult. The study suggested that donors and other funding sources could develop a basic telecommunications plan for Africa roughly analogous to the national defense highway system plan in the United States. Financial assistance could then be granted to individual nations or groups of nations to implement portions of the plan in a timely and rational manner.

It was concluded that telecommunications projects in Africa should usually pay for themselves. Thus, when a project for regional or continental communications does not appear to be financially self-sustaining, a rationale based on "Pan Africanism" or "regional solidarity" deserves skeptical scrutiny.

2. Principal Study Methods

The present state of telecommunications was reviewed first on a general continental basis and then for African regions individually. Selected studies of African telecommunications were assessed. Particular attention was given to the ECA/ITU projection (1964) which formulated a billion dollar ten-year program for African development. An approach to an integrated program of telecommunications development was then described in terms of required surveys, personnel programs, investment in fixed assets, implementation time, and capital assets.

3. The Study in Retrospect

As shown in Exhibit One, the Checchi study provided a program which differed in size and basic orientation from the 1964 ECA/ITU program for African development. The latter program was characterized as too optimistic given the manpower, budget, and political constraints present in the African environment. The Checchi program placed less emphasis on interregional microwave routes than did the ECA/ITU plan and gave greater relative importance to domestic requirements.

Checchi's subsequent studies have tended to confirm the findings of Improving African Telecommunications in the Next Decade. African economies are basically oriented toward Europe and the United States rather than toward each other. Principal economic flows occur (1) between the

EXHIBIT ONE

COMPARISON OF PROGRAM LEVELS AND ELEMENTS (Millions of U. S. Dollars)

<u>Element</u>	<u>ECA/ITU Program</u>		<u>Checchi Program</u>	
	<u>Funding</u>	<u>Percentage of Total</u>	<u>Funding</u>	<u>Percentage of Total</u>
I. Pre-investment Surveys and Technical Field Studies	5.0	.5	5.0	1.2
II. Operational Telecommunications Facilities:				
A. Domestic Requirements	450.0	44.7	300.0	69.8
B. International Facilities	475.0	47.1	100.0	23.2
III. Manpower Development	<u>77.6</u>	<u>7.7</u>	<u>25.0</u>	<u>5.8</u>
TOTAL	<u>1,007.6</u>	100%	<u>430.0</u>	100%

Source: Checchi and Company, Improving African Telecommunications
During the Next Decade (PIO/T 698-6-612066) Washington:
AID, July 1966, p. 27.

hinterland and the African cities, (2) within African cities, (3) among near-by African cities, and (4) between African cities and the industrialized nations. Telecommunications projects designed to facilitate these principal flows are of great importance to African development. It is true that in some cases, air and ocean traffic generate significant requirements for interregional communications in Africa. On the whole, however, the interregional features of African telecommunications projects yield the least promise of important payoffs in terms of financial viability and development. It may be anticipated that interregional and even regional communications systems in Africa will develop most satisfactorily as adjuncts to systems which have been designed principally to carry intercity or intercontinental traffic.

Africa does not thus far have an integrated program for telecommunications development, and although there have been efforts at continental and regional planning, an over-all network plan has not been developed. Nor has a means of demonstrated effectiveness yet emerged for implementing African telecommunications projects in an integrated fashion.

C. MINIMUM AFRICAN PROGRAM (1966)

The Minimum African Program (MAP) study examined the practicability of establishing some minimum form of satellite communications program for Africa by January 1, 1967, or as soon as possible thereafter. The study assumed initial funding in 1966. Earth stations were included in the program whenever financial projections indicated that they would break even by 1972.

1. Principal Findings

Seven countries in Middle Africa¹ were identified as locations at which satellite earth stations could break even by 1972.

<u>Station Location</u>	<u>Nations to be Served</u>
Dakar, Senegal	Senegal, Gambia
Abidjan, Ivory Coast	Ivory Coast, Upper Volta, Niger
Lagos, Nigeria	Nigeria, Dahomey, Togo
Brazzaville, Congo	Congo (Brazzaville), Congo (Kinshasa)
Nairobi, Kenya	Kenya, Tanzania, Uganda, Burundi, Rwanda
Khartoum, Sudan	Sudan
Addis Ababa, Ethiopia	Ethiopia

Six of the seven earth stations were found to break even by 1972 even if no other earth stations were constructed in Middle Africa.

1 Middle Africa is defined for these purposes as south of the Maghreb and north of the Southern Tier.

African intercontinental traffic was found to account for a relatively small percentage of earth station revenues. Only in the case of Ethiopia would loss of African intercontinental traffic delay the break even point beyond 1972.

The seven stations, operating as a network or basic configuration, would link 17 African countries, Europe, and the United States. Capital costs for the entire seven-station configuration were estimated at about \$25 million, or about \$3.5 million per station.

The earth station service areas for the basic configuration were made up of small groupings of countries for which cooperation at a practical level had been demonstrated. Consideration was given, however, to larger service areas, both in terms of variations within the basic configuration and in terms of principal alternatives to it. While some economies could be effected by extensive use of microwave links to carry African traffic, it was concluded that predominant reliance upon large regional groupings would prove impractical or undesirable in terms of African political, economic, and technical realities.

2. Study Methods

The study's conclusions were based on a fairly complex methodology and several series of iterations. Two secondary sources of infor-

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mation on traffic data were used. International Telecommunication Union data provided historical series on total international telephone, telegraph, and telex traffic for the countries surveyed. Traffic matrices contained in the ITU Rome Plan (1963) provided a basis for breaking down data on each country's total international traffic into bilateral traffic patterns.

Forecasts of satellite candidate traffic were made on the basis of historical trend extrapolations with certain modifications. An "impulse jump" of 25 percent was added to the telephone traffic projections to account for increases in traffic attributable to higher service quality.

The status of African communications facilities was analyzed, together with plans expected to be implemented by 1967-68. The extent to which regional cooperation might be expected to foster or impede joint development of satellite and conventional communications was assessed.

Each of the seven earth stations in the basic configuration was evaluated on the basis of "commercial viability", i.e., identification of the year at which the station would break even on pro forma profit and loss statements. Alternatives to the basic configuration and modifications within this configuration were evaluated on the basis of cost-effectiveness analysis.

3. The Study in Retrospect

None of the seven earth stations was funded in 1966 as assumed by the MAP study. None was in operation in May of 1969, the date of the present report.

Construction of an earth station is under way in Morocco.

Kenya is understood to have entered into a contract for an earth station. Earth stations in Algeria, Cameroon, Congo (Kinshasa), Ethiopia, Ivory Coast, Madagascar, Nigeria, Senegal, Sudan, the United Arab Republic, and Zambia are in various stages of study or planning.

There is a vast difference between paper planning and tangible accomplishment in African telecommunications development. Announced dates for future earth station operation may be based upon very little economic and technical analysis. Even where there has been a solid planning effort, political instability or difficulties in obtaining needed financing can push target dates substantially forward in time. Costs are also subject to considerable change as projects move from planning estimates, to contract estimates, to amounts actually charged to complete an installation in a satisfactory fashion.

Recent developments in Africa nevertheless appear to bear out the rationale of the basic configuration contained in the MAP report. The prospects are for a relatively large number of earth stations serving either single nations or comparatively small groupings of nations.

Eighteen months after the submission of the MAP report, Checchi and Company undertook a field survey in Ethiopia to determine the economic, technical, and financial feasibility of installing an earth

station in that country. It is useful at this point to compare several of the key findings of these two studies.¹

The MAP study found that an Ethiopian earth station would show a profit or net income of \$33, 224 in 1972. The feasibility study showed a net income of \$552, 281 in the same year. On the surface, it might appear that the feasibility study strengthened the case which had been made in the MAP report. This is not the case.

As Exhibit Two illustrates, there were significant differences in the composition of revenues projected by the two studies. The feasibility study forecasted less than half the revenues from international voice traffic that the MAP study forecasted. The disparity in these two forecasts principally reflects different treatment of Ethiopian telephone traffic with other African countries.² The MAP study indicated that the Ethiopian earth station would generate some \$163, 000 from African international telephone traffic. The feasibility study projected less than \$2, 000 from such telephone traffic.

1 The Ethiopia Telecommunications Study is discussed in greater detail in Section F of this chapter.

2 The MAP study assumed that an Ethiopian earth station could communicate with earth stations in Kenya, Sudan, and Senegal as well as with other earth stations in the basic configuration. By contrast, the feasibility study assumed that the Sudan and Senegal stations would not be installed in 1972 and that the Kenya station would access the Indian Ocean satellite. Since an Ethiopian station would access the Atlantic satellite, it would not be able to communicate with the Kenya earth station.

EXHIBIT TWO

ETHIOPIA EARTH STATION

COMPARISON OF PROJECTED REVENUES FOR 1972

(Thousands of U.S. Dollars)

	<u>Minimum African Program Study</u>		<u>Ethiopia Telecommunications Study</u>	
	<u>Revenue</u>	<u>Percentage of Total Revenues</u>	<u>Revenue</u>	<u>Percentage of Total Revenues</u>
Telephone (Voice)	\$235.5	25.9	\$ 113.6	5.8
Telegraph (Record)	461.6	50.7	913.6	47.2
Telex (Record)	212.7	23.4	764.7	39.6
Leased Circuits (Record)	--	0.0	144.0	7.4
Total Earth Station Revenues	\$909.8	100%	\$1,935.9	100.0%

Sources: Checchi and Company, Study of the Application of Satellite Communications for Under-Developed Nations, Interim Report (NASW-1357) Washington: N.A.S.A.; February 25, 1966, page I-E-5; and

Checchi and Company, Ethiopia Telecommunications Study, (AID/AFR 522) Washington: A.I.D., May 1969, page IV-3.

The data developed in the feasibility study showed that the MAP study's projections of Ethiopia's traffic with African countries had been far too high. For example, an analysis of the 1963 Rome Plan telephone traffic matrices had resulted in a MAP study finding that ten percent of Ethiopia's international telephone traffic went to Senegal. A careful review of the Ethiopian traffic records indicated that telephone calls to and from Senegal represented less than one hundredth of one percent of Ethiopia's international telephone traffic.

The MAP study treated all of Ethiopia's traffic with Sudan (estimated at 35 percent of total international traffic) as satellite candidate traffic. Discussions with officials of Ethiopia's telecommunications agency revealed that a preponderance of Ethiopia's telephone traffic with Sudan represented traffic among population centers located close to the Ethiopia-Sudan border. Such border traffic would not utilize satellite communications even if both countries were to install earth stations accessing the same satellite.

The feasibility study showed that an Ethiopian satellite earth station would show profits in 1972. It also showed, however, that the Ethiopian telecommunications agency could make substantially greater profits if its international traffic were carried on HF facilities until the

middle or late seventies. Accordingly, installation of an earth station was not recommended for the near future. A comparison of the findings of the MAP study and the Ethiopia feasibility study illustrates the importance of direct field evaluation of data, as distinguished from reliance on secondary sources and estimating procedures. Such a comparison also suggests that the "commercial viability" or break even analysis alone does not provide a suitable basis for a decision to install a satellite earth station.

D. IMPROVING TELECOMMUNICATIONS IN CHAD (1967)

Checchi's study of the economic, technical, and financial feasibility of improving telecommunications in the Republic of Chad dealt with a landlocked nation in an early stage of development. Chad is bordered by Cameroon, Nigeria, Niger, Libya, Sudan, and the Central African Republic. The study reviewed Chad's international telecommunications services, rate structure, and revenues. However, the study focused principally on domestic communications improvements.

1. Principal Findings

Chad's urban and interurban telecommunications systems were found to be close to saturation. The national telecommunications agency was subject to significant management, personnel, and financial constraints. Forecasts of telecommunications traffic showed a clear need for telecommunications improvements.

Government agencies and businesses (many of them operated by foreigners) were found to be the principal users of telecommunications services in Chad. Only in the case of domestic telegraph traffic were the general public significant users. Lack of satisfactory telecommunications services was found to be retarding the growth of the market sector of the Chad economy.

A technical expansion representing a capital investment of \$4,532,800 was proposed. It included a dual diversity troposcatter link; improved high frequency radio facilities; installation of automatic telephone exchanges in population centers of medium size; and replacement or improvement of automatic exchanges located in the four principal cities.

Changes in the organization, functions, and personnel programs were found to be essential to the success of the proposed technical expansion. These changes included providing additional headquarters staff, establishing regional field staffs, and making needed adjustments in financial practices.

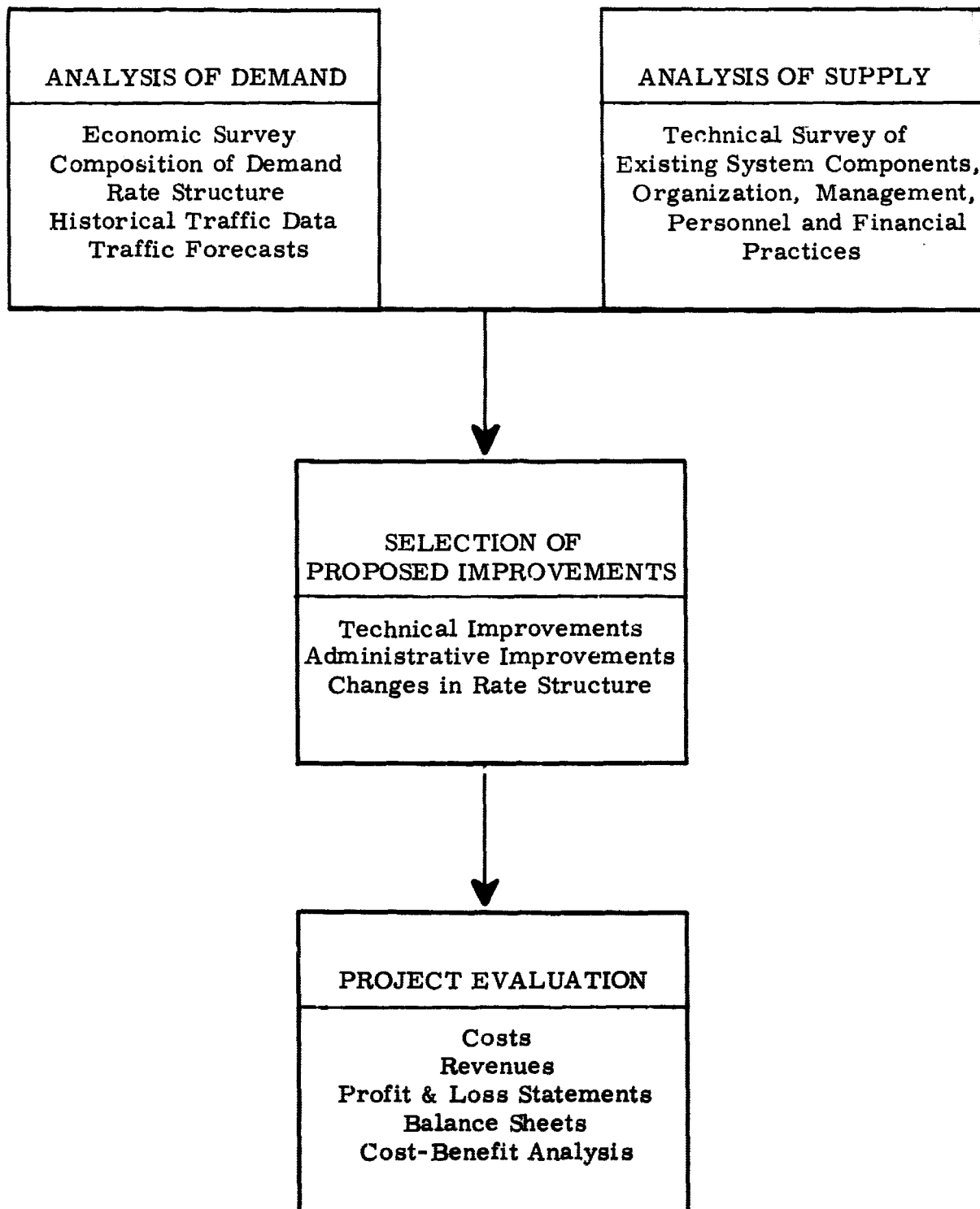
Chad's international communications consist of high frequency radio circuits only. Continued use of HF circuits was found to represent the only economical means of transmission, given the magnitude and composition of Chad's international traffic and the lack of

international terrestrial links. Access to high quality international telecommunications facilities was found to depend upon (1) the installation of a satellite earth station in West Africa, (2) improved high quality national networks in Nigeria or the Cameroon, and (3) availability of high quality communications links interconnecting Chad's system with the improved Nigerian or Cameroon systems. Direct high quality interconnection between Chad and East African nations, such as Sudan or Ethiopia, was not considered a practicable alternative. Distances to East Africa are greater than those to West Africa, and Chad did not have a significant level of traffic with East Africa.

2. Study Methods

The Chad study was organized to reflect the four classic elements of a feasibility study. An analysis of demand was designed to determine the magnitude and character of future requirements for telecommunications services. An analysis of supply sought to identify the degree to which existing systems could meet this demand. Various alternatives for correcting projected imbalances between supply and demand were considered, and preferred alternatives were selected. Financial analysis and cost-benefit analysis were then used as techniques of project evaluation. The relationships of these study elements are shown schematically in Exhibit Three.

CHAD STUDY: ELEMENTS OF ANALYSIS



The analysis of demand started with a brief overview of the Chad economy. The composition of telecommunications demand was then examined in terms of the main categories of users and principal factors influencing traffic growth. The influence of rate structure on demand was assessed. Historical data was analysed and traffic projections made.

The analysis of supply examined the technical capacity of Chad's existing communications system. Constraints arising from organization, management, personnel, and financial practices were also identified.

Proposed improvements were selected from among a range of technical, financial, and management alternatives. Technical alternatives were selected on the basis of cost-effectiveness analysis. Improvements of a nontechnical character were designed to remedy constraints in the existing system and to be consistent with the proposed technical improvements.

Project evaluation was accomplished by examining various relationships among projected revenues and costs. Pro forma profit and loss, cash flow, and balance sheet statements were constructed and analyzed. A cost-benefit analysis was prepared, employing the internal rate of return criterion.¹ Benefits were calculated as those additional revenues which

1 The internal rate of return is a form of discounted present value analysis. The internal rate of return is that rate of interest which would ~~make~~ the present value of benefits equal the present value of costs.

would accrue to the Chad telecommunications agency as a result of the proposed improvements. Secondary and intangible benefits were described qualitatively, but were not quantified.

3. The Study in Retrospect

The Chad study revealed the considerable financial significance of international record traffic to a country in an early stage of development. In 1964, for example, Chad's international telegraph and telex revenues represented 22 percent of all revenues collected by the Chad agency, including domestic and industrial telecommunications revenues, broadcasting service fees, fees from private networks, and other income sources.

Most of Chad's international traffic was handled by France Cable and Radio Company (FCR), a corporation owned by the Government of France. Chad and FCR had rate splitting arrangements which provided that Chad would receive the equivalent of 20 percent of the applicable international rate in some cases, or a fixed charge per word or minute in other cases. Although international telecommunications represented a significant and profitable revenue source, the principal operational and financial responsibilities were not in the hands of the national telecommunications administration.

The Chad study came to grips with the problems of availability and reliability of information common to many developing countries. On

the whole, the data on international communications were the most extensive and satisfactory. However, like many African countries, Chad had only recently installed telex and it was necessary to rely on the experience of other African countries in order to make forecasts of future telex traffic.

The data on interurban traffic were both very limited and incomplete. It was necessary to construct a forecasting model to fill in gaps and resolve ambiguities in the available information. Despite the limitations of the data, econometric analysis demonstrated some striking relationships between the number of telephone instruments installed in Chad's population centers and the volumes of traffic flowing among them.

Because of Chad's relatively simple economy, it was possible to examine in a fairly comprehensive way the functional relationships between telecommunications services and activities carried on by telecommunications users. It was found, in general, that those industries on which Chad depended for the growth of its market economy depended most heavily on telecommunications in their operations. Telecommunications were found to be very important to industries whose sources of supply, markets, or operations were spread over large distances and whose profits were subject to uncertainties of supply and demand. Development plans and potentials of 29 population centers, ranging from 2,500 to 99,000 inhabitants were assessed in some detail.

The examination of relationships between telecommunications development and economic development provided useful inputs to traffic forecasts. They did not, however, lead to quantitative estimates of benefits which would accrue to the Chad economy (as distinguished from the telecommunications organization) as a result of the proposed improvements. Direct revenues were the only benefits quantified. Although the analysis indicated the nature of indirect benefits to the Chad economy which would result from improved telecommunications, it did not provide a sufficient basis for quantifying these benefits.

E. IMPROVING INTERNATIONAL TELECOMMUNICATIONS IN WEST AFRICA (1968)

The basic purpose of this study was to determine the economic, technical, and financial feasibility of improving international communications among the five West African nations by providing an integrated, multi-channel network extending along the coastal area from Lagos, Nigeria to Abidjan, Ivory Coast. For this study it was assumed that satellite earth stations would be installed in Lagos and Abidjan to coincide with the availability of the international ground network.

The study was principally concerned with (1) traffic among the five West African countries; (2) intercontinental (satellite candidate) traffic to and from the five countries; and (3) African (satellite candidate) traffic

to and from the five countries. Attention was also given to domestic interurban traffic along the proposed route.

1. Principal Findings

Each of the five countries was found to use high frequency radio circuits for its intercontinental and African satellite candidate traffic. Overhead wire, VHF radio and submarine cable, as well as HF radio, were used for traffic among the five countries.

Organizational responsibility for international telecommunications varied among the five countries. Nigeria's international communications were handled largely by Nigerian External Telecommunications, Limited, a corporation jointly owned by the Government of Nigeria and a British public corporation, Cable and Wireless, Limited. A French public enterprise, France Cable and Radio Company, owned and operated most of the international facilities in Dahomey, Togo, and the Ivory Coast. All international circuits in Ghana were operated by the External Telecommunications Service in the Ministry of Communications. In each of the countries, except Ghana, the national telecommunications administration operated some international circuits.

The study revealed international telecommunications constraints of three types: outages on existing telecommunications facilities; lack of circuits to desired locations; and deficiencies relating to the promptness

and quality of service. The existence of these constraints and the prospects for the growth of the economic activities which generate telecommunications requirements indicated a need for improved facilities.

Proposed international improvements included a dual diversity microwave system extending from Nigeria to the Ivory Coast, and terminal facilities in Cotonou, Dahomey, and in the capitals of the other four nations served by the system. The improved system would replace various high frequency radio, overhead wire, submarine cable, and VHF links operating among these cities.

The system would permit interconnection with the satellite communications earth terminals planned for Lagos and Abidjan, thus providing all five nations with high quality international and intercontinental circuits. In Nigeria and Ghana, the proposed system would be integrated with portions of the national microwave systems under construction, thus achieving economies through the use of common buildings and facilities.

It was recommended that each participating nation should move toward a single, financially self-sustaining national administration which would operate both its domestic and international telecommunications. Such an organization was not, however, regarded as essential to the proposed international improvements.

It was also recommended that a committee of telecommunications representatives should be convened under the auspices of the ITU, the African Development Bank, or other suitable international bodies. This committee would reach agreements on a technical system concept for the proposed international improvements and on procedures for employing an engineering consultant. Subsequent international arrangements would reflect the nature of revenue sharing agreements made among the countries, and provide for periodic review of the system's operation.

2. Study Methods

The basic elements of analysis in the West Africa study were essentially the same as those for the Chad study: analysis of demand; analysis of supply; selection of improvements; and project evaluation.¹

A number of special problems of methodology were posed by the multinational nature of the study. These included: conflicting international traffic data; nonparallel rate structures; rate splitting arrangements; and selection of the appropriate cost-benefit methodology.

Despite anomalies and conflicts in the basic data, it was possible to develop forecasting methods based on correlations found between the telephone traffic, numbers of telephone subscribers, and the value of inter-

¹ These basic elements are described in Section D-2 of this chapter.

national trade among the West African countries. A rise in traffic attributable to the introduction of high quality capacity was added to the telephone traffic forecasts. This telephone "impulse jump" was predicted to amount to 25 percent in each of the system's first two years of operation.

A comparative analysis was undertaken of existing international rates and of recommended maximum rates included in the CCIR/CCITT Africa Plan (Addis Ababa, 1967). International rate structures in West Africa were found to lack uniformity, reciprocity, and a clear relationship to costs. For purposes of analysis, three modifications were made in existing rate structures and rate splitting arrangements. First, when existing rates between two countries were unequal, the rate closest to the Africa Plan recommendations was applied to traffic in both directions. Second, certain across-the-board reductions were made in telephone and telex rates. Third, costs of the proposed system were shared on the basis of common user arrangements.

A modification of the common user, or "wayleave," system was used for computing revenues accruing to the five countries. Under this modified system, the annual costs incurred by the five countries in connection with the trunk route would be totaled each year. Total costs then would be allocated among the five countries in proportion to the revenues they collect for trunk route traffic. If a country's allocated trunk route costs were

greater than its incurred trunk route costs during a given year, it would make an "outpayment". If its allocated costs were less than its incurred costs, it would receive an inpayment.

For the purposes of the cost-benefit analysis, benefits were calculated as equal to the net revenues from the proposed improvements plus residual value of the system at the close of the period of analysis. It was also concluded that indirect benefits flowing from the improvement would amount to several times the system's annual cost.

3. The Study in Retrospect

The West African telecommunications study was designed on the premise that it was meaningful to evaluate the international trunk route as a self-contained entity. The scope of the study did not require detailed analysis of (1) the domestic telecommunications systems of the five countries involved, (2) the economics of the satellite earth stations in the Ivory Coast and Nigeria, or (3) international traffic not expected to utilize the trunk route. It was expected that relationships with domestic systems and the satellite earth stations could be limited to estimating traffic requirements at system interfaces, and that the analysis of telecommunications traffic not expected to use the international trunk route was irrelevant to trunk route evaluation.

In retrospect, it appears that the scope of the study was too narrowly drawn for the circumstances found to exist in West Africa. For example, it was not possible to resolve the question of which telecommunications entity in Nigeria should be responsible for the Nigerian portion of the proposed international trunk route without first resolving a number of issues only indirectly related to the trunk route.

The Post and Telegraph Division (P&T) of Nigeria's Ministry of Communications was responsible, at the time of the field survey, for specific circuits to Dahomey and Togo which were regarded as extensions of Nigeria's domestic telecommunications system. Nigerian External Telecommunications Limited (NET) was responsible for all other international communications. The proposed international trunk route would carry some of the P&T's present traffic, some of NET's present traffic, as well as other traffic to and from the satellite earth station.

At the time of the field survey, it seemed likely that the proposed international trunk route would make use of the first hop of a planned Nigerian domestic microwave system. There was some question, however, as to which organization would be responsible for the domestic microwave route. Neither had it been determined whether P&T, NET, or a third organization would operate Nigeria's earth station.

Nigeria's investment in the international trunk route proved to be the smallest of the five countries involved. By contrast, the magnitude of its prospective investment in the satellite earth station and the other facilities which would be involved in defining the respective roles of P&T and NET was found to be quite substantial. The question of the organization of Nigeria's telecommunications was discussed in terms of general principles in the trunk route study. However, it could not be resolved definitively without addressing issues outside the scope of the study.

It proved difficult to confine many other economic, technical, and financial issues neatly to the trunk route facilities and trunk route traffic. For example, it appeared likely that high frequency radio facilities displaced by the trunk route could be profitably used for domestic or international traffic. It was not possible to analyze these prospects in detail without assessing requirements for other domestic and international facilities. In some instances it proved difficult to specify the sources of constraints on international services without giving attention to the performance of the domestic distribution systems. The question of earth station charges for satellite traffic had to be examined in terms of general considerations rather than in terms of specific economics of the earth stations involved.

Fortunately, the feasibility of the West African trunk route did not turn out to be a close question. Quite clearly, the project would be an

attractive one in terms of financial viability and in terms of its impact on economic activity. Had the project been more marginal, however, it is doubtful that it could have been properly evaluated without expanding the scope of the study.

As a general proposition, international telecommunications traffic is far more profitable to developing countries than is domestic traffic. Rate-making principles aside, this disparity is a fact of life for telecommunications organizations in developing nations. Placing international and domestic telecommunications in the hands of separate organizations often leads to unbalanced development. A study which attempts to insulate analysis of international services from domestic services runs a danger of producing unbalanced or even misleading results.¹ Rather than attempting "self-contained" analyses, it is believed that studies of this type should squarely address strategic relationships among the basic elements of each nation's telecommunications structure.

F. ETHIOPIA TELECOMMUNICATIONS STUDY (1969)

The purpose of this study was to determine the economic, technical, and financial feasibility of two investment projects: a satellite earth station for Ethiopia; and improvements in the existing link between Ethiopia's two largest cities, Addis Ababa and Asmara. The study was based on the

¹ See Final Report, President's Task Force on Communications Policy, December 7, 1968, Chapter Four.

assumption that satellite earth stations would be installed in Nigeria, the Ivory Coast, and East Africa by 1972. It also assumed that foreign governments in Ethiopia, utilizing their own private international communications systems, would not use an Ethiopian satellite earth station.

1. Principal Findings

Responsibility for Ethiopian international and domestic telecommunications services is vested in a single organization, the Imperial Board of Telecommunications of Ethiopia (IBTE). The IBTE was organized as a government-owned corporation and operated on a financially self-sustaining basis.

Ethiopia's international telecommunications system was found to consist solely of high frequency radio facilities and landlines. Both were subject to capacity constraints. There was little evidence, however, of substantial suppressed demand among users of the IBTE's intercontinental telephone services.

The IBTE's international telecommunications services were found to be far more profitable than its domestic services. In 1966, international services represented only 27 percent of the IBTE's revenues, but accounted for approximately 70 percent of its profits. The portion of international services which would be carried by a satellite earth station repre-

sented less than 17 percent of the IBTE's revenues, but accounted for about 46 percent of its profits.

It was found that a satellite earth station could contribute to the IBTE's net income in the year 1972. However, this contribution would be much smaller than that which would be made by continuing to operate HF facilities. An earth station installation in 1972 would cause the IBTE to forego well over \$2,000,000 of profit in its early years of operation. Accordingly, it was recommended that the earth station investment should be deferred until the middle or late 1970's.

Most of Ethiopia's interurban telecommunications traffic is carried on the Addis Ababa-Asmara trunk route. Telephone service on the trunk route between Addis Ababa and Asmara was subject to long waiting times and frequent interruptions. Demand for service on this route far exceeded capacity.

Requirements for improved service between Addis Ababa and Asmara were found throughout the Ethiopian economy. Important requirements were also noted for improved communications among the ports of Djibouti, Assab, and Massawa, as well as between these three ports and Addis Ababa and Asmara.

A microwave trunk route which would serve Addis Ababa, Asmara, and principal intervening cities was found to be economically, technically, and financially feasible.

2. Study Methods

The Ethiopia study dealt with a number of options for both a satellite earth station and a microwave trunk route. International traffic forecasts were developed for three principal situations:

- | | |
|--------------|--|
| Situation A: | No earth station; no trunk route improvement. |
| Situation B: | Earth station, but no trunk route improvement. |
| Situation C: | Earth station and a trunk route improvement |

The report did not include an economic, technical, or financial feasibility study of improving Ethiopian high frequency radio communications. However, a parametric analysis was conducted to establish possible cost magnitudes of handling future international traffic requirements by means of HF facilities. A separate analysis established that Ethiopia had sufficient high frequency circuit assignments to handle traffic projected through the late 1970's.

Two technical options were developed for the Addis Ababa-Asmara microwave trunk route:

- A short-hop system, consisting of 20 or more radio relay stations located along the Addis Ababa-Asmara all-weather highway; and

- A long-hop system consisting of nine hops and using high peaks between the two cities as repeater sites.

The short-hop route was found to be technically feasible. The long-hop alternative was found to require a more detailed study of propagation conditions in order to confirm a conclusion of feasibility.

3. The Study in Retrospect

The findings of the Ethiopia Telecommunications Study serve to underline the rather substantial shortcomings of the "commercial viability" or break even criterion as a means of evaluating satellite communications projects. This criterion, which is perhaps useful for taking a first cut at the problem, is unsuitable as a basis for evaluating earth station feasibility.¹ Indeed, it may serve to obscure considerations which are truly critical to sound decision making.

Break even analysis is at best a crude and incomplete method for evaluating an investment. Certainly, if an earth station is not expected to break even until many years after its installation, it is likely that the project should be deferred. Fundamentally, however, it is just as important to determine what will happen before and after the project breaks even as it is

1 The break even criterion was used in the Minimum Africa Program report and continues to be used in a number of feasibility studies prepared for developing nations.

to know when the break even point occurs. Costs and revenues should be assessed in terms of the project's entire useful life, not simply for a portion of that time. Such an assessment can be accomplished by calculating the present values of projected revenues and costs at a given discount rate. Alternatively, the internal rate of return on investment can be calculated from a time-phased projection of revenues and costs.

It is important to recognize that developing countries have alternatives before them in seeking to improve their international communications. A critical question is: What respective rates of return on investment will result from the alternative means of carrying international traffic? Both "high quality" and "low quality" systems should be included as alternatives. Careful analysis may show that a "low quality" system such as high frequency radio will provide a developing country with substantially greater revenues than a "high quality" system. On the other hand, it is possible that a high quality system would so enhance the activities carried on by users of international communications that its lower profitability to the telecommunications administration would be offset. Prompt, high quality, intercontinental voice communications may, for example, be of critical importance to a nation's principal export industries. Economies which are "external" to the telecommunications administration can be of great, even overriding, significance. But such external economies should be demonstrated, not assumed.

Developing countries are, as a general proposition, in need of improved telecommunications systems. But it is not axiomatic that they require "high quality" communications in all instances. In the case of Ethiopia, requirements for high quality interurban systems were apparent. High quality international service with French Somaliland was clearly needed to coordinate shipping movements and the movement of goods through the port of Djibouti. However, substantial or critical requirements for high quality voice services to locations which could be served by satellite simply were not in evidence. Ethiopia's intercontinental requirements for record traffic were found to be very important to its economy, but they could be accommodated by expanded use of high frequency communications.

In retrospect, it appears that the basic notion of "a satellite earth station feasibility study" for a developing nation is somewhat suspect. The very formulation of the study implies prejudgments as to which portions of a nation's international services are in need of improvement and which technical means are most appropriate for this purpose. An analysis of the economic, technical, and financial feasibility of improving Ethiopia's international high frequency facilities were, strictly speaking, outside the scope of the Checchi study. The HF option could be explored only to the extent necessary to establish that the answer to the earth station alternative was "yes" or "no".

A more tentative and balanced approach to earth station studies in developing nations may well be desirable. Such studies could be framed in terms of "improving international telecommunications" or some other formulation which enables the development of any constructive alternatives which emerge from the analysis. Indeed, there would be considerable merit in a study which required the analysis to present in some detail both the best earth station solution and the best high frequency radio solution for a country in an early stage of development. There are, in fact, some technical options in high frequency radio communications which approach 'high quality' service.¹ It would be useful to have a fair and thorough comparison of such options with satellite communications on economic, technical, and financial grounds.

1 See International Radio Consultative Committee, Working Group III-A, on An Improved Transmission System for Use Over HF Radiotelephone Circuits (Document III/72-E, October 18, 1968).

CHAPTER FOUR

SUBSTANTIVE PROBLEMS REQUIRING FURTHER STUDY

A. INTRODUCTION

The purpose of this chapter is to briefly discuss substantive problems requiring further study. Part Two of the report, which is concerned with the design of future studies, considers these substantive problems in greater detail.

Section B discusses improving the telecommunications data base.

Section C deals with rate structure and revenue sharing problems.

Section D discusses need for work in the field of telecommunications traffic forecasting.

Section E deals with relationships between telecommunications development and economic growth.

B. ADEQUACY OF THE TELECOMMUNICATIONS DATA BASE

Readily available basic data on international communications in developing countries are far less complete, reliable, and detailed than they could be. The potential for developing a satisfactory telecommunications data base is at least as great as that for international trade statistics. The form and substance of the presently

available international telecommunications statistics, however, are decidedly inferior to information published on international trade. Of particular concern are fundamental inconsistencies in telecommunications traffic reporting concepts; lack of reliable information on countries of origin and destination; and ambiguities concerning the treatment of transit traffic. These problems are of such magnitude as to suggest the need for a high degree of caution in using available data as inputs to decision-making models.

First steps toward improvement of the telecommunications base should include the following:

- Classifying data sources useful for performing telecommunications studies in developing nations. Main data sources should include ITU statistics, data available from telecommunications organizations in the United States, data contained in existing policy and feasibility studies, and data available from telecommunications organizations in developing countries.
- Identifying principal data limitations and the significance of such limitations to principal categories of telecommunications studies in developing nations.
- Compiling methods for cross-checking, reconciling, and establishing reliability of data.

- Recommending improvements in those portions of the data base which are most important to the findings of telecommunications studies.

C. RATE STRUCTURE AND REVENUE SHARING PROBLEMS

There are substantial variations in rate structure and revenue sharing arrangements evident throughout the developing world. Anomalies exist both within the international rate structure of individual countries and in the rate structure patterns prevailing among countries. Rate structure and revenue sharing problems constitute a significant impediment to regional cooperation among developing nations and pose substantial difficulties for telecommunications analysis.

Further study of these problems should include the following elements:

- Evaluation of the principal factors influencing rate structures and revenue sharing arrangements, including historical precedents; monopoly position of telecommunications administrations vis-a-vis users of international telecommunications; bargaining relationships among the telecommunications administrations of industrialized and developing countries; bargaining relationships among regional groupings of developing countries.

- Analysis of cost-price relationships important to negotiations, including establishment of ~~cost-price~~ relationships among modes of international communications, e.g., telephone, telegraph, telex, facsimile, television; establishment of post-price relationships among international and domestic telecommunications services; establishment of transit charges for satellite earth stations and international distribution links; and revision of revenue sharing formulas affecting relationships between ~~industrialized~~ industrialized and developing countries.
- Identification of techniques for resolving rate structure and revenue sharing problems typically confronted by developing nations.

D. FORECASTING METHODS

There has been considerable work on methods for forecasting telecommunications traffic in industrialized nations. However, efforts to address the problem in developing nations have been sporadic. These efforts deserve comprehensive review and synthesis. In addition there are several areas of traffic forecasting in which existing techniques require additional development.

The techniques used to forecast the "impulse jump" deserve special attention because of the importance of this phenomenon to

the evaluation of high quality improvements in international telecommunications systems. The impulse jump represents the release of suppressed demand for telecommunications services when improvements are introduced. This phenomenon may be studied either from the point of view of analyzing its cause, or more simply, of determining its correlation with other data. However, it is important to determine whether an impulse jump in demand is due to increased capacity, improved quality, lower rates, other causes or a combination of these, in order to understand the relationship between the impulse jump and the underlying demand to which it applies.

Gravity model analysis is another area of forecasting methodology which deserves further study. Gravity models can be used to predict traffic between population centers in terms of their respective size and spatial separation. Such models are particularly helpful when historical data is incomplete. However, gravity model analysis merits further empirical and theoretical examination as a forecasting method.

The importance of retrospective studies of telecommunications forecasts and traffic patterns cannot be overstated. It is important to evaluate just how accurate telecommunications forecasts for developing countries turn out to be and, insofar as possible, to

identify the reasons for differences between forecasts and the traffic levels which subsequently occur.

E. RELATIONSHIPS BETWEEN TELECOMMUNICATIONS DEVELOPMENT AND ECONOMIC GROWTH

~~Relationships~~ between telecommunications and economic growth are sometimes treated as an article of faith. However, it is by no means a foregone conclusion that all telecommunications projects proposed for developing countries bear a close relationship to, or make a major contribution to, economic growth.

Relationships between telecommunications development and economic growth have not thus far been adequately explored in quantitative terms. There are two sides to the relationships: (1) the influence of economic growth on the need for telecommunications services; and (2) the impact of telecommunications improvements on economic development. There have been a number of attempts to deal with the first relationship, principally concerned with correlations between trade, GNP, telephone subscribers, telecommunications traffic, and similar resources. We know of no studies which have addressed the second relationship in a comprehensive, quantitative manner. The Checchi African studies identified qualitative relationships and occasionally were able to identify prospective cost savings to specific industries or telecommunications users.

A satisfactory treatment of the impact of telecommunications development on economic growth would require (1) detailed studies of the traffic magnitudes, costs, business functions and cost-savings associated with telecommunications services used by specific industries or other economic activities, and (2) an examination of interindustry relationships. Such studies would represent efforts of very large proportions, even in a relatively simple economy. Until studies of this kind are performed, however, the prospects for making meaningful, comprehensive, quantitative estimates of the impact of telecommunications development on economic growth are slim.

Telecommunications facilities, along with highways, ports, and electric power generating facilities, are often categorized as elements of the infrastructure of a country's economy. The term "infrastructure" implies something which must be in place before something else can be constructed or utilized. Investments in infrastructure are thereby placed in a predecessor relationship to external benefits expected to be derived from those investments.

In attempting to estimate benefits to be derived from telecommunications investments, one is faced with the problem that a large portion of the expected benefits, perhaps the majority, are difficult to quantify because the economic activities which the investment would make possible are not in existence. For example, a greatly improved interurban telephone

system in a developing country may stimulate the establishment of a new enterprise (or even a whole new industry), highly dependent on telecommunications, which did not exist before and could not even have been considered if the improved telephone service had not been available. A timely agricultural price reporting service may represent such an enterprise.

One approach to this problem likely to yield useful results would be a thorough survey of the history of past telecommunications projects to see what could be learned about the impact of telecommunications improvements on subsequent business investments. The information obtained could make a valuable contribution to improving the techniques of telecommunications project analysis.

CHAPTER FIVE

PRINCIPAL POLICY ISSUES

A. INTRODUCTION

The purpose of this chapter is to identify key policy issues involved in improving telecommunications systems in developing countries. International telecommunications studies inevitably evoke a broad range of problems ranging from political relationships among nations, to rate policy, to the philosophy of telecommunications organization. This chapter focuses on three policy issues which are believed to be of a particularly fundamental nature.

Section B discusses the problem of providing decision makers with information on prospective telecommunications projects in developing nations in a form which is suitable to their needs.

Section C considers the issue of regional integration in the pattern of telecommunications development.

Section D discusses the bases on which uncertainties as to the prospects for telecommunications projects may be resolved.

Section E examines the pertinence of organizational considerations to decisions on telecommunications projects.

B. THE INFORMATION PROBLEM

There is evidence that decision makers are not receiving information which they need in order to reach fully informed conclusions on proposed

telecommunications projects in developing countries. There may in fact be important omissions and unidentified biases in the project and program evaluations which they receive.

The studies conducted by Checchi and Company have dealt principally with the feasibility or advisability of installing telecommunications systems in Africa. They have not been directly concerned with the considerations which in fact influence telecommunications administrations, government agencies, and international lending institutions in making decisions on earth stations or other telecommunications projects. Nevertheless, our analysis of various reports, feasibility studies, and assessments of the economic viability of telecommunications projects clearly suggests the presence of an information problem for decision makers.

The information problem has three principal aspects. First, decision makers may not be fully alerted to the unreliability of data underlying a given evaluation. Second, projections of future performance may be strongly influenced by optimistic assumptions. Third, the basic structure of the analysis may omit considerations which are important to the making of a sound decision or which may give disproportionate weight to considerations which are of limited importance.

The information problem can be dealt with in a number of ways. First, there can be an effort to promote a general understanding among decision makers of the nature and importance of the information problem. Second, decision makers can raise hard and searching questions before accepting the results of a project or program evaluation which have been presented to them as a basis for action. These include:

- Were the data on which the analysis was based gathered from secondary sources, or were they carefully cross-checked at their point of origin?
- What levels of confidence are placed on the results by the analysts who performed the work?
- How important were any unsubstantiated assumptions to the results achieved?
- To what extent and in what particulars do projection techniques rely heavily on individual judgment?
- Were all alternatives explored in the course of the analysis and how much effort was devoted to this purpose?
- Do the organizations or analysts performing the studies possess strong preconceptions with respect to the study's conclusions?
- Has the study been independently reviewed by persons or organizations possessing a sophisticated understanding of project evaluation techniques?

Finally, an effort can be mounted to improve the reliability of telecommunications studies in the developing nations. Telecommunications statistics can be improved. Methods of analysis can be refined and a better formulation of the contents of a telecommunications study can be developed. Retrospective studies can check predictions against realities.

It should be recognized that the art of evaluating satellite earth stations and related projects for developing countries is itself in its infancy. Substantial effort will be required before methods of analysis are brought to the point where they can be regarded as both sound and generally accepted.

C. THE REGIONAL INTEGRATION PROBLEM

Integrated regional networks for developing nations frequently can be shown to be advantageous in terms of theoretical systems economics. Such integrated networks may involve a group of nations sharing a common earth station or other modern communications systems. It is also frequently the case that commitment to greater social, economic or political integration would represent enlightened national policy for the countries involved.

International telecommunications projects do have a potential for contributing to regional integration. But that integrating potential can be overstated or misunderstood. Telecommunications projects should not be regarded as a kind of mystic technoeconomic "glue". Telecommunications technology can serve the centripetal forces of national autarky as well as the interests of regional integration. Moreover, the ability of telecommunications projects to link nations together effectively is in large part dependent on the basic relationship among these nations.

Many developing countries experience periods of friction with their neighbors. There are, in addition, hard questions of national interest at stake in arrangements concerning regional links. Considerations of financial returns, operational capabilities, national prestige, and even national security pose very real and very complex issues.

Regional projects can have some far reaching effects on national communications systems, altering national telecommunications development priorities and altering the responsibilities or form of existing national telecommunications organizations. They can require renegotiation of agreements with external communications agencies owned in whole or in part by foreign nations whose assistance may be of great importance to developing countries. Regional arrangements may require a total assessment of a developing country's telecommunications relationships with countries who are not members of the regional grouping. Given these considerations and a number of divisive forces at work in the developing world, the prospects are for a proliferation of earth stations and a relatively modest reliance on integrated regional systems.

If the potential of modern telecommunications improvements for regional integration is to be realized, an effort of considerable magnitude will have to be mounted. In order to make an impact, this effort will require

a good deal more than studies of regional cooperation. It will require an effective and continuing organizational advocate of the merits of regional telecommunications solutions. Such an organization must combine control of substantial funds with significant analytical and negotiating skills.

D. THE PROBLEM OF UNCERTAINTY

Telecommunications technology is a product of an industrial society. It is no simple task to apply this technology to developing nations in a way that is appropriate to their special needs and circumstances. Satellite communications and other modern telecommunications systems possess their share of partisans and enthusiasts. There is no doubt that, properly applied, such systems can make a very significant contribution to the developing world. There is also a danger that the cumulative effects of entrepreneurial optimism, national pride, and incomplete analysis will lead to the installation of telecommunications systems in developing nations which are, in fact, poor choices from technical, economic, or financial viewpoints.

Distinguishing soundly conceived projects from "white elephants" can be a difficult undertaking for both the analyst and the policy maker. The analyst's problem is not merely lack of data or uncertainty about projecting revenues and costs. Telecommunications technology is in the process of working a revolution which promises to outdate familiar rules of thumb and to transform virtually every parameter of the problem. The policy maker

is confronted with the need for decisions in an environment that inevitably contains uncertainties and risks. The cause of development can be harmed just as much by a failure to undertake a needed communications project as it can by the installation of a project which is poorly suited to a country's needs. In effect, the "white elephant" may be the status quo. There are limitations to the amount of effort that should be expended in research. At some point study ceases to reduce the uncertainty to any significant degree and a decision is required.

There are, moreover, intangible considerations such as the political and psychological impact of a telecommunications project which may be of importance to a particular decision. Such factors call for intuitive judgment and possibly measurement of quantitative economic, technical and financial trade-offs against achievement of desirable non-quantifiable objectives.

Finally, a decision may involve fairly sophisticated financial considerations. The problem may not be that the project will stand idle or will fail to make money. Rather the choice may be between a prestigious but moderately profitable system, and an alternative which is, although substantially more profitable, also more pedestrian. The consequences of error in choice thus may not be obviously disastrous.

E. THE ORGANIZATIONAL PROBLEM

The management, structure, ownership, and scope of responsibilities of the operating organization can be important ingredients in decision-making. First, the relative success of the pertinent alternatives may be heavily dependent on the technical and managerial capabilities of the organization responsible for the operation of the system. Second, if the responsible organization is a traditional government ministry or agency, the relative success of the project will impact on the revenues and expenditures of the national government. This impact may not be highly visible and indeed may not affect the budget of the government entity involved. It would, of course, affect the country's economy. If the organization is an external telecommunications agency partly or wholly owned by foreign interests, the relative success of the project may be expected to impact on external communications only and will affect owners in proportion to their ownership shares. If the organization is a financially self-sustaining national administration with responsibility for both international and domestic services, the relative success of the project may impact throughout the national telecommunications structure and have a direct effect on the morale and functioning of the organization itself. In weighing the imponderables implicit in most telecommunications projects in developing countries, it is appropriate for decision-makers not only to consider whether a proposed project is a promising one, but also to take into account the nature of the organization on which success or failure will impact.

PART TWO

CONSIDERATIONS FOR THE DESIGN OF FUTURE STUDIES

CHAPTER ONE

INTRODUCTION AND SUMMARY

A. INTRODUCTION

Part Two of this report is directed toward government officials concerned with the design of telecommunications studies for developing nations. It presents the lessons, concepts, and considerations which emerged during the course of the five Checchi and Company studies of African telecommunications development ¹ and which merit consideration for the design of future studies. Part One of this report summarizes for decision makers the principal implications of the five Checchi studies.

B. SUMMARY OF PART TWO

1. Types of Telecommunications Studies

Chapter Two discusses four principal study categories: program surveys, project surveys (prefeasibility studies), feasibility studies, and engineering design studies.

¹

These studies are: Study of the Application of Satellite Communications for Under-Developed Nations, Interim Report (NASW-1357) Washington: NASA, February 25, 1966; Improving African Telecommunications During the Next Decade (PIO/T 698-6-6121066) Washington: AID, July, 1966; A Study of the Economic and Technical Feasibility of Improving Telecommunications in the Republic of Chad (AID/AFR-433) Washington: AID, May, 1967; A Study of the Economic and Technical Feasibility of Improving International Telecommunications in West Africa (NASW-1357) Washington: NASA/AID, October, 1968; and the Ethiopia Telecommunications Study (AID/AFR-522) Washington: NASA/AID, May, 1969.

A program survey of international telecommunications is typically regional or continental in scope. It seeks to identify broad needs, program content, and order-of-magnitude costs.

A project survey, often called a "prefeasibility study", is designed to provide a preliminary assessment of the prospects for a given project, and to define a scope of work for a detailed feasibility study.

A feasibility study is typically designed to provide a basis for decisions as to whether to install a given system. It includes technical descriptions of the project, but does not normally include site surveys or design work necessary for preparation of specifications. It may also be meant to serve as a basis for an application for financial assistance.

A preliminary engineering design study has as its objective the preparation of a bid package on which construction contractors may submit proposals. It normally includes site surveys, preliminary design work, and the preparation of specifications.

An international telecommunications ~~program~~ survey should maintain a fairly even balance between its technical, economic, financial, and sociopolitical analyses.

A project survey (prefeasibility study) is likely to be heavily oriented toward engineering considerations. It is most often concerned with a preliminary determination of which types of telecommunications

facilities are operating at capacity or are otherwise in need of improvement.

An important characteristic of a feasibility study is that the elements of analysis, i. e., technical, economic, financial, and sociopolitical, should be effectively integrated into a meaningful whole to a much greater extent than is required in other types of studies. The interplay between the technical, and economic and financial portions of a feasibility study is intimate, and generally involves several analytical iterations before telecommunications projects which are technically, economically, and financially feasible can be developed.

An engineering design study is heavily technical in nature. It is primarily concerned with the development of specific technical components for the proposed telecommunications system. A significant portion of such a study may, however, involve the application of engineering economics, or "cost-effectiveness" analysis, to determine the most desirable engineering solution.

Study categories may be combined in a number of ways. For example, a program survey may pinpoint several areas in which telecommunications projects would have a high likelihood of utility, and continue directly into prefeasibility studies of such projects. Likewise, a feasibility study may proceed directly to the preliminary engineering design study of the projects determined to be feasible.

A comprehensive approach could include all four types of studies under its aegis, with perhaps one major contractor overseeing the entire program, and subcontractors responsible for portions of the program. Telecommunications systems are particularly amenable to such a comprehensive and integrated systems evaluation, as distinguished from a piecemeal analysis. The major advantage of an integrated program is that it may be more cost-effective than a series of separate studies designed to serve the same end.

The principal disadvantage of composite or comprehensive telecommunications studies is that they lodge responsibility in a single organization for study elements requiring different mixes of skills and essentially different approaches. Placing responsibility in different organizations for successive studies provides more assurance that recommendations have been scrutinized from a number of pertinent viewpoints and are soundly and objectively based.

2. Adequacy of the Telecommunications Data Base

Chapter Three deals with a problem which is characteristic of developing countries: the absence and unreliability of basic statistics. It is a serious mistake, but a common one, for analysts to accept a telecommunications agency's data as accurate without extensive comparison and confirmation. Much the same can be said for any source of information

in developing nations on which study results are dependent. It is particularly important for analysts who have not had prior experience in developing countries to understand that dealing with data deficiencies is a central part of their work. The analyst must be cautious and skeptical, without being overwhelmed by uncertainties which he inevitably will confront. Solving data problems can be one of the most challenging and satisfying tasks in a telecommunications study. A properly evaluated and adjusted data base can in itself constitute a significant contribution to the cause of telecommunications development.

Data may be obtained from secondary sources such as ITU publications, U. S. Government publications, or industry and other organizations. These sources in turn are based upon primary sources. In working with secondary sources, the analyst has little choice concerning the form in which the data is received, and he is often not in a position to make definitive judgments concerning its accuracy.

Information obtained from telecommunications agencies and other organizations which gather and record data represents data received from primary sources. During a field survey, the analyst may be in a position to review basic records and work sheets in order to evaluate the accuracy, completeness, and reliability of the information obtained. He may also be able to have special compilations made, and hence to influence the form in which statistics are presented to him.

Measured or created data is that which is gathered or synthesized by the analyst himself. It includes personally conducted equipment inventories, traffic measurements, propagation measurements, site surveys, and similar activities. In such cases, the analyst himself becomes a primary source of data.

On the whole, engineering analysis tends to place the heaviest emphasis on measurement and creation of data. As a general rule, economic, financial, and sociopolitical analysts are able to put secondary sources to the greatest use. All types of analysis draw significantly on primary sources, however. Differences in emphasis on data sources are of significance to the design of particular study categories. Data implications for each of the four principal types of studies are discussed in Section C of Chapter Three.

3. Forecasting Methods

Chapter Four deals with four forecasting methods which are pertinent to telecommunications studies in developing countries.

a. Historical Trend Extrapolation

Historical trend extrapolation is the most widely used of the various forecasting methods. Analysis of extensive historical data shows that the extrapolation method may lead to misleading conclusions unless the analyst has a substantial amount of historical data available, and is keenly aware of special factors which may influence traffic in given periods.

b. Correlation Analysis

Correlation analysis is a tool for studying the statistical relationship between two or more variables so that the value of one variable can be predicted on the basis of one or more other variables. It is sometimes possible to find good correlation between total international trade and total international telecommunications traffic in developing countries. However, researchers to date have had only occasional success in applying correlation analysis to trade and telecommunications on a route-by-route basis in developing countries.

c. Gravity-Potential Models

Gravity-potential models represent a mathematical approach for evaluating various interactions between masses of population as these interactions vary with the distance between population masses. Quantitative relationships may be established among distance, population size, and telecommunications flows on the basis of modest amounts of data. The principal advantage of the method is that instead of trying to find a correlation between telecommunications data and general economic data, the analyst can focus attention on what appears to be a fundamental relationship between population masses, distance, and telecommunications services. Additionally, forecasts can be made for routes for which little or no historical telecommunications data exist.

d. Impulse Jumps

On many world routes, and particularly on those of

developing nations, for example, historical traffic trends may reflect limitations on the capacity and quality of existing circuits rather than the underlying telecommunications demand which would exist if sufficient high quality circuits were made available. When new and improved facilities, such as submarine cables or earth stations, are installed, the traffic volume typically exhibits a sharp and permanent increase. These effects are explained by the fact of the existence of a certain amount of "suppressed demand." This phenomenon may also be explained on the basis that improved facilities provide customers with essentially "new" types of services, i. e., those which are more prompt and of higher quality. Recent historical trends in international traffic, therefore, are regarded principally as an indication of the growth of capacity and quality of telecommunications facilities.

No comprehensive and rigorous study of telecommunications impulse jumps in developing countries presently exists. Hence, researchers are constrained to employ methods of qualitative analysis in determining approximate values of anticipated impulse jumps in a given study region, as well as in evaluating the ~~limited quantitative data~~ which may be available in situations which are believed to be analogous. One way to gain insights into the magnitude of the impulse jump is to estimate suppressed demand by interviewing major telecommunications users, particularly users of ~~the international voice mode~~. A related procedure is to make independent forecasts of the growth of the activities of heavy users

of telecommunications. These procedures can inject a vitally needed sense of reality into a process which in some cases has been little short of a guessing game, drawing on historical precedents which have little in common with the circumstances from which forecasts are made.

e. Forecasting and Study Design

As an area of research, forecasting methods have perhaps received more attention than other elements of economic analysis in studies of telecommunications development. However, these materials are scattered, difficult to synthesize, and largely unevaluated. Telecommunications forecasting is sufficiently important to merit the development of a body of literature which would be readily available to the analyst. In essence, a treatise on forecasting methodology is required, followed by a continuing process of application and refinement. While the development of a treatise on forecasting is a substantial undertaking in itself, the process of application and refinement can be carried on within the framework of studies principally directed toward specific telecommunications programs and projects.

Forecasting is ultimately an exercise in judgment within a disciplined quantitative framework. However good the historical data, and however sophisticated the methods used to deal with these data are, the forecaster will be required to make assumptions and some out-and-out guesses. Wherever forecasts represent an important input to study

results, the study designer should require the analyst to identify those areas in which assumptions and intuitive judgments were made.

4. Selection of Technical Alternatives and Configurations

Chapter Five deals with the selection of technical alternatives and configurations, a process which lies at the heart of project feasibility studies. It is important for the designer of feasibility studies to have a good understanding of this process. In particular, the study designer should guard against the temptation to assume the nature of the desirable technical solution or to discard technical alternatives before such alternatives have been properly evaluated.

The objective of the technical analysis portion of telecommunications feasibility studies is to determine the most suitable technological means of meeting the projected demand for telecommunications. This technical analysis would be relatively straightforward if newer and more advanced means of communications simply displaced older means, but this is not the case. The advent of microwave and tropospheric scatter systems did not displace systems which depend upon wires and cables, rather, these systems now complement each other. Satellite communications was initially heralded as the death knell for submarine cables. Rather, these media are also likely to play complementary roles. Thus, new systems add to the complexity of the system selection process by offering a wider range of technical and economic choices than previously existed.

The system selection process consists of three well-defined steps: requirements analysis; formulation of technical alternatives; and cost analysis. These steps, however, are interrelated, and require several iterations before a firm system selection can be made. The formulation of technical alternatives, for example, may justify a re-examination of the initial set of requirements. Later, cost analysis may uncover a need for re-examination of a technical alternative in order to determine whether there are methods available which will be less costly.

The preliminary objective in systems analysis is to identify, in gross terms, those technical alternatives which warrant serious consideration. This is followed by a gross cost analysis. From this initial analytical cycle, certain alternatives may be discarded, while others emerge as valid candidates. These remaining candidates are then subjected to successive technical and economic analysis, which refine the technical detail and the costing accuracy to the point that a clear selection can be made and justified.

A summary of the principal characteristics of alternative types of telecommunications systems, their application to developing countries, and their approximate cost per channel mile, is contained in Section D of Chapter Five. It should be noted that these system types differ markedly in both performance and cost. There are also marked

differences in their normal application. Rules-of-thumb are useful for making general approximations as to the applicability of various systems to a given requirement, and the range of cost variation among applicable systems. It is emphasized, however, that costs, and even applicability, may vary widely in a specific situation due to local geographical or economic conditions, or the availability of appropriate technical skills.

The process of system selection is closely related to, and strongly influenced by, investment objectives. If, for example, an investment objective is to minimize capital expenditures, this could rationally lead to a system design incorporating less sophisticated and less costly equipment, or the use of leased facilities in preference to purchased facilities. Such a choice could, on the other hand, result in higher total costs, since increased operating and maintenance costs may result.

In some instances, telecommunications studies have been made in which economic or financial projections were to be extended only a few years beyond commencement of operations. While this procedure may be suitable for determining whether a project will break even financially, it also may seriously distort conclusions regarding adequacy of the chosen system or its viability relative to that of other systems, since cost and system capacity factors were not evaluated over the full economic lifetime of the system. It is recommended that all telecommunications studies consider design features and economic factors over the expected

lifetime of each system alternative. The ultimate design adequacy cannot usually be verified over a shorter period.

In telecommunications studies which are restricted to one sector of a national communications structure (such as long lines transmission systems, or central telephone exchanges), the improvement or expansion program recommended for the selected sector may be dependent upon related improvements in other portions of the telecommunications system. The usefulness of such studies may prove to be limited, unless the terms of the study are carefully constructed. Hence, it is suggested that telecommunications studies, centered on one sector of an overall national telecommunications system, also include adequate investigation of the needs and methods for obtaining correlative improvements in sufficient scope to support the recommendations made.

Most telecommunications feasibility studies involve field surveys in the host nation, and direct contact with local governmental telecommunications planners. These local officials usually have a keen interest in the project and strong feelings regarding the technical features of planned improvements. They will, of course, ultimately exercise considerable influence over implementation of study recommendations.

There appears to be a need for some degree of prescribed uniformity as to liaison with local telecommunications representatives. They should be "brought into the picture" at appropriate checkpoints along the way,

e. g. , to review traffic forecasts, to review the requirements base developed for analysis of system alternatives, and for consultation on recommendations prior to their publication. The usefulness of the study would be enhanced thereby, if only because the attitudes of these officials toward possible telecommunications improvements can be taken into account in formulating study conclusions. It is recommended that mention be made of the nature and conditions of such liaisons in requests for proposals for future studies.

While most system studies require the objective analysis of system alternatives, the level of analytical detail to be included in the study documentation is not always clearly defined. It is suggested that study documentation be specified to include a summary of the analysis of alternatives in sufficient detail to justify the choice on technical, operational and economic grounds. Analytical detail beyond this point may be of special interest to engineers and economists, but would neither aid in decision making nor reduce study costs.

5. Rate Structure Analysis

Chapter Six discusses rate structure analysis. The underlying purpose of a telecommunications rate structure is to set the market price for telecommunications services. A rate structure also serves as a principal determinant of the amount of revenues which will be received from telecommunications services.

Public utility rate-making principles constitute a body of theory and practice which is particularly useful in analyzing telecommunications rate structures. These principles have received their fullest refinement in situations where a monopoly owned by private interests is subject to government regulation. A basic principle of rate making is that rates should produce sufficient revenues to allow an efficient organization to obtain a fair rate of return on investment. In general, rates for individual services should reflect the costs of these services, except that some modifications may be made to take into account social, political, and economic considerations.

International services in many developing countries are priced so as to be far more profitable than domestic services. Economists whose thinking is conditioned by experience in industrialized nations may tend to look with disfavor upon this practice. It should be recognized, however, that the pattern of relying upon international transactions as a primary source of revenues with which to finance internal development is a common one in developing countries. It is believed that the telecommunications rate structure of developing countries should be evaluated with the specific circumstances of each developing country firmly in mind. Public utility rate-making principles provide a useful framework within which to analyze the problem, but recommendations as to changes in rate structure should take full account of the nature of development processes.

A study of international rates usually requires the analysts to examine a broad range of criteria and techniques for establishing rates and revenue splitting arrangements, including rate-distance formulas, sender-keeps-all arrangements, channel leasing arrangements, concessionaire arrangements, multilateral preferential arrangements, and frontier arrangements. These criteria and techniques are discussed in Section C of Chapter Six.

Analysis of international rate structures involves, in addition to factors common to domestic rate structures, international revenue sharing arrangements based upon each country's individual requirements, preferences, and international relationships. The purpose of revenue sharing arrangements is to provide an equitable method for apportioning the cost of transmitting telecommunications between sender, receiver, and intermediary countries. Many factors enter into revenue sharing arrangements, making it unsound to generalize as to the most appropriate sharing method. Considerations of national interest and political relationships are often critical to a sound solution.

Rate structure analysis, although it may be discussed simply in terms of its fundamentals, is an extremely complex field. It often requires the combined efforts of telecommunications administrations, regulatory bodies, international organizations, and rate structure analysts for sound and comprehensive recommendations.

An additional complicating aspect of rate structure analysis is that there are substantial variations in rate structures and revenue sharing arrangements throughout the developing world. Anomalies exist in rate structure patterns prevailing among countries, as well as within the national rate structures of individual countries. Rate structure and revenue sharing problems constitute a significant impediment to regional cooperation among developing nations. They also constitute an area in which study could provide valuable contributions to both national and international telecommunications cooperation and development, and future telecommunications studies. In any case, a thorough international rate structure analysis will generally be crucial to a sound study of the telecommunications development of an international region. Determinations of interregional rate structure consistency, and comparative analysis of the rate structures of other countries and regions will, at a minimum, be required, and will of themselves involve substantial effort. If an in-depth examination of the regional international supply, demand, and pricing relationships are ultimately required, the level of effort involved will be magnified many fold, and could appropriately constitute a large study in itself.

6. Methods of Economic and Financial Evaluation

Chapter Seven deals with four methods of economic and financial evaluation: cost-effectiveness analysis; public utility analysis; cost-benefit analysis; and business investment analysis.

Cost-effectiveness analysis is concerned with either maximizing system effectiveness at a given level of cost, or minimizing costs at a given level of system effectiveness. In the latter case, the principal problem in regard to effectiveness is defining the job to be done accurately in order that cost comparisons present meaningful alternatives. In the former case, a quantitative measure of effectiveness is required in order to compare competing systems in terms of a fixed cost. Cost-effectiveness analysis is closely associated with techniques of systems analysis.

Cost-effectiveness analysis is subject to limitations when used in analyzing projects involving commercial telecommunications services. First, it is designed to compare dollar costs with non-monetary quantitative units, and avoids direct comparisons of dollar costs with dollar revenues or benefits. Thus, it stops at least one step short of coming to grips with the ultimate problem of evaluating revenue-generating projects. Second, in its application to feasibility studies, cost-effectiveness analysis is largely dependent on the establishment of a fixed number of "requirements". In fact, the costs of filling anticipated requirements may necessitate a revision of rates which will, in turn, affect the magnitude of requirements. This problem, which is a familiar one to the public utility economist, may prove quite difficult for a cost-effectiveness analyst to handle by use of conventional techniques.

Public utility analysis is concerned with the economics of monopolies which are regulated in the public interest. It deals with rate-making principles, capital structure, service adequacy, rates of return on investment, and other aspects of business operation. In the telecommunications field, many public utility analysts are accustomed to dealing with a fairly conservative industry whose present requirements and future prospects are reasonably clear. As a body of doctrine and practice, public utility analysis tends to be slow in coming to grips with circumstances in which rapid and fundamental changes occur in system parameters. Unlike cost-benefit analysis, public utility analysis does not seek to measure benefits external to the telecommunications administration; its principal concern is with relationships existing within the telecommunications administration itself.

Cost-benefit analysis seeks to identify benefits and costs wherever they may occur in the economy. It looks beyond the telecommunications agency to a project's quantitative impact on the entire nation. It is concerned ultimately with the effect which a proposed investment will have on the national income of the country in which it is made.

Cost-benefit analysis provides a broad and comprehensive framework for evaluation. There are, however, several problems associated with cost-benefit analysis. First, there is the difficulty of quantifying, in dollar terms, the "external economies", that is, the economic impact of the project outside of the telecommunications agency involved. This

problem is considered in Chapter Nine, "Telecommunications Development and Economic Growth". Second, the use of both public utility rate analysis and cost-benefit analysis in projects of large magnitudes can lead the evaluation in a circle. Thus, if: (1) telecommunications rates are established on the basis of a "fair rate of return on investment" as established by the rate analyst; (2) the investment in the proposed project strongly influences the specific rates set for the specific services which it is to provide; and (3) the revenues from the project constitute all or a large proportion of the revenues which are taken into account in the time-phased evaluation by the cost-benefit analyst; a tautological result will follow. The "fair rate of return" calculated by the rate analyst at the start will largely determine the cost-benefit analyst's results at the end. In effect, project evaluation becomes little more than a self-fulfilling prophecy. Third, there is a continuing debate among theorists and practitioners as to which method is most appropriate for converting time-phased streams of costs and benefits into a meaningful evaluation criterion. The three most important types of cost-benefit methods -- benefit-cost ratio, net present value, and internal rate of return -- are discussed in Section D of Chapter Seven.

Business investment analysis is a way of assessing the financial performance of an organization, and is a method of determining requirements for loans or grants from appropriate funding sources. It may also be used as a project evaluation alternative to cost-benefit analysis if

cost-benefit analysis proves to be too unwieldy in a given situation.

Business investment analyses are necessary in order to determine the financial viability of operating agencies and the financial status of the related development project. While many facets of financial structure can be probed, an in-depth profile of the overall structure may be constructed through the use of three different pro forma statements. These are the income statement, the balance sheet, and the sources and uses of funds statement, also called, or closely related to, funds flow or cash flow statements. Each of these pro forma statements is discussed in Section E of Chapter Seven.

Ideally, a telecommunications study should include full elaboration of all four types of analysis. However, time and funding constraints often prevent this. Consequently, study designers are often faced with the critical problem of selecting for inclusion in a scope of work a limited analytical framework, which must, however, be adequate in light of the following considerations:

- How many system alternatives requiring evaluation are likely to emerge from the study;
- What analytical scope and level of detail is required for adequate evaluation; and
- Are personnel with the full range of skills available?

To frame a meaningful scope of work in the light of these considerations, the designer should have a keen appreciation of the state of the art and the practical requirements of the various kinds of analyses. Unless substantial resources are available for the purpose, for example, it may not be prudent to require intensive analysis of external benefits in a cost-benefit analysis. Nor is it reasonable to expect that a project requiring investment on the part of several nations will not require substantial attention to rate structure problems. Another important consideration is that cost-effectiveness analysis and business investment analysis provide hard and useful insights into the circumstances facing telecommunications administrations in developing countries, and that the theoretical advantages of other forms of analysis should not be allowed to divert attention from these insights.

7. Telecommunications and the Socioeconomic Environment

Chapter Eight deals with socioeconomic factors which affect telecommunications development.

Vast changes have occurred in the developing nations over the past thirty years. The pace of change should accelerate during the remainder of the century, as the developing nations take significant steps toward industrialization and as they experience more acutely the cultural and economic impacts of modern technology.

The developing countries may be expected to attempt to telescope these processes of technological and social change, which have occurred somewhat more gradually in industrialized states. These processes will be accompanied by requirements for the development of many types of telecommunications systems.

The developing nations are presently characterized by suppressed demand for "single destination", as distinguished from "mass", communications modes. Single destination modes include telephone, telegraph, telex, and other services which are essentially used to transmit information from an origin to an individual destination or to allow simultaneous transmission between two points.

To the extent that the drive toward an industrial society, with its related business, professional, and service requirements is successful, it will accelerate the use of, and need for, greatly expanded communications services. Telecommunications requirements will grow in volume, quality, and sophistication as population grows, as wealth increases, and as society becomes more complex. The outlook is for increasing investment in telecommunications, both on an aggregate and per capita basis.

The age of mass communications has arrived in industrialized nations. Mass communications include newspapers, magazines, radio, and television. The two latter media may be considered as "broadcasting"

or "mass telecommunications". The impact of mass communications is just beginning to be felt among the developing nations. A significant and continuous development of mass telecommunications may be anticipated in the next decades among these nations.

A perceptive telecommunications analyst will examine the ethnic composition of a telecommunications organization in order to determine whether the organization is recognizing talent wherever it may be found, or whether it is confining its source of talent to specific tribal or social elements. An organization which places a premium upon talent, wherever it is found, will generally prove to be more efficient than one which is more restrictive in developing talent. On the other hand, ethnic factors may cause difficulties in a telecommunications organization, or may deprive it of talent which it has already developed. The telecommunications analyst's task in such a case is to examine the possibilities of ameliorating the difficulties, or of predicting the future course of events and suggesting alternative sources of talent.

It often occurs that while some telecommunications services are very profitable, others are barely paying for themselves, or are even operating at a loss. In developing countries, the latter is often the case with inland telegraph, interurban telephone, and even urban telephone services in small population centers. The provision of telecommunications development in remote or newly opened areas may be deemed an important societal objective, even though such service is far from

profitable. Such factors should be taken into account in analyzing the total pattern of a telecommunications organization's rates and revenues.

Traffic analysts often find considerable differences in patterns of modal usage among developing countries. The differences may be attributable in part to cultural preferences. For example, certain ethnic groups may attach great importance to a paper copy of a message, or perhaps require it in order that a message, in a foreign language, can be translated at leisure. On the other hand, another societal group may distrust record communications because of deep suspicions that unless a sender can ascertain that a communication has been delivered, the telecommunications administration will have no reason to deliver it.

A telecommunications study which is well designed and executed can yield basic data of value beyond that pertaining to telecommunications development alone. Insights into the basic political structure of a country can be strengthened by an examination of the ethnic and regional structure of the telecommunications organization. Perspectives on social and economic relationships among areas within a country can be derived from an analysis of the magnitude and composition of telecommunications traffic. A thorough knowledge of telecommunications development can clarify factors of critical importance to analysts of the social, economic and political growth of a nation, and suggest new insights into the dynamics of developing societies.

8. Telecommunications Development and Economic Growth

Chapter Nine deals with the contribution which telecommunications development makes to economic growth. In practice, there has been little success in attempting to quantify the relationships between a particular project and growth of national income in developing nations. This is unfortunate, since it is apparent that telecommunications often contributes significantly to economic development. A quantitative formulation of this relationship would aid in developmental planning.

The role of telecommunications in economic growth may be approached from several directions, including consideration of telecommunications as:

- A precondition for attaining self-sustaining economic growth;
- An element of infrastructure;
- A competitor for scarce resources;
- An important input to the outputs of key users; and
- A component of gross national product.

Each of these approaches is discussed in Section B of Chapter Nine.

The problem of relating telecommunications development to economic growth in quantitative terms is one of the most challenging areas of telecommunications analysis, both in terms of its theoretical complexity and its practical importance. It is not a small problem and it is not realistic to suppose that it can be addressed in all its implications

within the scope of any of the four principal types of studies discussed in this report. A feasibility study can, as part of a market analysis, discover some potential savings and economic opportunities likely to result from a given project, and it can also make modest contributions to theory and practice in the area. However, for a thorough evaluation, designers of telecommunications studies are faced essentially with two choices. First, they can mount a major effort to solve the problem by means of a separate study addressed solely to this purpose. Second, they can seek to achieve a steady growth in knowledge from study to study by requiring analysts to review previous research and to devote specific amounts of effort to testing hypotheses designed to advance the state of the art in this important area.

9. Regional International Organizations

Chapter Ten deals with the role of international regional organizations in telecommunications development, and gives particular emphasis to lessons learned from Checchi studies of African telecommunications.

Regional integration in the field of telecommunications often has substantial technical and economic advantages. However, a number of difficulties stand in the way of such integration, including problems of international regional organization.

It should be clearly understood that regional integration and regional organization are not identical. It is possible to have an

integrated telecommunications network shared by several countries without establishing an international organization to own and operate the network. Conversely, a regional telecommunications organization can remain in existence for considerable periods of time without successfully achieving an integrated regional network.

An analysis of telecommunications-related organizations in Africa may suggest that such organizations fall into three categories: (1) world-wide and continental organizations; (2) "hard" regional operating organizations; and (3) "loose" regional affiliations of countries which have, or are contemplating, telecommunications agreements in limited areas.

World-wide and continental telecommunications organizations in Africa include the Economic Commission for Africa (ECA), a United Nations body created by the Economic and Social Council in 1958 as one of its four Regional Commissions. It is dedicated to the promotion and planning of African economic and social development through cooperative and regional action by African states. It is presently working with the International Telecommunications Union (ITU) in developing African telecommunications networks and was instrumental, along with the ITU, in the recent, successful completion of the pilot link between Addis Ababa and Abidjan.

The ITU is the international organization responsible for technical standards, frequency registration, and other technical matters related to

telecommunications. It also supports developing countries in establishing their facilities by giving various kinds of assistance.

The Organization of African Unity (OAU) is an African organization devoted to cooperation in all fields. Like the ECA, it has as members all the independent African countries except South Africa. The OAU has actively sponsored regional economic cooperation, and although it is not specifically telecommunications oriented, it cooperates with the ECA and ITU for telecommunications purposes.

The ECA, ITU, and OAU, although effective in providing assistance, are not designed to be telecommunications operating agencies.

There is presently in Africa only one operating "hard" regional telecommunications organization. This is the common telecommunications administration of Kenya, Uganda, and Tanzania which operates corporately as the East African Posts and Telecommunications Corporation, and which is an integral part of the East African Community (EAC). The EAC is much more than a telecommunications organization. It is, in addition, a common market under which there is planned to be, among other things, a common external tariff and internal freedom of transit. The EAC has also undertaken to harmonize monetary policies among its members.

Another African organization, the Transequatorial Communications Agency (ATEC), was organized to be responsible for the maintenance of international surface communications among the Central African Republic, Chad, Congo (Brazzaville), and Gabon. However, ATEC has apparently not fully accomplished this purpose.

African organizations which are involved with regional telecommunications, other than the East African common telecommunications administration, may be termed "loose" affiliations. To date, their contributions to regional telecommunications growth in Africa have been limited. Such organizations include the Organisation Commune Africaine et Malgache (OCAM), an organization of fourteen ex-French and ex-Belgian territories; Conseil de l'Entente, a regional organization within OCAM comprised of the Ivory Coast, Dahomey, Niger, Upper Volta, and Togo; the Regional Economic Organization of the Maghreb, an organization comprised of Algeria, Libya, Morocco, and Tunisia; the Union of Central African States (UEAC), an organization presently comprised of Congo (Kinshasa), the Central African Republic, and Chad, but with membership open to all African states; and the West African Regional Group (WARG), an organization still in the process of being created, comprised of Gambia, Ghana, Guinea, Liberia, Mali, Mauritania, Nigeria, Senegal, and Upper Volta.

The choice of the appropriate form of regional telecommunications organization, whether in Africa or elsewhere, requires a careful assessment of specific circumstances including political, economic, and social relationships as well as the nature of the regional telecommunications systems envisioned. A regional organization can be ineffective because it is too "hard" for the situation as well as because it is too "loose". A very careful evaluation must be made of the degree of underlying agreement which is present among regional neighbors, as well as the organizational

imperatives which may flow from an analysis of the characteristics of a particular regional telecommunications system.

The results of Checchi's African telecommunications studies suggest that the following considerations are pertinent to the design of future studies:

a. Importance of Regional Organizations

The designer of telecommunications studies should not, in general, attempt to prejudge the form which regional international organizational arrangements should take. In most instances, however, he will have enough information available to him to evaluate in advance the relative importance of this type of analysis to a given study. The technical characteristics of the telecommunications system to be evaluated, the number of countries in which it may be located, and the relative importance of regional traffic will normally provide good indicators of the importance of a regional international organization to the study results.

b. International Relationships

International political relationships between developing countries can be quite mercurial. Disputes may stem from disagreements over boundaries, differing orientation toward industrialized countries, or disagreements concerning internal political affairs. Like commercial air transport and postal relationships, telecommunications relationships

among neighbors may be isolated, to a degree, from political difficulties. Nevertheless, where international problems are of a longstanding or particularly bitter nature, they can complicate organizational arrangements with respect to regional telecommunications, and can require substantial analytical effort in order to formulate approaches to solutions.

c. The Relative Size and Importance of the Countries Under Study

An integrated network usually requires (1) agreement as to which nations are to serve as transit centers for their neighbors and (2) agreement on the part of some nations to accept a higher degree of dependence on the telecommunications systems of neighboring countries than would be the case with a non-integrated system. It is usually easier to work out such agreements between nations whose wealth, population, and telecommunications development are unequal than it is between nations of similar size. Small nations can more easily accept a position of dependence upon the facilities of a large neighbor than on a neighbor of equal size. Two large neighbors can be vigorous competitors for the prestige of providing central facilities, the more so because each may have the resources to proceed independently. Agreements between equals often call for hard and sophisticated bargaining, and will usually impact on organizational arrangements.

d. Geographical Location

The relationships between countries which are not contiguous will differ from those of countries which adjoin each other. Normally non-contiguous countries will be less willing to establish relationships of mutual dependence with contiguous countries. On the other hand, there may, in such cases, be fewer immediate irritations of the type which arise from proximity. On the whole, however, the more non-contiguous countries included in the study, the more difficult the organizational problems will be.

e. Organizational Problems

If the study designer perceives the existence of a significant problem of regional international organization, he should decide whether he wishes the analysis to (1) establish a framework within which the problem can be solved by the parties, and/or (2) suggest in some detail the nature of an organizational solution. In developing a scope of work, he should recognize that the details of an organizational solution are inextricably connected with the nature of the technical and financial arrangements which are made among the countries concerned. Moreover, developing detailed plans for regional organization requires activities on the part of the analyst which take on the character of preliminary negotiations. A two-phase organizational study should be considered in such circumstances. The first phase

would consist of the preparation of an economic, technical, and financial feasibility study which establishes the framework for an organizational solution, and relates it to other pertinent aspects of the proposed improvements. The second phase would commence after the principal interested parties had had an opportunity to review the study and to react to it.

Taking these reactions into account, the analyst would then be in a position to make detailed suggestions pertinent to bargaining realities, and which could expedite the process of achieving constructive results.

CHAPTER TWO

TYPES OF TELECOMMUNICATIONS STUDIES

A. INTRODUCTION

The purpose of this chapter is to discuss principal types of telecommunications studies.

Section B classifies four principal types of telecommunications studies.

Section C discusses the skills required for each of these types of studies.

Section D deals with composite and comprehensive studies, i. e., those which encompass two or more of the four principal study categories described in previous sections.

B. CLASSIFICATION OF STUDIES

There is a wide range of types of telecommunications studies. The content of a specific study will depend upon the specific decisions, types of systems, geographical areas, and substantive problems with which the study is concerned, as well as upon the level of effort envisioned and the deadlines established for study results.

Telecommunications research covers a very broad area. Any classification of studies inevitably contains omissions and arbitrary distinctions. This chapter focuses attention upon four study categories particularly appropriate for analyzing the need for international and other telecommunications systems in developing countries. These study categories are:

- Program surveys;
- Project surveys (prefeasibility studies);
- Project feasibility studies; and
- Engineering design studies.

A program survey¹ of international telecommunications is typically regional or continental in scope. It seeks to identify broad needs, program content, and order-of-magnitude costs. While some preliminary analysis and screening of projects may be included in a program survey, the study is designed neither to provide a basis for project funding, nor to define a scope of work for a detailed study of project feasibility. A program survey may or may not involve a brief visit to the country or countries studied for the purpose of obtaining data.

A project survey,² often called a "prefeasibility study," is designed to provide a preliminary assessment of the prospects for a given project and to define a scope of work for a detailed feasibility study. It usually involves a visit to the country or countries in which the feasibility study is to be conducted.

1 For examples of program surveys, see Checchi and Company, Study of the Application of Satellite Communications for Under-Developed Nations, Interim Report (NASW-1357) Washington: NASA, February 25, 1966; and Improving African Telecommunications During the Next Decade (PIO/T 698-6-6121066) Washington: AID, July, 1966.

2 For an example of a project survey, see Morcom Systems, Inc. Report on Telecommunications Survey of Ghana (AID/AFR-477) Washington: AID, May, 1967.

A feasibility study¹ is typically designed to provide a basis for decisions as to whether to install a given system. It includes technical descriptions of the project, but does not normally include site surveys or design work necessary for preparation of specifications. It may also be meant to serve as a basis for an application for financial assistance.

A preliminary engineering design study has as its objective the preparation of a bid package on which construction contractors may submit proposals. It normally includes site surveys, preliminary design work, and the preparation of specifications.²

It is important to note that the line between such studies is not fixed, and a given study may partake of aspects which are more characteristic of another type of study. Moreover, as discussed in Section D, composite or comprehensive studies can combine the elements of these studies in many ways.

C. SKILLS REQUIRED

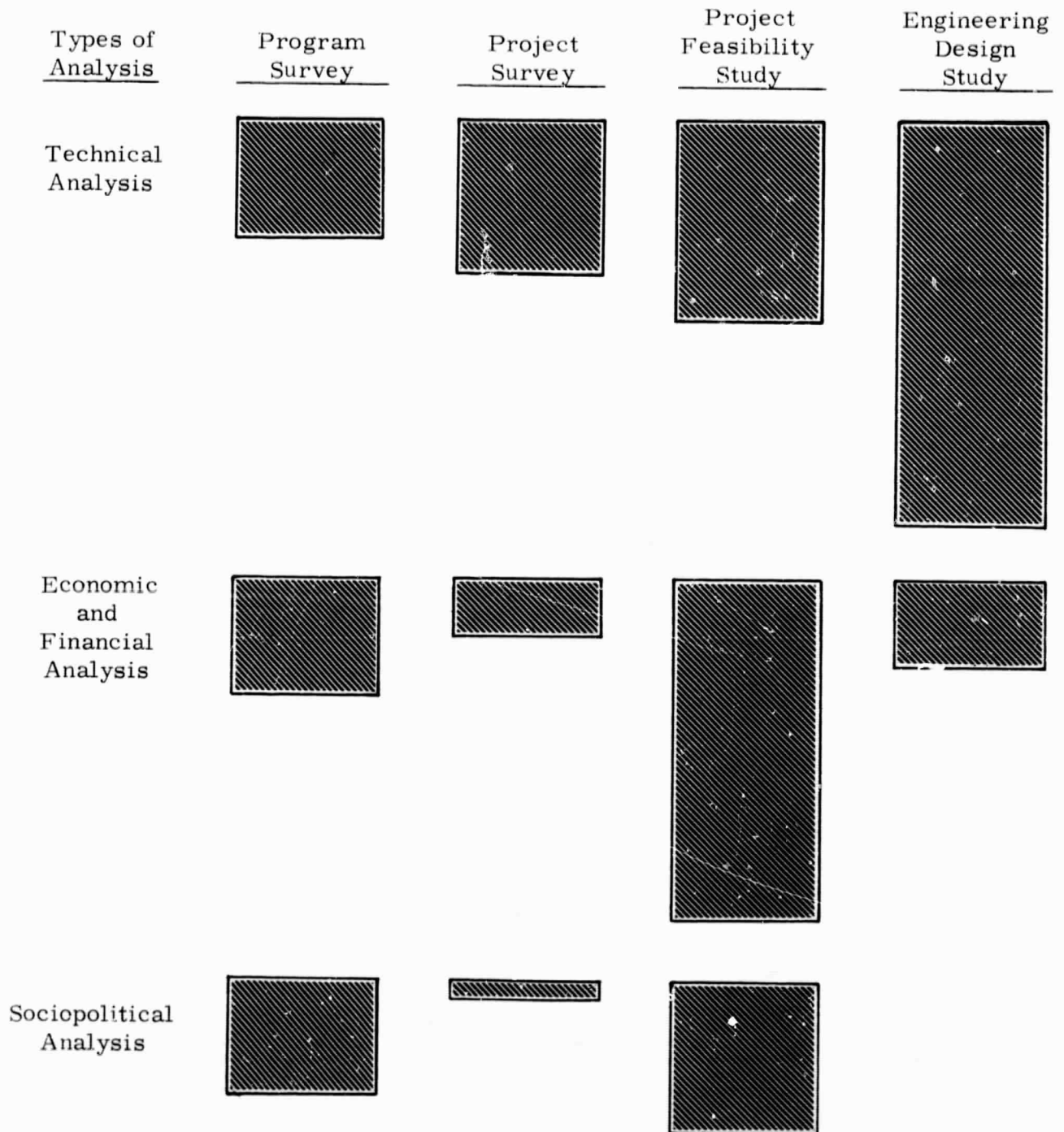
Exhibit One suggests in schematic form the balance of skills required to carry out the four types of studies discussed in the preceding section. It should be recognized that technical, economic, financial, and socio-

1 For examples of project feasibility studies see Checchi and Company, A Study of the Economic and Technical Feasibility of Improving Telecommunications in the Republic of Chad (AID/AFR-433) Washington: AID, May, 1967; A Study of the Economic and Technical Feasibility of Improving International Telecommunications in West Africa (NASW-1357) Washington: NASA/AID, October, 1968; and the Ethiopia Telecommunications Study (AID/AFR-522) Washington: AID, May, 1969.

2 For an example of a preliminary engineering design study, see Telcom, Inc. Site Survey Report for a Satellite Communications Earth Station (TER-132A) 1968.

EXHIBIT ONE

BALANCE OF SKILLS REQUIRED FOR FOUR PRINCIPAL CATEGORIES OF TELECOMMUNICATIONS STUDIES



Source: Checchi and Company

political analysis may involve overlapping areas of concern and expertise. Thorough traffic analysis and forecasting requires economic, financial, and engineering inputs. Traffic analysis is sometimes regarded as the province of economists and sometimes as the province of engineers.¹ In some borderline areas, it is fairly easy to work out a common approach among analysts of differing backgrounds; in others, accommodation is more difficult. For example, sociopolitical phenomena--which represent straightforward inputs to area specialists and which can be understood as "external constraints" or "intangibles" by economists--may be regarded by some telecommunications technicians as little more than manifestations of irrationality. Such phenomena are important to many studies, and methods must be found for giving them appropriate consideration in pertinent analyses.

The following subsections discuss the analytical skills required for each category of study discussed in Section B of this chapter.

1. Skills Required for a Program Survey

An important characteristic of an international telecommunications program survey is that there should be a fairly even balance between its technical, economic, financial, and sociopolitical analyses.

1 A discussion of the interaction of economic, financial, and technical analysis in connection with traffic data evaluation and forecasting is contained in Subsection 3 of this section.

The technical analysis portion of a program survey should include at least a characterization of the existing telecommunications systems in the area under study, and a preliminary analysis of the nature and scope of the improvements likely to be needed under the circumstances.

The economic and financial analysis portion of a program survey should, at a minimum, place order-of-magnitude costs on the kind of program needed. The sociopolitical analysis should assess the needs, and prospects for success, of international telecommunications development programs in terms of social and political relationships among the countries or groups of countries involved.

2. Skills Required for a Project Survey

A project survey, often called a prefeasibility study, is likely to be heavily oriented toward engineering considerations. It is most often concerned with preliminary determination of which types of telecommunications facilities are operating at capacity or are otherwise in need of improvement.

To the extent that a project survey addresses economic questions, it is likely to focus on expected traffic growth, on the financial circumstances of the telecommunications administration, or on a summary of existing economic and financial studies:

The sociopolitical analysis portion of a prefeasibility study is usually limited to an examination of factors which are pertinent to the effective operation of the telecommunications administration in the region under study. However, some project surveys may, because of existing special circumstances, be required to identify sensitive sociopolitical problem areas and/or to provide a rudimentary evaluation of the sociopolitical environment.

3. Skills Required for a Feasibility Study

An important characteristic of a feasibility study is that the elements of analysis, i. e., technical, economic, financial, and sociopolitical, should be effectively integrated into a meaningful whole to a much greater extent than is required in other types of studies. The interplay between the technical, and economic and financial portions of a feasibility study are intimate, and generally involve several analytical iterations before telecommunications projects which are technically, economically, and financially feasible are developed.

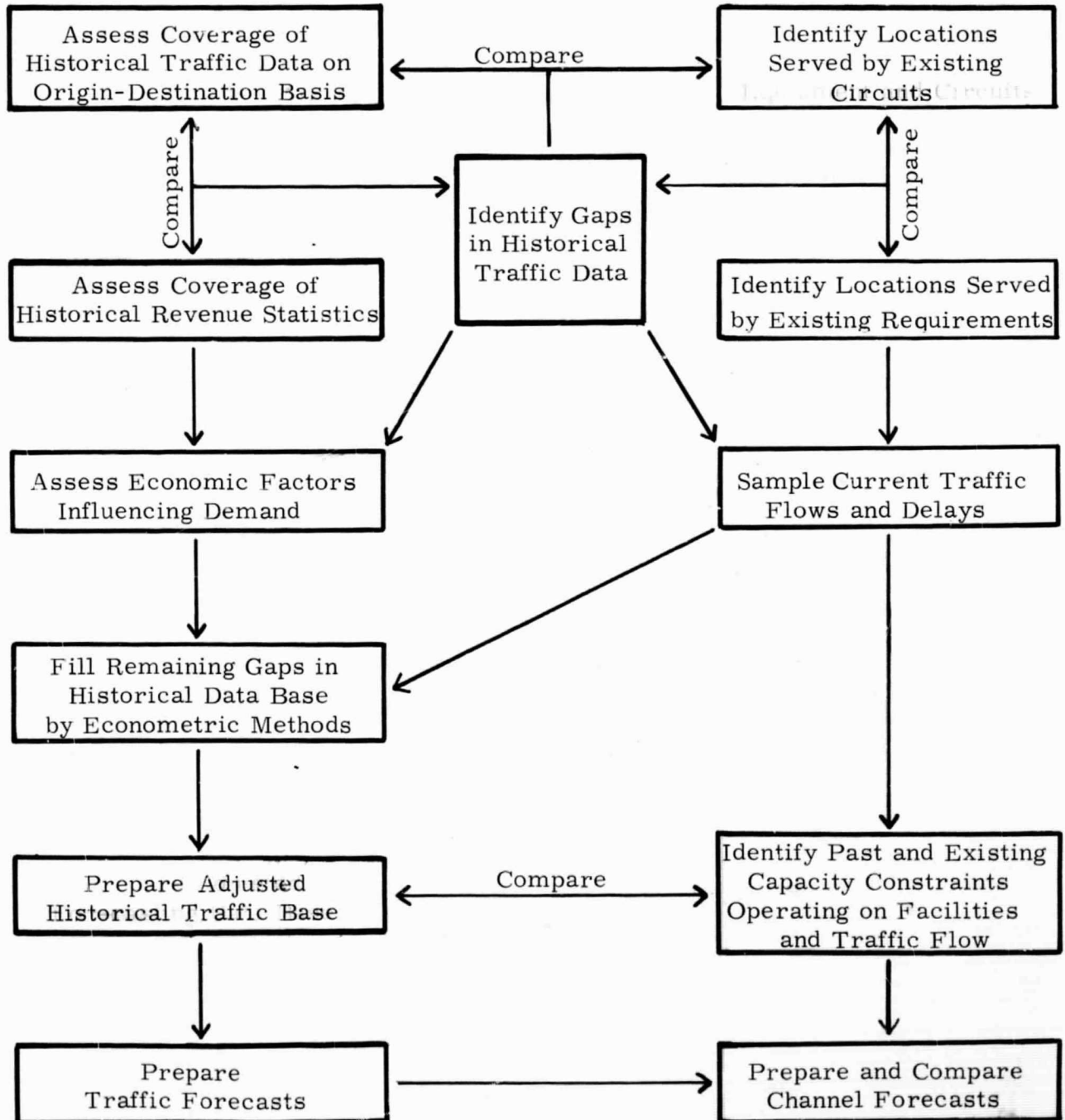
This interplay is illustrated in Exhibit Two, which shows some of the interaction between economic-financial analysis and technical analysis in evaluating traffic data and preparing forecasts. When a telecommunications agency first provides analysts with data on historical traffic, revenues, equipment, and circuits, the compilations may appear

EXHIBIT TWO

TRAFFIC DATA EVALUATION AND FORECASTING:
SOME ANALYTICAL INTERACTIONS

ECONOMIC-FINANCIAL ANALYSIS

TECHNICAL ANALYSIS



to be quite complete. However, as these data are compared with each other, a number of gaps and inconsistencies may appear. Such a comparison may show:

- Traffic flows for which there are no identifiable revenues;
- Revenues for which there are no identifiable traffic flows;
- Circuits or equipment for which there are no identifiable traffic flows or revenues; and
- Traffic flows or revenues for which there are no identifiable circuits or equipment.

Such a review may also show, among other things, that traffic records are incomplete and that the historical data base must be filled out by estimating procedures. If data gaps are identified early in a field survey, information usable for such estimates may be obtained by sampling traffic volumes for particular routes. Sampling can, however, prove to be an expensive and time-consuming procedure. A second useful source of information for estimates may be broadly described as assessment of economic factors influencing telecommunications demand. Such assessment includes interviews with users of telecommunications services, comparisons of traffic magnitudes with economic phenomena, and other econometric analyses. Interviews with telecommunications users are normally designed to identify relationships between telecommunications service, cost savings, and economic growth. They can,

however, provide insights into traffic magnitudes or particular routes. Comparisons of traffic magnitudes with economic phenomena are normally used for forecasting traffic in a network of origin-destination nodes and traffic flows. They can also be used to "complete the historical matrix" when some flows are missing. Other econometric methods can also be used to estimate missing data on the basis of whatever historical information is available.

Once an adjusted historical traffic base has been established, it should be double-checked against technical estimates of system capacity constraints to make sure that technical and economic findings are consistent. Such a comparison is also extremely important in that it throws considerable light on the meaning of past trends in historical traffic. If portions of a system have been at capacity for some time, modest historical growth rates may not reflect the underlying demand.¹

It is important to understand that a procedure such as the one described previously may involve several iterations among economic and technical analyses, and that serious anomalies may not become apparent until the final stages of the process. For example, as forecasts are used

¹ See Chapter Four for the discussion of a related phenomenon, the "impulse jump."

for purposes of system design, it may become apparent that locations for which traffic forecasts have not been made should be included in the system, thus retroactively creating data requirements which were not originally envisioned. Similarly, the comparison of channel forecasts with other channel forecasts made by previous studies for a particular route or system may reveal, at the end of the entire process, difficulties in the underlying data which were not seen at the beginning. In addition, a number of elements of comparison, such as revenue or circuit analysis, will be themselves subjected to comparative analysis for purposes other than traffic forecasting, again yielding new insights into the adequacy of the traffic data base. A project feasibility study in a developing country should be designed as a fairly intricate series of checks and balances to assure that all pertinent factors are taken into consideration and that consistent treatment is accorded to each of these factors. An adjustment in one portion of the "study system" will inevitably require changes in other elements of the analysis.

Sociopolitical analysis is of great importance to studies of regional telecommunications links. Here the relationships among countries can have significant impact on technical options, rate structures, revenues, and forms of organization. Even in the case of national studies, however, such considerations may be important. For example, there appears to be marked differences among ethnic groups in their proclivity to use voice and

record modes. This phenomenon should be taken into account for purposes of traffic forecasting. Sociopolitical factors can also have important implications for the form and internal structure of a telecommunications agency. While sociopolitical inputs are likely to be less quantitative than other inputs, they may nevertheless have an impact on the quantitative outputs of the study as an integrated whole.

The balance in the kinds of skills needed for analysis of project feasibility will vary somewhat from study to study. It is believed, however, that feasibility studies represent the study category to which economic and financial skills are most clearly critical.

4. Skills Required for Engineering Design Study

An engineering design study is heavily technical in nature. It is primarily concerned with the development of specific technical components for the proposed telecommunications system. A significant portion of such a study may involve the application of engineering economics, or "cost-effectiveness" analysis, to determine the most desirable engineering solution.

D. COMPOSITE AND COMPREHENSIVE STUDIES

The types of studies discussed in the previous sections may be combined in a number of ways. For example, a program survey may pinpoint several areas in which telecommunications projects would have a high likelihood of utility, and continue directly into prefeasibility studies of

such projects. Likewise, a feasibility study may proceed directly to the preliminary engineering design study of the projects determined to be feasible.

A comprehensive nationwide or even international telecommunications approach could include all four types of studies under its aegis, with perhaps one major contractor overseeing the entire program, and subcontractors responsible for portions of the program.

In a comprehensive program, the program survey would likely include a comprehensive overview of the nation or international region under study in preparation for a more detailed project survey. The project survey (or prefeasibility study) would screen out candidate projects for even more detailed project feasibility studies. Projects determined to be feasible would then be rated according to priority of installation, and preliminary engineering design studies would begin according to the priority.

Telecommunications systems, especially, are particularly amenable to a comprehensive and integrated system evaluation, as distinguished from piecemeal analysis. An integrated program may be more cost-effective than a series of separate studies designed to serve the same end.

The principal disadvantage of composite or comprehensive telecommunications studies is that they lodge responsibility in a single organization for study elements requiring different mixes of skills and essentially different

approaches. Placing responsibility in different organizations for successive studies provides more assurance that recommendations have been scrutinized from a number of pertinent viewpoints and are soundly and objectively based.

CHAPTER THREE

ADEQUACY OF THE TELECOMMUNICATIONS DATA BASE

A. INTRODUCTION

The purpose of this chapter is to discuss the adequacy of the data base for telecommunications studies in developing nations.

Section B deals with deficiencies in the existing data base.

Section C identifies data requirements and sources for principal categories of telecommunications studies and types of analyses. It also discusses the implications of data problems for study design.

B. DEFICIENCIES IN THE DATA BASE

A problem characteristic of developing countries is the absence and unreliability of basic statistics. This problem stems from a variety of sources. First, there may be a fundamental lack of appreciation of the importance of accurate quantitative measurement. Attitudes toward measurement stem from deep-seated cultural causes, as well as from other causes.

One of Africa's most effective telecommunications administrations draws its technical trainees from the most accomplished group of the nation's high school graduates. Yet, it starts their training with a simple course in the importance of measurement. Trainees are required to construct wooden frames according to a simple set of dimensions.

The lesson which it seeks to impart is that the task to be accomplished by the technician is not one of individual expression or craftsmanship, but one of performing within the discipline of a quantitative framework. This fundamental lesson is often a very difficult one to impart in societies in an early stage of development.

A more immediate cause of data deficiencies is lack of funds. Telecommunications agencies and other organizations are often subject to severe financial constraints. The data base is neglected in favor of more urgent requirements. Eventually, the statistical base becomes so unreliable as to become a critical problem in itself.

A third and related cause of data problems lies in the reliability of the procedures by which data is gathered and compiled. A careful review of basic records may reveal that information has been lost, omitted through inadvertence, misconstrued, improperly totaled, or otherwise rendered unusable. In some instances, a careful analysis may suggest the possibility that deficiencies are attributable to the misuse of funds.

A fourth source of difficulty is the failure on the part of many organizations in developing countries to subject their data to comparative analysis. Related data series may prove inconsistent when checked against each other. A study which draws on related series will reach anomalous conclusions unless inconsistencies are identified and resolved.

In the area of international traffic statistics, national telecommunications agencies may maintain records of traffic with each other which differ dramatically. For example, during Checchi's West African telecommunications study,¹ it was discovered that Nigeria's statistics indicated 245,414 words of incoming and outgoing telegraph traffic with the Ivory Coast in 1965, while the Ivory Coast reported, for the same year, only 138,778 words with Nigeria. Similarly, Ghana showed 934 telephone calls with Togo in 1966, while Togo reported 2,152 calls. In a number of instances, these countries were unable to provide complete data. Dahomey submitted no data on traffic with Ghana. The Ivory Coast submitted information only on traffic with Nigeria, Togo, Dahomey, and Ghana. Ghana reported only outgoing telegraph traffic.

This phenomenon of inconsistent data is reflected, and sometimes compounded, in secondary data sources. For example, the ITU compiles data annually on telephone, telegraph, and telex traffic for all countries which file reports with it. It has also periodically prepared traffic matrices² showing rationalized bilateral traffic flows between

1 Checchi and Company, A Study of the Economic and Technical Feasibility of Improving International Telecommunications in West Africa, (NASW-1357) Washington: NASA/AID, October, 1968.

2 See, for example, the International Telecommunications Union, General Plan for the Development of the International Network, 1963-1968, Geneva: 1964 (The Rome Plan), and the General Plan for the Development of the Interregional Telecommunications Network, 1967-1970-1975, Geneva: 1968 (The Mexico City Plan).

countries for specific years. As a general matter, analysis suggests that these matrices are sometimes based upon mutually agreeable estimates rather than upon rigorous analysis. This lack of rigor was apparent during the preparation of Checchi's Minimum African Program report.¹ It was found at that time that significant anomalies appeared when the ITU's annual traffic figures for individual countries were compared with the Rome Plan breakdowns. It is believed that a greater degree of rigor in preparing international traffic matrices is necessary and desirable. There is a substantial opportunity for international organizations to undertake a rationalization of such statistics by methods analogous to those used to rationalize statistics on international trade.

It is a serious mistake, but a common one, for analysts to accept a telecommunications agency's data as accurate without extensive comparison and confirmation. Much the same can be said for any source of information in developing nations on which study results are dependent.

It is particularly important for analysts who have not had prior experience in developing countries to understand that dealing with data deficiencies is a central part of their work. The analyst must be cautious and skeptical, without being overwhelmed by uncertainties which he inevitably will confront. Solving data problems can be one of the most challenging

1 Checchi and Company, Study of the Application of Satellite Communications for Under-Developed Nations, Interim Report (NASW-1357). Washington: NASA, February 25, 1966.

and satisfying tasks in a telecommunications study. A properly evaluated and adjusted data base can in itself constitute a significant contribution to the cause of telecommunications development.

Opportunities for improving the telecommunications base may arise in many ways. For example, a pilot HF circuit project providing service between Ethiopia and the Ivory Coast, constructed with the support of the United Nations Special Fund and the ITU, is designed not only to establish commercial services between the two countries, but also to obtain valuable traffic statistics to be used as a guide to the viability of similar circuits in Africa. Imaginative project planning can thus serve to improve the telecommunications data base, as well as to provide new and higher quality service.

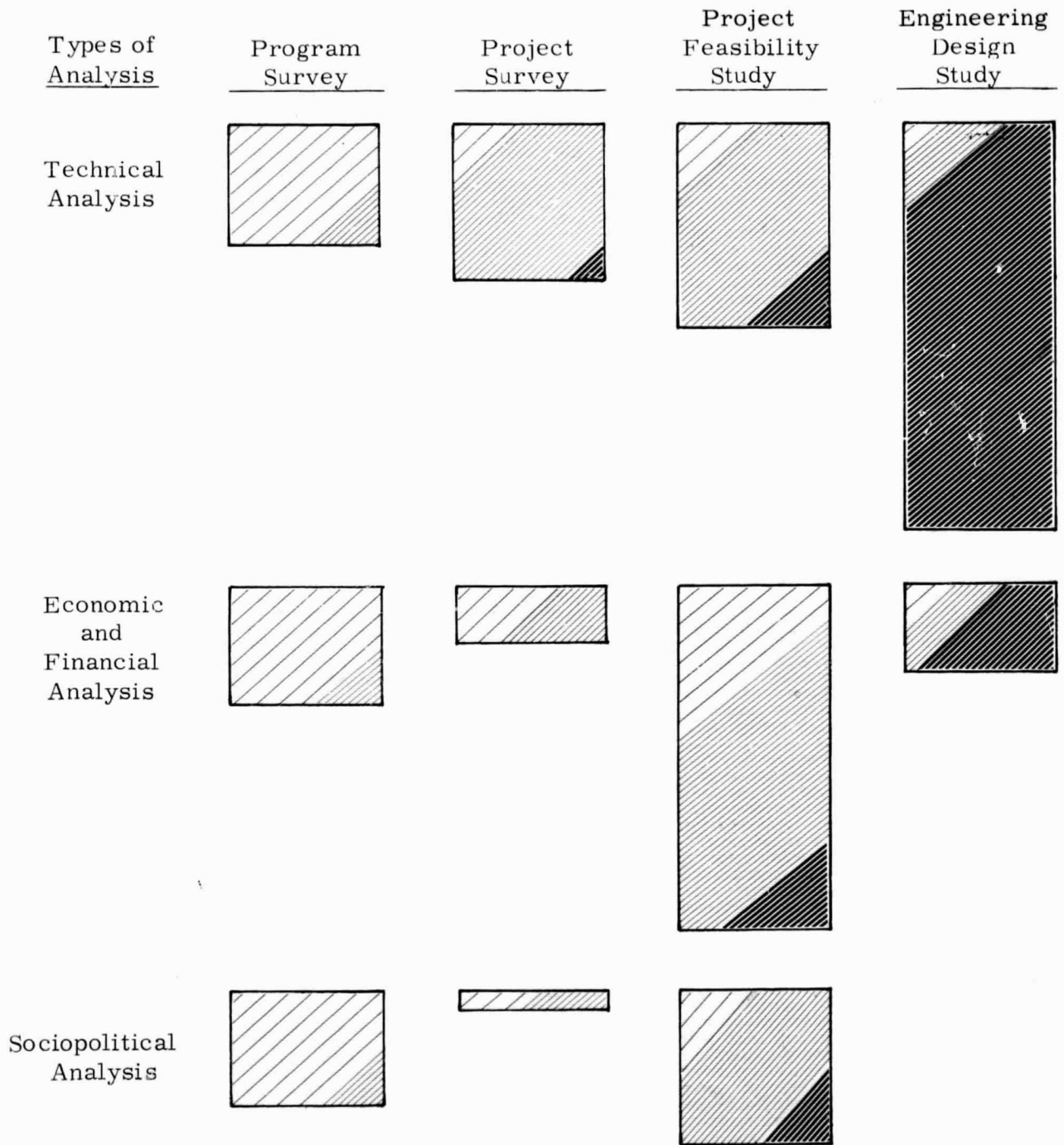
C. DATA REQUIREMENTS AND SOURCES

This section deals with the kinds of information needed for the four principal categories of telecommunications studies discussed in Chapter Two. Exhibit Three shows, in schematic fashion, a classification of data sources typically used for each study category according to each type of analysis.

Data may be obtained from secondary sources such as ITU publications, U. S. Government publications, or industry and other organizations. These sources in turn are based upon primary sources. In working with secondary

EXHIBIT THREE

TYPES OF DATA SOURCES FOR FOUR PRINCIPAL
CATEGORIES OF TELECOMMUNICATIONS STUDIES



KEY:

	Data from secondary sources
	Data from primary sources
	Data measured or created by analyst

sources, the analyst has little choice concerning the form in which the data is received, and he is often not in a position to make definitive judgments concerning its accuracy.

Information obtained from telecommunications agencies and other organizations which gather and record data represents data received from primary sources. During a field survey, the analyst may be in a position to review basic records and work sheets in order to evaluate the accuracy, completeness, and reliability of the information obtained. He may also be able to have special compilations made, and hence to influence the form in which statistics are presented to him.

Measured or created data is that which is gathered or synthesized by the analyst himself. It includes personally conducted equipment inventories, traffic measurements, propagation measurements, site surveys, and similar activities. In such cases, the analyst himself becomes a primary source of data.

On the whole, engineering analysis tends to place the heaviest emphasis on measurement and creation of data. As a general rule, economic, financial, and sociopolitical analysts are able to put secondary sources to the greatest use. All types of analysis draw significantly on primary sources, however.

Differences in emphasis on data sources are of significance to the design of particular study categories. For example, it is often desirable for a project feasibility study to start with a "pre-study," i. e. , a preliminary **analysis** based on secondary sources conducted in the home office before the survey team goes to the field. This allows the team to set up a framework of analytical checks and balances in a relatively unharried environment, and to ascertain what data inputs are most critical to the survey. Some telecommunications technicians may be impatient in working with secondary sources when they expect that superior sources will shortly be available to them. Nevertheless, in most feasibility studies, the advantages gained from working through a problem with available data are considerable in terms of establishing a common frame of reference and an agreed set of priorities in seeking data. These advantages generally outweigh the effort expended on the pre-study.

1. Program Survey

The technical analysis portion of a program survey largely involves a determination of the nature and scope of the telecommunications system which exists in a developing country. For most countries, much information can be derived from secondary sources, such as the ITU, governmental agencies, and U. S. and foreign corporations. A quick field survey of the region or country is particularly appropriate where it is

important to assure that information is up to date. A program survey may include a first, rough-cut determination of possible projects with approximate and preliminary costing. Normally, rules-of-thumb and order-of-magnitude estimates will suffice for this purpose, and detailed information inputs are not essential.

The economic and financial data required for a program survey are also largely derivable from secondary sources. However, telecommunications demand projections, made on the basis of such information, are by nature preliminary and approximate. They should not be deemed comparable to feasibility study projections, which are the result of much more detailed and precise analysis, and which are based upon the best available data.

The sociopolitical analyses suitable for a program survey are also largely derivable from secondary sources. If the analysts who perform this work have a good understanding of the areas with which they are dealing, the results can be quite meaningful.

The data requirements and sources for program surveys thus can be summarized as follows: the data required are typically of a general and preliminary nature obtainable from secondary sources such as private publications, governmental and international organizations, and domestic and foreign corporations. The telecommunications analyst's job is to

collect these data from these sources, and to convert available data into a coherent telecommunications program on the basis of experience and good judgment. Certain rough-cut preliminary analyses may be carried out to indicate basic trends and magnitudes. A field survey may, in certain circumstances, be required in order to obtain data not otherwise obtainable.

2. Project Survey

A project survey is heavily technically oriented. In order to prepare a scope of work for a specific project, a short field survey is usually required. Engineering data may be obtained from primary and secondary sources, but there is seldom time for more than limited measurements or gathering of original data. The economic, financial, and sociopolitical analyses required are modest in extent and sophistication, and are typically evenly balanced between primary and secondary sources.

3. Feasibility Study

There are three fundamental characteristics of feasibility studies which determine the nature of the data requirements and data sources of such studies. The first characteristic is the requirement for a large amount of detailed data covering several fields of analysis. For example, the traffic and financial information analyzed during a feasibility study will

often involve 75 to 100 different historical data series. Types of equipment and circuits assessed can also be extensive, as can the range of sociopolitical issues considered. The second characteristic is that all types of analysis draw heavily on secondary, primary, and self-generated data. The third characteristic is that feasibility studies require the continuing exercise of judgment as to the reliability of data sources and the balance of effort to be employed in analyzing information. It is important that each member of a study team become familiar with the work and data of other analysts, and that all team members understand the organization of the telecommunications administration, its technical system, and its statistical base.

As noted earlier, close relationships among the technical, economic, and financial analyses depend upon the iterative process of analysis which should start from the outset of the study. The creation of an improved telecommunications system by engineers generally begins when they compare traffic projects with existing capacity. However, the nature of improvements which are then created can generate new needs for forecasts and for determination of the nature and scope of existing capacity. These needs create new data requirements and provide new insights into the nature and adequacy of the existing data base. In essence, a good telecommunications study in a developing

country creates, as one of its most important products, a data base which incorporates the best information available from all sources. The allocation of effort to this task requires not only analytical judgment, but an acute sense of the relative importance of information to the entire scheme of the study.

The sociopolitical portion of a feasibility study involves both the collection and evaluation of data from primary sources, such as the telecommunications administration and other governmental agencies, as well as the recording of information which may not have previously been reduced to written form. Such an analysis is linked to organizational rate structure, revenue, and engineering analysis, but its inputs tend to be qualitative rather than quantitative.

4. Engineering Design Studies

Engineering design studies are heavily oriented toward data created by the engineer himself in the course of the analysis. Engineers usually prefer to rely upon their own measurements wherever possible, and wisely so. Such measurements are important because they often reveal previous errors and shortcomings which are critical to design work. Whenever engineers cannot create their own data, they are constrained to use the most reliable existing data, whether from the telecommunications administration itself, or other engineering studies, site surveys and similar sources.

CHAPTER FOUR

FORECASTING METHODS

A. INTRODUCTION

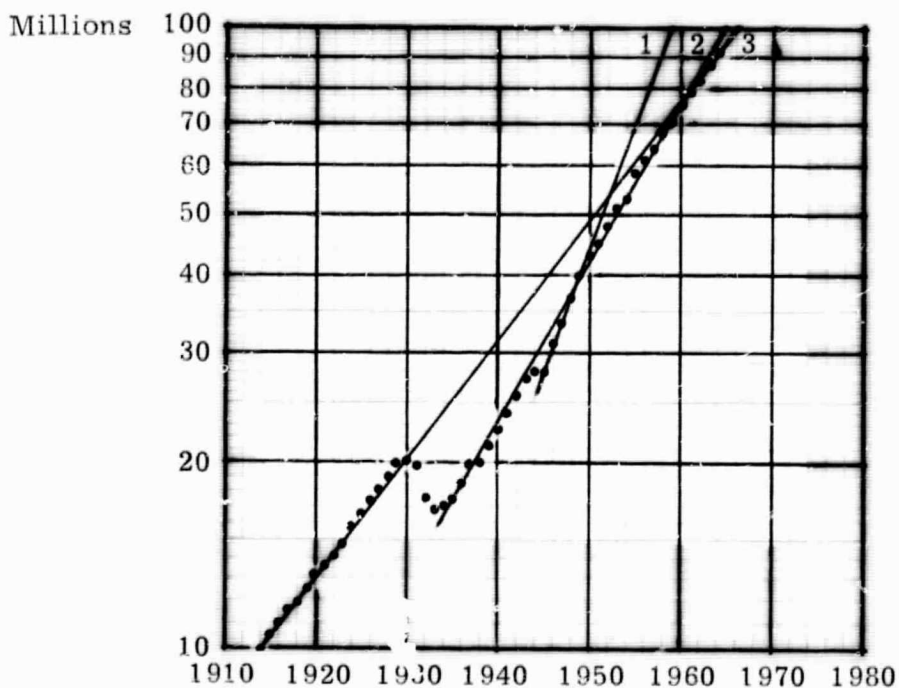
This chapter deals with the forecasting methods which are most pertinent to telecommunications studies. These include historical trend extrapolation, correlation analysis, and gravity-potential models. The impulse jump, a special demand factor which should often be applied to each of these methods, is also discussed, as are judgmental factors which are often important in forecasting telecommunications demand, especially in developing countries.

Section B introduces forecasting analysis with a discussion of the most used method--historical trend extrapolation. Sections C and D discuss correlation analysis and gravity-potential models, respectively. Section E discusses the impulse jump. Section F deals with forecasting methods and study design.

B. HISTORICAL TREND EXTRAPOLATION

Historical trend extrapolation is the most widely used and conceptually simple of the various forecasting methods. It is not, however, without its pitfalls. A projection of data depends upon the historical period chosen for extrapolation. For example, telephones in service in the United States from 1910 to date could be plotted as shown in Exhibit Four.

EXHIBIT FOUR
TELEPHONES IN SERVICE IN THE UNITED STATES



Source: Hans Y. Kraepelien, "Forecasting in an Operating Company," Telephony, Vol. 169, No. 20, November 13, 1965; trend lines added by Checchi and Company.

Trend Line 1 of Exhibit Four projects data for the years 1945-1950, the period immediately following World War II. A projection based upon these years would have resulted in an inaccurate forecast of telephones in service in the United States because the years following World War II represented a period during which demand for telephones reflected economic dislocations caused by the depression and the wartime shortages of materials and equipment.

Trend Line 2, a projection based upon the years 1935-1960, appears more accurate than Trend Line 1, but less accurate than Trend Line 3, which incorporates the data from 1910 to 1964.

Today, Trend Line 3 appears reasonably accurate. However, it would have been difficult to forecast Trend Line 3 from historical data points in either 1945 or 1950. Data of the most recent years only are quite often the best data to use for historical trend extrapolations, but this was not the case in the late 1940's. Thus, a "simple" historical trend analysis may not be simple at all, and may involve consideration of many factors in addition to a particular set of data points.

An obvious disadvantage of the historical trend extrapolation method, and one common to developing nations particularly, is that it cannot alone be used to predict traffic on a new route for which no historical traffic data exist. Even where route data are available in developing countries, such data typically provide only a relatively few data points, not enough for a satisfactory historical trend extrapolation. Such circumstances require the application of more sophisticated forecasting methods, and/or judgmental analysis. Such forecasting methods will be discussed in the following sections.

C. CORRELATION ANALYSIS

Correlation analysis is a tool for studying the statistical relationship between two or more variables so that the value of one variable can be predicted on the basis of one or more other variables. If only one other variable is involved, the analysis is one of "simple" correlation. If two

8

or more other variables are involved, methods of "partial" or "multiple" analysis are required. Simple and multiple correlation analyses, as they relate to forecasting telecommunications traffic, generally involve a determination of the relationship between:

- Telecommunications traffic and some other telecommunications parameters (e. g. , telephone instruments), the growth of which can be predicted with relative accuracy; and/or
- Telecommunications traffic and some non-telecommunications parameters (e. g. , economic) the growth of which can be predicted with relative accuracy.

The parameters most often considered as useful for correlation analyses include the following:

- Gross National Product
- Population
- Telephone density
- Number of telephones
- Wage share of GNP
- Per capita GNP
- Trade

International trade is the most likely candidate for correlation with the international telecommunications traffic of developing countries. As a general proposition, it would be expected that the magnitude of goods and services moving between nations would relate to the magnitude of telecommunications services, because trade between countries directly generates a requirement for telecommunications services between those countries. International trade is often linked with the political and social ties between countries, which also produce requirements for telecommunications services.

It is sometimes possible to find good correlation between total international trade and total international telecommunications traffic in developing countries. However, researchers have not to date had great success in applying correlation analysis to trade and telecommunications on a route-by-route basis in developing countries.¹ There are a number of reasons for the lack of success. First, historical telecommunications traffic, particularly when considered on a route-by-route basis, may strongly reflect constraints imposed by limited circuit capacity. Second, there may be substantial difficulties in historical series which are long enough and accurate enough to perform meaningful correlation analyses. Third, the international trade of developing countries, particularly the export trade, is subject to sharp fluctuations, depending upon world supply, demand, and prices for particular raw materials and agricultural products. Requirements for telecommunications services may be related to changes in market conditions rather than to absolute levels of trade for some commodities. Fourth, trade-telecommunications relationships may vary according to distance between origins and destinations. For example, coordination of international trade movements over relatively short distances may involve substantially greater dependence on telecommunications on a per-ton or per-dollar basis than do long distance movements. The following section deals with a method of taking distance relationships into account in certain types of telecommunications forecasts.

¹ Checchi and Company did find a reasonably high multiple correlation between economic and telecommunications parameters for Nigeria, Ghana, and Dahomey. See A Study of the Economic and Technical Feasibility of Improving International Telecommunications in West Africa, (NASW-1357) Washington: NASA/AID, October, 1968, pp. II-48 through II-74.

D. GRAVITY-POTENTIAL MODELS

The concept of gravity-potential models is a mathematical approach for evaluating various interactions between masses of population as these interactions vary with distance between population masses. The models are called "gravity" or "potential" models because they employ a formulation of gravitational attraction:

$$F = G \frac{M_1 M_2}{R^2}$$

where F is the force of attraction between two masses, M_1 and M_2 , which are separated by a distance, R . G is a constant, sometimes termed, in combination with the distance function, the "friction of distance."

The mathematical formulation provides a basis for establishing quantitative relationships among commonly observed empirical phenomena. For example, two large cities located 50 miles from each other will normally experience more intercity telecommunications traffic than two cities of the same size located 100 miles from each other. A small city and a large city located 50 miles (or 100 miles) from each other will have less intercity telecommunications traffic than two large cities separated by the same distance from each other. Quantitative relationships may be established among distance, city size, and telecommunications flows on the basis of modest amounts of data. These quantitative relationships may then be used to project traffic for all pertinent population centers.

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The gravity model may be viewed as a special case of correlation analysis where F is the dependent variable and M_1 , M_2 , and R are the independent variables. Although the specific gravitation formulation set forth above may not be directly applicable to telecommunications studies, the basic concept is. Zipf¹ has done pioneering work in applying gravity models to telecommunications data. He found a direct relationship between telephone calls between American cities and the factor,

$$\frac{P_i P_j}{d_{ij}}$$

where P_i and P_j are the populations of two cities and d_{ij} is the distance between them.

The relationship is essentially that of the gravitation formulation set forth above, except for the exponent on the distance. Checchi and Company has developed this concept in several feasibility studies, particularly its Ethiopia telecommunications study.² The ITU also suggests the use of this concept for some forecasting purposes.³ The gravity model approach is a most useful one for forecasting interurban and regional international traffic in developing nations, and deserves further development.

¹ George K. Zipf, Human Behavior and the Principle of Least Effort, Reading, Massachusetts: Addison-Wesley Press, 1949.

² Ethiopia Telecommunications Study, (AID/AFR-522) Washington: AID, May, 1969, pp. II-47 to II-77.

³ The International Telegraph and Telephone Consultative Committee, Economic Studies at the National Level in the Field of Telecommunications (1964-1968), Geneva: The International Telecommunication Union, July 1, 1968, Chapter IV, pp. 13-15.

The principal advantage to the method is that instead of trying to find a correlation between telecommunications data and general economic data, one can focus attention on what appears to be a fundamental relationship between population masses, distance, and telecommunications services. Additionally, forecasts can be made for routes for which little or no historical telecommunications data exist.

E. IMPULSE JUMPS

There are several limitations in the methods of telecommunications forecasting. On many world routes, and particularly on those of developing nations, for example, historical traffic trends may reflect limitations on the capacity and quality of existing circuits rather than the underlying telecommunications demand which would exist if sufficient high quality circuits were made available. When new and improved facilities, such as submarine cables or earth stations, are installed, traffic volumes typically exhibit a sharp and permanent increase. These effects are explained by the fact of the existence of a certain amount of "suppressed demand." This phenomenon may also be explained on the basis that improved facilities provide customers with essentially "new" types of services, i. e., those which are more prompt and of higher quality. Recent historical trends in international traffic, therefore, are regarded principally as an indication of the growth of capacity and quality of telecommunications facilities.

When submarine cables were introduced on the North Atlantic route, telephone traffic increased by as much as 100 percent in the year following inauguration of service. Buyers¹ reported an increase of 23.5 percent in Alaskan traffic and 25 percent in Hawaiian traffic when cables were installed. Presently, some very large impulse jumps are being reported in developing areas, with 100 percent being considered likely where high frequency radio facilities have been replaced with higher quality facilities. However, great caution must be exercised in using any such figures. An impulse jump may be due to increased capacity, improved quality, lower rates, basic commercial patterns, other factors, or any combination of these. Unless an effort is made to discover which factors are operating in a given situation, a forecast of an impulse jump may represent little more than supposition. Impulse jumps reported for one developing region or continent may in fact have little in common with impulse jumps likely to occur in other developing regions or continents in terms of magnitudes or underlying causes.

No comprehensive and rigorous study of telecommunications impulse jumps in developing countries presently exists. Hence, researchers are constrained to employ methods of qualitative analysis in determining approximate values of anticipated impulse jumps in a given study region, as well as in evaluating the limited quantitative data which may be available in situations which are believed to be analogous. One way to gain insights into the magnitude of the impulse jump is to estimate suppressed demand by interviewing major telecommunications users, particularly of the international

¹ John W. A. Buyers, Wings of the Morning, Master's Thesis, submitted at the Massachusetts Institute of Technology, 1963.

voice mode. A related procedure is to make independent forecasts of the growth of the activities of heavy users of telecommunications. These procedures can inject a vitally needed sense of reality into a process which in some cases has been little short of a guessing game drawing on historical precedents which have little in common with the circumstances of the nations from which forecasts are made.

F. FORECASTING AND THE DESIGN OF TELECOMMUNICATIONS STUDIES

As an area of research, forecasting methods have perhaps received more attention than other elements of economic analysis in studies of telecommunications development. However, most of the work on forecasting methods tends to be oriented toward those developing countries which are in the later stages of development. Moreover, although there is a considerable amount of material devoted to forecasting in developing countries, this literature is scattered, difficult to synthesize, and largely unevaluated. Telecommunications forecasting is sufficiently important to merit the development of a body of literature which is readily available to the analyst. In essence, a treatise on forecasting methodology is required, followed by a continuing process of application and refinement. While the development of a treatise on forecasting is a substantial undertaking in itself, the process of application and refinement can be carried on within the framework of studies principally directed toward specific

telecommunications programs and projects. For example, designers of telecommunications studies could specify, as an essential part of a feasibility study, that the contractor undertake to develop and refine at least one of several forecasting methodologies. Moreover, retrospective analysis could in some cases be combined with forecasting requirements. Consider the case of a nation which has moved from an early stage of development to a more advanced stage. Such a country may well have replaced its high frequency facilities with submarine cable, and may now be in a position to add a satellite earth station to its telecommunications system. A study of the earth station feasibility might be combined with a historical study of the results of submarine cable installation. The latter study would seek not only to quantify traffic patterns before and after cable installation, but to isolate factors responsible for the resulting growth in traffic. Such a study could provide substantial insights into the impulse jump phenomenon. The designer of such a study should recognize that the historical examination would require effort beyond that which would be required in order to provide useful forecasts for the satellite earth station option. In other words, if a feasibility study includes a research task directed toward advancing the art of forecasting, it should be recognized that additional effort is required to achieve results of general application.

Forecasting is ultimately an exercise in judgment within a disciplined quantitative framework. However good the historical data, and however sophisticated the methods used to deal with these data are, the forecaster will be required to make assumptions and some out-and-out guesses. Wherever forecasts represent an important input to study results, the analyst should be required to identify those areas in which assumptions and intuitive judgments were made.

CHAPTER FIVE

SELECTION OF TECHNICAL ALTERNATIVES AND CONFIGURATIONS

A. INTRODUCTION

The purpose of this chapter is to discuss procedures used to select technical systems and configurations from among a range of alternatives. This chapter views the selection process principally from the technical viewpoint, emphasizing techniques of systems analysis and cost-effectiveness analysis. Economic and financial considerations closely related to the selection process are identified. These considerations are, however, given fuller treatment in Chapter Seven which deals with methods of economic and financial evaluation.

Section B discusses the general methodology used in the selection process.

Section C describes the process of system selection.

Section D reviews the range of alternative telecommunications systems.

Section E provides some comments and suggestions concerning the system selection process.

B. GENERAL METHODOLOGY

The selection of technical alternatives and configurations lies at the heart of project feasibility studies. It is important for the designer of

feasibility studies to have a good understanding of this process. In particular, the study designer should guard against the temptation to assume the nature of the desirable technical solution or to discard technical alternatives before such alternatives have been properly evaluated.

The objective of the technical analysis portion of telecommunications feasibility studies is to determine the most suitable technological means of meeting the projected demand for telecommunications. This technical analysis would be relatively straightforward if newer and more advanced means of communications simply displaced older means, but this is not the case. The advent of microwave and tropospheric scatter systems did not displace systems which depend upon wires and cables, rather, these systems now complement each other. Satellite communications was initially heralded as the death knell for submarine cable, but these two media are also likely to serve complementary roles. Thus, new systems add to the complexity of the system selection process, generally referred to as systems analysis, by offering a wider range of technical and economic choices than previously existed.

The process of selecting a preferred system from among several alternative systems which can accomplish a specified purpose may be

usefully approached in terms of systems analysis. Such an analysis involves a comparison of the costs, effectiveness, risks, and timing associated with competing system choices.

In the context of feasibility studies, systems analysis needs to be distinguished from systems engineering. Systems analysis is concerned only with that level of analytical detail which is necessary to establish the relative merit of alternative choices. Systems engineering, on the other hand, is concerned with the specific and detailed design features of a given system.

The general methodology of systems analysis, as applied to telecommunications feasibility studies, consists of a logical sequence of steps which can be retraced and verified. The following subsections present that sequence of steps.

1. Requirements Analysis

Within the framework of the decision maker's overall objective, the specific system requirements must be defined. This involves a determination of the required system capacity, locations to be served, types of traffic to be accommodated, desired level of transmission quality, speed of service, required compatibility with existing systems, and related system objectives which are common to any of the technical alternatives to be considered.

2. Formulation of Technical Alternatives

For a given set of requirements, there are choices as to the type of technical system to be employed. Normally, these choices are available at subsystem levels; that is, the overall system normally consists of several different networks or different types of facilities, and choices are available within those component parts of the overall system. The system which is most satisfactory, in a technical sense, is that one in which the best choices were made at the subsystem level.

3. Cost Analysis

The utilization of cost data in systems analysis fulfills two important functions: it provides a cost basis for selection among comparable technical alternatives; and it provides a cost basis for determining the investment merit of a proposed telecommunications project.¹

C. THE PROCESS OF SYSTEM SELECTION

As described above, the system selection process consists of three well-defined steps: requirements analysis; formulation of technical alternatives; and cost analysis. These steps, however, are interrelated, and require several iterations before a firm system selection can be made. The

1 See Chapter Seven for a discussion of the methods of economic and financial evaluation.

formulation of technical alternatives, for example, may justify a re-examination of the initial set of requirements. Later, cost analysis may uncover a need for a re-examination of a technical alternative in order to determine whether there are methods available which will provide lower costs.

The preliminary objective in systems analysis is to identify, in gross terms, those technical alternatives which warrant serious consideration. This is followed by a gross cost analysis. From this initial analytical cycle, certain alternatives may be discarded, while others emerge as valid candidates. These remaining candidates are then subjected to successive technical and economic analysis, which refine the technical detail and the costing accuracy to the point that a clear selection can be made and justified. The following list of variables requiring evaluation is indicative of the scope of analysis normally required for the selection process:

- Technical Analysis
 - Operational effectiveness
 - Maintainability/reliability
 - Integration with existing facilities
 - Environmental control requirements
 - Support equipment and services

Technical standardization

Potential for system expansion

Resistance to obsolescence

Technical training equipment

- Manpower Analysis

Skill required

Skill available

Training requirements and methods

Geographical deployment of personnel

Level of manpower required

- Cost Analysis

Engineering

Equipment

Installation

Test and acceptance

Buildings, roads, utilities

Training

Salaries

Operating and maintenance supplies and services

Amortization/depreciation

Reliability of costing data

D. ALTERNATIVE TELECOMMUNICATIONS SYSTEMS

A summary of the principal characteristics of alternative types of telecommunications systems, their application to developing countries, and their approximate cost per channel mile, is contained in Exhibit Five. It should be noted that these system types differ markedly in both performance and cost. There are also marked differences in their normal application. Exhibit Five is useful for making general approximations as to the applicability of various systems to a given requirement, and the range of cost variation among applicable systems. It is emphasized, however, that costs, and even applicability, may vary widely in a specific situation due to local geographical or economic conditions, or the availability of appropriate technical skills.

The approximate costs shown are computed on a "per-channel-mile basis" and reflect estimated total life cycle costs reduced to an annual basis, assuming amortization at a six percent interest rate. A 15-year equipment lifetime, and loan period, was assumed except in the case of submarine and coaxial cable paths, where a 20-year period was assumed.

As noted in Exhibit Five, the costs are applicable only to a 24-channel system over a path ranging from 300 to 1,000 miles. These values are considered to be representative of requirements in developing countries. In addition, the following are some general guidelines relating costs to other system capacities or other route lengths:

SUMMARY OF TELECOMMUNICATIONS

Type	Primary Characteristics	Principal Application in Developing Countries
Overhead Wire & Cable	1. Low cost, medium capacity (up to 60 channels), medium to high quality. 2. Required unbroken physical path over entire route. 3. Relatively low level of skill required for maintenance. 4. Relatively high maintenance costs.	National and international telephone and telegraph circuits within a regional area of several hundred miles.
High Frequency	1. Low cost, low capacity, low quality. 2. Suitable for distances from 100 to 12,000 miles. 3. Real estate for "antenna farm" increases with distance covered by links. 4. Only moderate skills required for maintenance. 5. Dependent upon use of highly congested frequency spectrum between 3,000 and 30,000 KHz. 6. Subject to wide fluctuations in transmission quality resulting from natural perturbations of the earth's ionosphere.	1. National and international telephone and telegraph circuits when high quality is not essential. 2. Widely used for low capacity circuits over extreme distances, especially transcontinental.
Submarine Cable (independently owned and operated - not common carrier)	1. Medium cost, medium capacity, high quality. 2. Relatively low maintenance cost. 3. Highly specialized maintenance skills. 4. Requires cable repair vessel on call.	International telephone and telegraph along coastal routes and intercontinental routes.

EXHIBIT FIVE

ELECOMMUNICATIONS SYSTEMS

Principal Application in Developing Countries	Constraints	Approximate Annual Cost Per Channel Per Mile (Computed on Total Life Cycle Cost Basis for a 24-channel system over distances ranging from 300 to 1,000 miles).
al and international tele- and telegraph circuits a regional area of several ed miles.	1. Entire route must be accessible by land transportation. 2. Vulnerable to natural hazards (floods, high winds, sleet, lightning). 3. Cable or wire breakage in remote areas can cause extended periods of outage before repair is made.	\$ 25
tional and international one and telegraph circuits high quality is not essential. dely used for low capacity s over extreme distances, ally transcontinental.	1. Not suitable for high quality transmission due to effects of atmospheric static and ionospheric disturbances. 2. Highly vulnerable to interference from other stations occupying the same or adjacent frequencies. 3. Costs steadily rising due to need for higher power, larger antennas, more sensitive receivers, to overcome frequency interference. 4. Suitable frequency authorizations increasingly difficult to obtain.	\$ 30
tional telephone and tele- along coastal routes and ntinental routes.	1. Applicable only to marine routes. 2. Cable breaks infrequent, but cause extended outage periods pending location and repair of break.	\$ 50

Fold out

<u>Type</u>	<u>Primary Characteristics</u>	<u>Principal Application in Developing Countries</u>
Microwave	1. Medium cost, high capacity (up to video bandwidth), high quality. 2. Requires repeater station spaces within line of sight (normally within 30 miles). 3. Relatively high maintenance skills required. 4. Repeater stations can be designed for unmanned operation.	National and international telephone, telegraph and television circuits across land terrain.
Coaxial Cable	1. High-cost, high capacity (up to video bandwidth), high quality. 2. Requires unbroken physical path (normally underground) over entire route. 3. Relatively low maintenance costs and moderate maintenance skills.	National and international television circuits, and telephone circuits having a density of several hundred channels and traversing distances of less than 100 miles.
Tropospheric Scatter	1. High cost, medium capacity (up to 120 channels), high quality. 2. Transmission paths limited to "hops" normally less than 450 miles. 3. High maintenance skills required. 4. Relatively high maintenance costs.	National and international telephone and telegraph circuits of 150-450 miles where microwave or wire circuits are not practicable (such as over water or over inaccessible terrain).
Satellite (owned earth terminals; leased satellite channels)	1. High cost, high capacity (up to video bandwidth), high quality. 2. Cost independent of distance. 3. High maintenance skills. 4. Independent of terrain traversed. 5. Maximum range varies from 5,000 to 10,000 miles, depending upon location of earth stations with respect to satellite location.	High volume international communications over distances in excess of 1,000 miles; transcontinental and intercontinental television transmission.

Fold out

Principal Application in Developing Countries	Constraints	Approximate Annual Cost Per Channel Per Mile (Computed on Total Life Cycle Cost Basis for a 24-channel system over distances ranging from 300 to 1,000 miles)
nal and international tele- e, telegraph and television its across land terrain.	1. Not normally economic on routes having less than 12 voice circuits. 2. Not normally feasible for routes traversing large bodies of water. 3. Sometimes uneconomic when service areas are located in difficult mountainous terrain.	\$ 50
nal and international tele- n circuits, and telephone its having a density of al hundred channels and rsing distances of less 100 miles.	1. Entire route must be accessible by land transportation. 2. High costs normally restrict use to routes of high density, or to television circuits.	\$ 85
nal and international tele- e and telegraph circuits of 50 miles where microwave re circuits are not practic- (such as over water or over ossible terrain).	Not normally a good economic choice if microwave or wire circuits are feasible.	\$100
volume international com- ications over distances in s of 1,000 miles; trans- ental and intercontinental sion transmission.	1. Satellite voice circuits cannot be relayed over other satellite circuits due to delayed echoes. 2. Not normally a good economic choice for distances less than 1,000 miles for routes carrying less than 8 voice channels.	\$100-\$330 (\$100 applies to 1,000 miles) (\$330 applies to 300 miles)

all out

(

- Per-channel-mile costs decrease as channel capacities increase, although not in a linear manner.
- Per-channel-mile costs tend to remain constant or decline slightly, with increasing distance, except in the case of communications satellite systems.
- Satellite system costs per channel mile change in direct proportion to changes in distance.
- Costs per channel mile for distances under 300 miles increase more than indicated above, and the rate of cost increase for most systems is greater than the rate of decline in distance.

E. EVALUATION OF THE SYSTEM SELECTION PROCESS

The studies performed to date indicate that there are several problem areas which warrant consideration in the design of future studies.

1. System Choices and Investment Objectives

The process of system selection is closely related to, and strongly influenced by, investment objectives. If, for example, an investment objective is to minimize capital expenditures, this could rationally lead to a system design incorporating less sophisticated and less costly equipment, or the use of leased facilities in preference to purchased facilities. Such a choice could, on the other hand, result in higher total costs, since increased operating and maintenance costs may result.

If an investment objective is to optimize the net present value on internal rate of return of the project, both the selection of system type and the time phasing of its implementation will be influenced. It is evident that the systems analyst needs clear guidance as to the investment objective in order to establish the economic criteria to be used in system selection.¹

2. Short-Term Versus Long-Term Projections

In some instances, telecommunications studies have been made in which economic or financial projections were not to be extended beyond a few years period. While this procedure may be suitable for determining whether a project will break even, it also may seriously distort the adequacy of the system choice, or the relative viability of that choice, since economic factors or system capacity factors were not evaluated over the economic lifetime of the system. It is recommended that all telecommunications studies consider design features and economic factors over the expected lifetime of each system alternative. The ultimate design adequacy cannot usually be verified over a shorter period.

3. Correlative Improvements

In telecommunications studies which are restricted to one sector of a national communications structure (such as long lines trans-

1 See discussion in Chapter Seven.

mission systems, or central telephone exchanges), the improvement or expansion program recommended for the selected sector is dependent upon correlative improvements in the other related sectors. Such studies are potentially vulnerable as to their validity, unless the terms of the study are carefully constructed.

As an example, a study of the feasibility of a proposed international or national microwave route will necessarily be based upon forecasts of telephone and telegraph traffic growth. However, this growth cannot occur unless the number of subscribers, and therefore the capacity of the telephone and telegraph exchanges, also increase. Thus, the study may recommend that the microwave system be funded and constructed without positive assurance that the correlative improvements prerequisite to overall traffic growth will also be funded and constructed. In nations which are deficient in investment capital, such recommendations can be hazardous.

It is suggested that telecommunications studies, centered on one sector of an overall national telecommunications system, also include adequate study into the needs and methods for obtaining correlative improvements in sufficient scope to support the recommendations made.

4. Accuracy of System Traffic and Cost Projections

A survey of available telecommunications feasibility studies reveals a significant variation in projections of future traffic and system cost factors. These projections interrelate in a manner that can result

in wide variations in estimates of project costs and viability. Future studies should, therefore, require an analysis of the reliability of estimated traffic projections (and related revenue projections) and system costs. The calculated variabilities in these forecasting areas should then be correlated in a manner which provides an index as to the potential variability of the project viability calculations.

5. Technical Coordination with Host Nations

Most telecommunications feasibility studies involve field surveys in the host nation, and direct interrelationships with local governmental telecommunications planners. The local officials have a keen interest in the project, and usually a strong viewpoint regarding the technical features of future improvements. Also, they will ultimately exercise judgment and influence on the study recommendations.

There appears to be a need for some degree of prescribed uniformity as to the liaison with local telecommunications representatives. They should be "brought into the picture" at appropriate checkpoints along the way (e. g., to review traffic forecasts, to review the requirements base developed for analysis of system alternatives, and for consultation on recommendations prior to their publication). The validity of the study would be enhanced thereby, if for no other reason than that their predisposition to the intended study conclusions will be known in advance.

In order to provide such beneficial uniformity in liaison with local telecommunications officials, the terms of coordination with these officials should be specified in the request for proposal for future studies.

6. Documentation of Alternatives

While most system studies require the objective analysis of system alternatives, the level of analytical detail to be included in the study documentation is not always clearly defined. It is suggested that study documentation be specified to include a summary of the analysis of alternatives in sufficient detail to justify the choice on technical, operational, and economic grounds. Analytical detail beyond this point may be of special interest to engineers and economists, but would neither aid in decision making nor reduce study costs.

CHAPTER SIX

RATE STRUCTURE ANALYSIS

A. INTRODUCTION

The purpose of this chapter is to discuss the use of rate structure analysis in telecommunications studies. Rate structure analysis is likely to be most critically involved in feasibility studies since such studies enable the analyst to examine relationships between rates, revenues, costs, and financial viability. However, both program and project surveys may include a preliminary assessment of whether rate structure problems exist.

Section B briefly discusses public utility rate-making principles. Section C deals with international rate structures and revenue sharing arrangements. Section D evaluates the impact of rate structure analysis on the design of telecommunications studies.

B. TELECOMMUNICATIONS RATE STRUCTURE: PRINCIPLES AND ANALYSIS

The underlying purpose of a telecommunications rate structure is to set the market price for telecommunications services. A rate structure also serves as a principal determinant of the amount of revenues which will be received from telecommunications services.

Public utility rate-making principles constitute a body of theory and practice which is particularly useful in analyzing telecommunications

rate structures.¹ These principles have received their fullest refinement in situations where a monopoly owned by private interests is subject to government regulation. A basic principle of rate making is that rates should produce sufficient revenues to allow an efficient organization to obtain a fair rate of return on investment. In general, rates for individual services should reflect the costs of these services, except that some modifications may be made to take into account social, political, and economic considerations.

Rates may be tied in with specific cost or expense categories. For example, components of subscriber charge may cover part of the capital cost of the telecommunications plant, the installation charge, rental for equipment actually used on the premises of the subscriber, plus variable charges. Variable charges will be incurred in proportion to the subscriber's use of the telecommunications services. For example, tariffs may provide variable charges based upon the number of calls made, the distances involved, the duration of the call, the time of day, and the type of service (e. g. , telephone, telegraph, or telex) used.

This type of subscriber payment, i. e. , based upon apportioned usage of the telecommunications system and service, is the one most clearly related to costs. However, rates may also take into account ease of administration, public welfare considerations, and other criteria.

¹ See, for example, James C. Bonbright, Principles of Public Utility Rates, New York: Columbia University Press, 1961.

Public utility rate-making principles may be adapted to the circumstances of a government-owned telecommunications agency which operates on a self-sustaining basis. Such organizations use "profits" either to pay dividends to the government or to provide additional investment in the public enterprises. As in the case of a regulated privately owned organization, the administration's revenues should cover all costs and provide a modest surplus. However, the organization should not use its monopoly position to obtain excessive profits. Rates for individual services should normally be such as to allow the service to cover at least its marginal costs, with some special exceptions prescribed by social, political, or economic policy. Telecommunications services may also be operated as a traditional government agency. Under these circumstances, the administration's expenses are funded as part of the government budget cycle, its revenues being paid into the Treasury. The administration may receive substantial services at no cost from other government agencies, and it may be hard to relate telecommunications revenues to full service costs. Public utility rate-making principles may also be applied as a way of optimizing the use of national resources in such circumstances, but such application often involves different theoretical and practical problems.

A rate structure necessarily influences the magnitudes and patterns of telecommunications demand. If a telecommunications service were offered without charges of any kind, excessive use, bordering upon waste, would probably prevail. Rates charged for services tend to bring use of

telecommunications resources into balance with needs. In most cases, very low rates will result in substantially more traffic than would occur with very high rates. This phenomenon, known as the "price evaluation of demand," is a great deal easier to describe in theory than it is to measure. Historical analysis of the relationships of changes in rate levels to changes in traffic levels often involves the problem of isolating the effects of changed rates from other factors influencing traffic. In practice, it is usually easier to evaluate the internal consistency of a rate structure, or its relationships to service costs, than it is to assess its quantitative impact upon demand.

Analysis of the rates and revenues of individual services often reveals a pattern characterized by internal imbalance. A given service may be operating at a loss, or at less-than-normal profit, while other services cover more than "their share" of overhead expenses or contribution to the agency's surplus. This is a common phenomenon in developing nations, and may occur for a variety of reasons. First, the users of certain classes of telecommunications services may be in a position to more easily bear the full cost of their services than are users of other services. Second, the imbalance may be part of a **deliberate** policy of telecommunications development which takes into account both marketing and financial factors. Third, the imbalance may be essentially an unplanned phenomenon resulting from the use of traditional structures which have not been readjusted to changing cost patterns.

International services in many developing countries are priced so as to be far more profitable than domestic services. Economists, whose thinking is conditioned by experience in industrialized nations, may tend to look with disfavor upon this practice. It should be recognized, however, that the pattern of relying upon international transactions as a primary source of revenues with which to finance internal development is a common one in developing countries. It is believed that the telecommunications rate structure of developing countries should be evaluated with the specific circumstances of each developing country firmly in mind. Public utility rate-making principles provide a useful framework within which to analyze the problem, but recommendations as to changes in rate structure should take full account of the nature of development processes.

C. INTERNATIONAL RATE AND REVENUE SHARING ARRANGEMENTS

A study of international rates usually requires the analysts to examine a broad range of criteria and techniques for establishing rates and revenue splitting arrangements, including those briefly discussed below.

Rate-distance formulas may be used to establish basic relationships between rates for telecommunications services, and the corresponding distances transited. They are one of the primary criteria for national traffic structures, but are only one of several considerations in international revenue sharing arrangements.

Rate base formulas relate revenue to the investment underlying the revenue, often in terms of a fair rate of return on investment. As in the case of rate-distance formulas, rate base formulas are one of the primary criteria for national tariff structures, but are only one of several considerations in international revenue sharing arrangements.

Transit charges are fixed charges received by transiting countries for the use of their facilities in cases where traffic is relayed between the country of origin and the country of destination by intermediate countries.

Terminal charges are fixed charges received by countries of origin and destination to cover terminal costs. The essential problem in establishing terminal charges and transit charges, as described above, is estimating the unit costs related to handling messages or calls.

Parcours splitting formulas generally provide for the sharing, by countries of origin and destination, of the revenue remaining (the "parcours") after transit and terminal charges have been allocated.

Common user or "wayleave" arrangements treat facilities commonly utilized by participating countries somewhat like a common easement over real estate. Each participant is required to pay for his use of the common facilities, and is entitled to compensation for his depreciation, interest, and operating costs incurred in connection with the commonly used facilities maintained in his country, as well as for amounts in excess of these costs.

Sender-keeps-all arrangements are most commonly used among neighboring countries with reciprocal volumes of outgoing traffic and

identical rates for the traffic. Each country simply keeps all the revenue it collects from outgoing calls and no accounts are exchanged.

Channel leasing arrangements provide that charges are made on a periodic basis for a unit of capacity rather than on the basis of message units. A given channel may be used for two or more communications modes.

Concessionnaire arrangements provide for the operation of a country's international facilities by an independent, generally foreign, entity. The entity is responsible for providing agreed upon telecommunications services, administration, and specified functions in connection with the collection or disposition of revenues. It makes specified payments to the country for the right to operate under the concession.

Multilateral preferential arrangements often are imposed on the arrangements discussed above. They are usually based upon long-standing political or commercial ties, and are exemplified by the arrangements existing among the Francophone nations of Africa.

Frontier arrangements are special rate arrangements, often utilizing domestic rates, related to the often less profitable domestic-type traffic which exists between small population centers on two sides of a common border.

Analysis of international rate structures involves, in addition to factors common to domestic rate structures, international revenue sharing arrangements based upon each country's individual requirements, preferences, and international relationships. The purpose of revenue

sharing arrangements is to provide an equitable method for apportioning the cost of transmitting telecommunications between sender, receiver, and intermediary countries. Many factors enter into revenue sharing arrangements, making it unsound to generalize as to the most appropriate sharing method. Considerations of national interest and political relationships are often critical to a sound solution.

D. RATE STRUCTURE ANALYSIS AND THE DESIGN OF TELECOMMUNICATIONS STUDIES

Rate structure analysis, although it may be discussed simply in terms of its fundamentals, is an extremely complex field. It often requires the combined efforts of telecommunications administrations, regulatory bodies, international organizations, and rate structure analysts for sound and comprehensive recommendations. The approach to rate structure analysis must be to investigate each country's rate structure in terms of each country's unique social, economic, and political circumstances. A writer in the field of utility rates has stated: "No writer whose views on public utility rates command respect purports to find a single yardstick by sole reference to which rates that are reasonable or socially desirable can be distinguished from rates that are unreasonable or adverse to the public interest."¹ A thorough evaluation of rate structures will involve, therefore, an understanding of all aspects of the country under study, including its international relations.

¹ James C. Bonbright, Principles of Public Utility Rates, New York: Columbia University Press, 1961, p. 67.

The minimum rate structure analysis required in any telecommunications study will involve an analysis of the internal consistency of the tariffs, and perhaps a comparative analysis of the rates of the country or countries under study with similarly situated countries. Following such preliminary analyses, a decision will have to be made on whether further rate structure analysis is crucial to the integrity of the study. If it is, substantial effort will be required. A thorough rate structure analysis, involving as it does extensive examination of supply, demand, and pricing, is a complete and complex research exercise in itself, and requires commensurate time and resources.

A correlative determination must also be made of the relationship of the rate structure to the economic and financial viability of the telecommunications entity or project under study. Unless subsidies from outside sources are acceptable, a rate structure must permit a telecommunications entity to be self-sustaining without permitting it to receive excessive profits. Thus, rate structure analysis is often a required input to the economic and financial evaluation analysis of a telecommunications organization or project.

An additional complicating aspect of rate structure analysis is that there are substantial variations in rate structures and revenue sharing arrangements throughout the developing world. Anomalies exist in rate structure patterns prevailing among countries, as well as within the national rate structures of individual countries. Rate structure and

revenue sharing problems constitute a significant impediment to regional cooperation among developing nations, and is an area in which study devoted solely to this situation could provide valuable contributions to both national and international telecommunications cooperation and development, and future telecommunications studies. In any case, a thorough international rate structure analysis will generally be crucial to a sound study of the telecommunications development of an international region. Determinations of interregional rate structure consistency, and comparative analysis of the rate structures of other countries and regions will, at a minimum, be required, and will of themselves involve substantial effort. If an in-depth examination of the regional international supply, demand, and pricing relationships are ultimately required, the level of effort involved will be magnified many fold, and could appropriately constitute a large study in itself.

The introduction and expansion of Global Comsat will ultimately require rationalization of international rate structures which are at present essentially unrelated. By so doing, it has created conditions requiring a reappraisal of traditional rate and revenue sharing arrangements. Indeed, it may be expected that such arrangements are entering a period of continuing revision as larger groups of nations recognize the need for commonly applied rate-making principles, and as they gain a better understanding of the cost structure emerging from the application of new technology.

CHAPTER SEVEN

METHODS OF ECONOMIC AND FINANCIAL EVALUATION

A. INTRODUCTION

The purpose of this chapter is to set forth and discuss the four basic methods of evaluating telecommunications projects in developing regions. The methods are: cost-effectiveness analysis; public utility analysis; cost-benefit analysis; and business investment analysis.

Sections B through E outline each of the four types of evaluation methods. Section F discusses the impact of evaluation methods on project design.

B. COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness analysis is concerned with either maximizing system effectiveness at a given level of cost, or minimizing costs at a given level of system effectiveness. In the latter case, the principal problem in regard to effectiveness is defining the job to be done accurately in order that cost comparisons present meaningful alternatives. In the former case, a quantitative measure of effectiveness is required in order to compare competing systems in terms of a fixed cost. Cost-effectiveness analysis is closely associated with techniques of systems analysis. It has received its fullest development in the defense and aerospace fields where considerations of the lifetime of existing facilities and equipment are considerably less important than

they are in other fields. Cost-effectiveness analysis is most useful in telecommunications studies in developing countries in preliminarily screening alternative system choices. The measures of effectiveness in a telecommunications study are traffic requirements and technical parameters. Cost-effectiveness analysis may be used in a program survey study to determine first-cut system choices, given an approximate program budget. In a feasibility study, cost-effectiveness analysis is used to reduce the number of possible system choices to a few which can then be analyzed in greater technical and economic detail.

Cost-effectiveness analysis is subject to limitations when used in analyzing projects involving commercial telecommunications services. First, it is designed to compare dollar costs with non-monetary quantitative units, and avoids direct comparisons of dollar costs with dollar revenues or benefits. Thus, it stops at least one step short of coming to grips with the ultimate problem of evaluating revenue-generating projects. Second, in its application to feasibility studies, cost-effectiveness analysis is largely dependent on the establishment of a fixed number of "requirements."¹ In fact, the costs of filling anticipated requirements may necessitate a revision of rates which will, in turn, affect the magnitude

¹ See discussion in Chapter Five, "Selection of Technical Alternatives and Configurations."

of requirements. This problem, which is a familiar one to the public utility economist, may prove quite difficult for a cost-effectiveness analyst to handle by use of conventional techniques.

C. PUBLIC UTILITY ANALYSIS

Public utility analysis is concerned with the economics of monopolies which are regulated in the public interest. It deals with rate-making principles,¹ capital structure, service adequacy, rates of return on investment, and other aspects of business operation. In the telecommunications field, many public utility analysts are accustomed to dealing with a fairly conservative industry whose present requirements and future prospects are reasonably clear. As a body of doctrine and practice, public utility analysis tends to be slow in coming to grips with circumstances in which rapid and fundamental changes occur in system parameters. Unlike cost-benefit analysis, public utility analysis does not seek to measure benefits external to the telecommunications administration; its principal concern is with relationships existing within the telecommunications administration itself.

D. COST-BENEFIT ANALYSIS

Cost-benefit analysis is a set of techniques which were first used to evaluate the public river valley development projects of the 1930's,

¹ See discussion in Chapter Six, "Rate Structure Analysis."

such as those sponsored by the Bureau of Reclamation and the Corps of Engineers. Cost-benefit analysis is presently prescribed as an evaluation technique by the Agency for International Development for studies of the feasibility of capital projects. Cost-benefit analysis assigns dollar values to the costs and benefits associated with a capital project, and quantifies relationships among time-phased costs and benefits in terms of a criterion of "public profitability". Cost-benefit analysis seeks to identify benefits and costs wherever they may occur in the economy. It looks beyond the telecommunications agency to a project's quantitative impact on the entire nation. It is concerned ultimately with the effect which a proposed investment will have on the national income of the country in which it is made.

Cost-benefit analysis provides a broad and comprehensive framework for evaluation. There are, however, several problems associated with cost-benefit analysis. First, there is the difficulty of quantifying, in dollar terms, the "external economies," that is, the economic impact of the project outside of the telecommunications agency involved. This problem is considered in Chapter Nine, "Telecommunications Development and Economic Growth." Second, the use of both public utility rate analysis and cost-benefit analysis in projects of large magnitude can lead the evaluation in a circle. Thus if: (1) telecommunications rates are established on the basis of a "fair rate of return on investment"

as established by the rate analyst; (2) the investment in the proposed project strongly influences the specific rates set for the specific services which it is to provide; and (3) the revenues from the project constitute all or a large proportion of the revenues which are taken into account in the time-phased evaluation by the cost-benefit analyst; a tautological result will follow. The "fair rate of return" calculated by the rate analyst at the start will largely determine the cost-benefit analyst's results at the end. In effect, project evaluation becomes little more than a self-fulfilling prophecy. Third, there is a continuing debate among theorists and practitioners as to which method is most appropriate for converting time-phased streams of costs and benefits into a meaningful evaluation criterion.

The three most important types of cost-benefit methods--benefit-cost ratio, net present value, and internal rate of return--will be discussed in the following subsections.

1. Benefit-Cost Ratio

The benefit-cost ratio is a ratio of total discounted present benefits, B^0 , to total discounted present costs, C^0 .

The discounted present values of a stream of benefits and costs accrued in future years are defined as:

$$B^O = \frac{b_1}{(1+r)} + \frac{b_2}{(1+r)^2} + \dots + \frac{b_n}{(1+r)^n} + \frac{s_n}{(1+r)^n}$$

$$C^O = \frac{c_1}{(1+r)} + \frac{c_2}{(1+r)^2} + \dots + \frac{c_n}{(1+r)^n}, \text{ where}$$

r = opportunity cost of capital in terms of a rate of interest

n = number of years

s_n = net salvage value of physical components

$b_1, b_2, \dots, b_n$ = benefits

$c_1, c_2, \dots, c_n$ = costs

Both benefits and costs are discounted by the opportunity cost of capital so that the investment can be placed in proper perspective to other investment opportunities. If the benefit-cost ratio, B^O/C^O , is greater than 1, the project may be considered a candidate for investment. There are a number of difficulties with the cost-benefit ratio. It is, for a number of technical reasons,¹ an unreliable way of comparing projects which have differing useful lives, or involve differing magnitudes of investment. This could prove to be the case in comparing an earth station with HF facilities as a means of serving international

¹

See Clell G. Harral, Preparation and Appraisal of Transport Projects, Washington: The Brookings Institution, October, 1965.

traffic. The second difficulty is that the opportunity cost of capital is very difficult to approximate in developing countries. To establish such a rate of interest would require a major research project in itself. However, by analyzing two polar interest rates, e. g. , six percent and 20 percent, it may be possible to establish that variations in cost of capital do not really make a difference to the evaluation.

2. Net Present Value

Net present value is defined as $B^0 - C^0$ using the terminology set forth above. Although there has been, and continues to be, much discussion among practitioners and theoreticians as to the relative merits of net present value and internal rate of return, the balance of evidence appears to be on the side of net present value. The most cogent argument against the use of net present value is that the opportunity cost of capital has to be determined, and that this is extremely difficult to do except by estimating outside limits. However, the ostensible alternative, the internal rate of return criterion, also requires a knowledge of the opportunity cost if it is to be soundly applied.

The advantage of net present value is that it gives the net dollar benefit to the economy stemming from the project. The benefit-cost ratio and the internal rate of return, while presenting relative measures of benefits, do not indicate total net benefits. In those cases in which overall contribution to economic growth is of vital importance,

the total net benefits, as determined by the net present value method, should be known. A project with the highest net present value may not have the highest benefit-cost ratio.

3. Internal Rate of Return

The internal rate of return has become a popular method of cost-benefit evaluation in recent years. Practitioners have felt that the method precludes the need for determining the opportunity cost of capital, at least as precisely as is required for the net present value formulation. Thus, in the following formulation, R , the internal rate of return, is the only unknown:

$$0 = \frac{b_1}{(1+R)} + \frac{b_2}{(1+R)^2} + \dots + \frac{b_n}{(1+R)^n} + \frac{s_n}{(1+R)^n} - \frac{c_1}{(1+R)} - \frac{c_2}{(1+R)^2} - \dots - \frac{c_n}{(1+R)^n}$$

However, the simplicity of the solution is misleading. The internal rate of return has many of the same deficiencies as the cost-benefit ratio, and is no less dependent on a determination of an opportunity cost of capital -- for a complete understanding of the investment situation -- than is the net present value formulation.¹ The essential point is that a project with the highest internal rate of return, often -- as in the case of the benefit-cost ratio -- will not be the project which will contribute the most to economic development in absolute dollar terms. An additional

¹ Clell G. Harral, Preparation and Appraisal of Transport Projects, Washington: The Brookings Institution, October, 1965.

danger with **the** internal rate of return formulation is that, where investment alternatives involve projects with different time profiles of costs and benefits, quite erroneous conclusions may be drawn.

4. Assessment

Net present value has more to recommend it as the sole tool of economic evaluation than do the other two methods, even though the opportunity cost of capital has to be treated in some fashion. Where feasible, all three methods should be used and the results compared. This will enable the decision maker to determine if the choice of criterion really has a significant impact on the conclusions of the study.

E. BUSINESS INVESTMENT ANALYSIS

Business investment analysis is a way of **assessing the financial** performance of an organization, and is a method of determining requirements for loans or grants from appropriate funding sources. It may also be used as a project evaluation alternative to cost-benefit analysis if cost-benefit analysis proves to be too unwieldy in a given situation.

Business investment analyses are necessary in order to determine the financial viability of operating agencies and the financial status of the related development project.¹ While many facets of financial

¹ Methods which do not evaluate performance over the entire useful life of a project, such as break-even analysis, or payback period analysis, should be used with great caution.

structure can be probed, an in-depth profile of the overall structure may be constructed through the use of three different pro forma statements.¹ These are the income statement, the balance sheet, and the sources and uses of funds statement, also called, or closely related to, funds flow or cash flow statements. Each of these will be discussed below.

1. Pro Forma Income Statement

Also called the profit and loss statement, the income statement is a critically important collection of financial information concerning an organization or project. It shows operating revenues, operating expenses, and all non-operating expenses, including interest, taxes, and depreciation. The result shows profit or loss (net income or net loss) for the operating period in question.

Ideally, profit and loss statements should be prepared with and without the proposed improvements. This procedure allows evaluation of the differential financial impact produced by the proposed project. If several alternatives are involved, the effort required can be massive. In practice, therefore, the analyst may be required to seek analytical shortcuts. Such techniques are difficult to prescribe in advance, and require a high degree of judgment.

¹ In some cases, telecommunications administrations will not have prepared these kinds of financial statements in the past. Under such circumstances, the task of creating pro forma statements will be very substantial.

2. Pro Forma Balance Sheet

A balance sheet essentially shows the financial status of an organization at a given point in time, commonly the end of an operating year. It balances assets against liabilities and shareholders' equity. Financial analysts whose experience has been gained in evaluating private companies place great emphasis on the growth of net worth, liquidity, and various ratios among balance sheet items. On the whole, however, such types of analysis are less significant for a national telecommunications administration than they are for a private company. Critical insights for the evaluation of telecommunications projects emerge from analysis of the financial dynamics of changes which occur in balance sheets from year to year. For this reason, balance sheet analysis should be supplemented with analysis of sources and uses of funds statements.

3. Pro Forma Sources and Uses of Funds Statements

Sources and uses of funds statements bridge the gap between the information presented in income statements and that presented in balance sheets. Essentially it sets forth the sources of all funds which were available to an organization during the operating period in question, including net income, loan proceeds, capital stock, subsidies, and depreciation allowances, and subtracts therefrom investments, equipment purchases, debt repayment, and dividends. The result is the net change in working capital. A somewhat different treatment of the accounts will yield net change in cash position. These statements give better insights into the financial dynamics of the organization than can be determined from either the income statement or the balance sheet alone.

F. EVALUATION METHODS AND PROJECT DESIGN

Ideally, a telecommunications study should include full elaboration of all four types of analysis. However, time and funding constraints often prevent this. Consequently, study designers are often faced with the critical problem of selecting for inclusion in a scope of work a limited analytical framework, which must, however, be adequate in light of the following considerations:

- How many system alternatives requiring evaluation are likely to emerge from the study;
- What analytical scope and level of detail is required for adequate evaluation; and
- Are personnel with the full range of skills available?

To frame a meaningful scope of work in the light of these considerations, the designer should have a keen appreciation of the state of the art, and the practical requirements of the various kinds of analysis. Unless substantial resources are available for the purpose, for example, it may not be prudent to require intensive analysis of external benefits in a cost-benefit analysis. Nor is it reasonable to expect that a project requiring investment on the part of several nations will not require substantial attention to rate structure problems. Another important consideration is that cost-effectiveness analysis and business investment analysis provide hard and useful insights into the circumstances facing telecommunications administrations in developing countries, and that the theoretical advantages of other forms of analysis should not be allowed to divert attention from these insights.

CHAPTER EIGHT

TELECOMMUNICATIONS DEVELOPMENT AND THE SOCIOECONOMIC ENVIRONMENT

A. INTRODUCTION

The purpose of this chapter is to consider socioeconomic factors which affect telecommunications development. Section B deals with telecommunications development from the perspective of the present and future socioeconomic environments of developing nations.

Section C assesses specific implications of the relationships between telecommunications development and the socioeconomic environment for the design of future studies.

B. TELECOMMUNICATIONS DEVELOPMENT AND THE SOCIO-ECONOMIC ENVIRONMENT IN PERSPECTIVE

Vast changes have occurred in the developing nations over the past thirty years. The pace of change should accelerate during the remainder of the century, as the developing nations take significant steps toward industrialization, and as they experience more acutely the cultural and economic impacts of modern technology.

The developing countries may be expected to attempt to telescope these processes of technological and social change which have occurred somewhat more gradually in industrialized states. These processes will be accompanied by requirements for the development of many types of telecommunications systems.

The developing nations are presently characterized by suppressed demand for "single destination", as distinguished from "mass", communications modes. Single destination modes include telephone, telegraph, telex, and other services which are essentially used to transmit information from an origin to an individual destination, or to allow simultaneous transmission between two points.

To the extent that the drive toward an industrial society, with its related business, professional, and service requirements is successful, it will accelerate the use of, and need for, greatly expanded communications services. Telecommunications requirements will grow in volume, quality, and sophistication as population grows, as wealth increases, and as society becomes more complex. The outlook is for increasing investment in telecommunications, both on an aggregate and per capita basis.

The age of mass communications has arrived in industrialized nations. Mass communications include newspapers, magazines, radio, and television. The two latter media may be considered as "broadcasting" or "mass telecommunications". The impact of mass communications is just beginning to be felt among the developing nations. A significant and continuous development of mass telecommunications may be anticipated in the next decades among these nations.

Mass telecommunications has at least three facets of importance to developing nations. First, mass communications has

great potential for working changes in a nation's social, economic, and political environment. Second, radio and television can help to lift a nation's educational level and create a sense of national purpose and unity. Third, mass communications can also create rising expectations which are difficult to fulfill and can serve as an instrument of authoritarianism.

However mass communications may be employed in developing nations, it is quite clear that they will be employed. It may be anticipated that future telecommunications studies will be increasingly concerned with interrelationships between individual destination telecommunications systems and mass telecommunications. Such studies will pose interesting challenges, particularly in the area of placing quantitative values on benefits. The further the state of the art for studies of bilateral telecommunications can be advanced, the easier it will be to deal with additional complexities posed by mass telecommunications.

C. SOCIOECONOMIC FACTORS AND STUDY DESIGN

At present, requirements for mass telecommunications occupy a peripheral position in most conventional studies of single destination telecommunications in developing countries. For example, it is sometimes necessary to determine whether television channels should be included in the design of a satellite earth station or a microwave link, although the subject is usually not treated as one of central concern. Likewise, a telecommunications administration may provide technical services to its

Ministry of Communications, i. e. , the organization responsible for mass communications. In such cases, it is often desirable to examine the financial and organizational relationships involved to determine whether adequate compensation is being provided and to determine whether the arrangement is a prudent one from the point of view of good management.

Socioeconomic factors may be of considerable importance to studies concerned with single destination modes. In international regional studies, in particular, it is useful to ascertain the socioeconomic composition of neighboring countries as part of an assessment¹ of the prospects for regional cooperation.

A perceptive telecommunications analyst will examine the ethnic composition of a telecommunications organization in order to determine whether the organization is recognizing talent wherever it may be found, or whether it is confining its source of talent to specific tribal or societal elements. An organization which places a premium upon talent, wherever it is found, will generally prove to be more efficient than one which is more restrictive in developing talent. On the other hand, ethnic factors may cause difficulties in a telecommunications organization, or may deprive it of talent which it has already developed.

1 See discussion in Chapter Ten: Regional International Organizations.

The telecommunications analyst's task in such a case is to examine the possibilities of ameliorating the difficulties, or of predicting the future course of events and suggesting alternative sources of talent.

It often occurs that while some telecommunications services are very profitable, others are barely paying for themselves, or are even operating at a loss. In developing countries, the latter is often the case with inland telegraph, interurban telephone, and even urban telephone services in small population centers. This difference in the profitability of different services may reflect socioeconomic and political weightings within the telecommunications rate structure. For example, the less profitable domestic service, generally used by the indigenous lower and middle strata of society, is often compensated for by the profitable international service, which is largely used by high income foreign businesses and operators. Likewise, the provision of economic or telecommunications development in remote or newly opened areas may be deemed an important societal objective, even though such service is far from profitable. Such factors should be taken into account in analyzing the total pattern of a telecommunications organization's rates and revenues.

Traffic analysts often find considerable differences in patterns of modal usage among developing countries. The differences may be attributable in part to cultural preferences. For example, certain ethnic groups may attach great importance to a paper copy of a message, or perhaps require it in order that a message, in a foreign language, can

be translated at leisure. On the other hand, another societal group may distrust record communications because of deep suspicions that unless a sender can ascertain that a communication has been delivered, the telecommunications administration will have no reason to deliver it.

A perceptively designed and well-executed telecommunications study can yield basic data of value beyond that pertaining to telecommunications development alone. Insights into the basic political structure of a country can be strengthened by an examination of the ethnic and regional structure of the telecommunications organization. Perspectives on social and economic relationships among areas within a country can be derived from an analysis of the magnitude and composition of telecommunications traffic. A thorough knowledge of telecommunications development can clarify factors of critical importance to analysts of the social, economic, and political growth of a nation, and suggest new insights into the dynamics of developing societies.

CHAPTER NINE

TELECOMMUNICATIONS DEVELOPMENT AND ECONOMIC GROWTH

A. INTRODUCTION

The purpose of this chapter is to explore the contribution which telecommunications development makes to economic growth as this consideration impacts on telecommunications studies. The role of telecommunications in economic growth may be approached both qualitatively and quantitatively. Section B deals with the role of telecommunications in economic growth. Section C discusses related considerations of study design.

B. ROLE OF TELECOMMUNICATIONS IN ECONOMIC GROWTH

In practice, there has been little success in attempting to quantify the relationships between a particular project and growth of national income in developing nations. This is unfortunate, since it is apparent that telecommunications often contributes significantly to economic development. A quantitative formulation of this relationship would aid in developmental planning.

Much work has been done in examining how economic indicators correlate with telecommunications development, and some relationships have been found to exist. These were discussed in Chapter Four, and will not be examined further here.

The role of telecommunications in economic growth may be approached from several directions, including consideration of telecommunications as:

- A precondition for attaining self-sustaining economic growth;
- An element of infrastructure;
- A competitor for scarce resources;
- An important input to the outputs of key users; and
- A component of gross national product.

Each of these approaches is discussed in the following subsections.

1. Precondition for Attaining Self-sustaining Economic Growth

A number of economists have emphasized the importance of communications in the transition of a nation from a traditional society to one in which the dynamics of self-sustaining economic growth are free to operate. Walt Rostow writes:

The transition we are examining has, evidently many dimensions. A society predominantly agricultural--with, in fact, usually 75% or more of its working force in agriculture must shift to a predominance for industry, communications, trade, and services. (underlining supplied)

A society whose economic, social, and political arrangements are built around the life of relatively small--mainly selfsufficient--regions must orient its commerce and its thought to the nation and to a still larger international setting.¹

¹

W. W. Rostow, The Stages of Economic Growth, Cambridge, Massachusetts, 1960, pp. 18-19.

W. Arthur Lewis links the development of internal communications to growth of foreign trade and rising per capita incomes. "It is clear," he states, "that the early stages of economic growth are marked by increased international specialization, associated with the development of communications..."¹ In these transitional stages, geographic accessibility is increased and markets become larger. Urbanization increases, local isolation is reduced, and the horizons of economic activity expand rapidly. Relatively large investments in public utilities are required to establish a framework which allows the establishment and growth of new enterprises.

Improvements in telecommunications, particularly when associated with improvements in transportation, can play an important role in the advancement of a developing region to a level of self-sustaining economic growth.²

2. An Element of Infrastructure

Telecommunications facilities, along with highways, ports, and electric power generating facilities, are often categorized as elements of the infrastructure of a country's economy. The term "infrastructure" implies something which must be in place before something else can be constructed or utilized. Investments in infrastructure are thereby placed in a predecessor relationship to external

¹ W. Arthur Lewis, The Theory of Economic Growth, London, 1955, p. 342.

² See Final Report, President's Task Force on Communications Policy, December 7, 1968, Chapter Four.

benefits expected to be derived from those investments. The relationships between telecommunications and transportation are particularly important in developing regions, especially in relation to distribution, marketing, government administration, and national security.

A basic investment in telecommunications is required in order to enhance access to an economic area, and to subsequently allow its development based upon modern technology. Moreover, once telecommunications links are established and used productively in a fairly promising location, they become in themselves locational attractions.

Where telecommunications services have lagged behind the development of other sectors of the economy, investment in their improvement serves as an essential element of expansion which unlocks potentialities of growth implicit in the disequilibrium. Where the telecommunications sector moves modestly ahead of balanced expansion of other sectors, it can serve as a stimulant or pace setter for the latter.

Whether considered as a precondition for attaining self-sustaining economic growth, or as an element of infrastructure, it is apparent that there exists no meaningful or effective alternative to telecommunications as a service to the economic activities which characterize advanced stages of development.

3. A Competitor for Scarce Resources

Telecommunications is a competitor for scarce resources, mainly skilled labor and investment capital. Hence, telecommunications investments should be compared with meritorious projects in other sectors which require these scarce resources. Telecommunications projects of course contribute to gross national product, as do other projects, although they tend to be relatively modest in terms of the size of the required investment. On the other hand, they tend to draw on the most proficient and technically sophisticated groups within the population. Advanced systems, in particular, demand types of manpower which are likely to be in very short supply in a developing economy. Hence the labor-supply implications of such projects should be carefully assessed.

4. An Important Input to the Outputs of Key Users

The impact of telecommunications on economic growth may be conceived of in terms of the significance of the services rendered to users who in turn utilize these services in making direct and important contributions to economic growth. Telecommunications are extremely important to industries whose sources of supply, markets, or operations are spread over large distances, and whose profits are subject to the uncertainties of supply and demand. As domestic or international competition becomes more severe, the uncertainties of supply and demand tend to increase, and good communications become more important.

In most developing countries, the major users of telecommunications services can be readily identified. Main users typically include transportation activities, major producers, banking interests, importers, exporters and government. Such users may well obtain substantial benefits from improved telecommunications. If they are given suitable assistance, users can usually supply enough information to indicate the order of magnitude of the dollar benefits or cost savings to their operations which may be attributable to improved telecommunications. Likewise, information can be obtained from key users as to their links, via telecommunications, with other industries. An effort of considerable proportion is required to gather and consolidate such information, but such an effort is strategic in the process of linking a specific telecommunications project to its impact on economic growth.

5. A Component of Gross National Product

Telecommunications may be viewed as a component of gross national product in at least two ways. First, it may be possible to establish the percentage of gross national product typically or optimally represented by telecommunications in various stages of development. If such percentages were established on the basis of a broad survey, it might be possible to identify situations in which a particular country's services were undesirably constricted or unnecessarily overdeveloped. However, few developing nations list

telecommunications separately in their national accounts. Most often, such services are lumped with transportation services and are not separately identifiable without extensive analytical effort. If such an analysis were feasible, moreover, it would only serve as an indicator of a general state of affairs, and would not directly identify the specific contribution which a particular project would make to national income.

A second, and more pertinent way of looking at the relationships between telecommunications and gross national product would attempt to link the particular project to its ramifications throughout the national economy by means of an input-output table. Such a procedure would require a very thorough analysis of the type suggested in Subsection 4. It also would require a fairly detailed input-output table. The construction of such a table is a large research task in itself, and usually could not be justified on the grounds of its contribution to telecommunications analysis alone.

C. DESIGN CONSIDERATIONS

The problem of relating telecommunications development to economic growth in quantitative terms is one of the most challenging areas of telecommunications analysis, both in terms of its theoretical complexity and its practical importance. It is not a small problem and it is not realistic to suppose that it can be addressed in all its implications within the scope of any of the four principal types of studies discussed in this

report. A feasibility study can, within the market analysis, discover some potential savings and economic opportunities likely to result from a given project, and it can also make modest contributions to theory and practice in the area. However, for a thorough evaluation, designers of telecommunications studies are faced essentially with two choices. First, they can mount a major effort to solve the problem by means of a separate study addressed solely to this purpose. Second, they can seek to achieve a steady growth in knowledge from study to study by requiring analysts to review previous research, and to devote specific amounts of effort to testing hypotheses designed to advance the state of the art in this important area.

CHAPTER TEN

REGIONAL INTERNATIONAL ORGANIZATIONS

A. INTRODUCTION

This chapter discusses the role of international regional organizations in telecommunications development. The chapter focuses on problems of study design, giving particular attention to lessons learned from Checchi studies of African telecommunications. Section B deals with the relationships between regional integration and regional international organization. Section C discusses the considerations which are important to study design.

B. REGIONAL INTEGRATION AND REGIONAL TELECOMMUNICATIONS ORGANIZATIONS

Regional integration in the field of telecommunications often has substantial technical and economic advantages. However, a number of difficulties stand in the way of such integration, including problems of international regional organization.

It should be clearly understood that regional integration and regional organization are not identical. It is possible to have an integrated telecommunications network shared by several countries without establishing an international organization to own and operate the network. Conversely, a regional telecommunications organization can remain in existence for considerable periods of time without successfully achieving an integrated regional network. There is no

single organizational route to achieving regional integration in telecommunications or indeed in other areas in which integration may be desirable.

Consider the case of Africa. During the colonial period, both Great Britain and France instituted measures for regional cooperation among their respective African territories. As early as 1923, a common market was formed by Kenya, Tanganyika, and Uganda. Gradually, the three British East African territories amalgamated port, transportation, communications, and other services under unified authorities, a procedure which was continued after independence. The Federation of Northern and Southern Rhodesia and Nyasaland,¹ created in 1953, was an even more ambitious attempt at regional cooperation, both political and economic. However, the Federation, advocated by most European settlers, was not enthusiastically embraced by African nationalists, perhaps because it appeared to be a means of perpetuating white domination, and perhaps because some of its members felt that the benefits would be apportioned unequally. In any case, the Federation no longer exists.

New efforts to achieve regional cooperation among independent African countries date from 1961. Only eight countries were in a position to determine their own policy before that year. These were Ethiopia,

¹ These countries are now the countries of Zambia, Rhodesia, and Malawi, respectively.

Libya, Sudan, Tunisia, Morocco, Guinea, Liberia, and Ghana. In 1959, Guinea and Ghana formed a political liaison which they conceived of as being the nucleus of a wider union of African states. The union did not develop, however, and thus did not serve as a model for the rapidly increasing number of newly independent African nations. Eighteen more countries became independent in 1960, including the remaining French territories, the Belgian Congo and the Trust Territories of Ruanda and Burundi, Nigeria, and Somalia.

Divisive forces have been very much in evidence in the past decade. Since the years immediately following independence, political conflicts have troubled relations among many African countries. Internal conflicts have also been very common, and have been particularly acute in the Congo and Nigeria. Where economic and financial matters are involved, there has been little tangible progress in recent years toward regional cooperation among more than a few countries. Although there have been some signs of improvement in this regard, international regional cooperation is not a clearly predominant trend.

For purposes of discussion, three categories of African telecommunications-related organizations may be identified. These are (1) world-wide and continental organizations, (2) "hard" regional operating organizations, and (3) "loose" regional affiliations of countries which have, or are contemplating, telecommunications agreements in limited areas.

1. World-Wide and Continental Organizations

The Economic Commission for Africa (ECA) is a United Nation's regional body created by the Economic and Social Council in 1958 as one of its four Regional Commissions. It is dedicated to the promotion and planning of African economic and social development through cooperative and regional action by African states. All independent African countries except South Africa are full members. It is presently working with the International Telecommunication Union (ITU) in developing African telecommunications networks and was instrumental, along with the ITU, in the recent successful completion of the pilot link between Addis Ababa and Abidjan.

The ITU is the international organization responsible for technical standards, frequency registration, and other technical matters related to telecommunications. It also supports developing countries in establishing their facilities by giving various kinds of assistance, such as:

- Advice as to the organization of administration and services;
- Establishing institutions for vocational training and the training of staff personnel of telecommunications administrations; and
- Technical recommendations for circuits, networks, surveys, pilot projects and other pre-investment activities.

The Organization of African Unity (OAU) is an African organization formed to coordinate and intensify African cooperation in all fields. Like the ECA, it has as members all the independent African countries except South Africa. The OAU has actively sponsored regional economic cooperation, and although it is not specifically telecommunications-oriented, it cooperates with the ECA and ITU for telecommunications purposes.

The three organizations discussed above, although effective in providing assistance, are not meant to be telecommunications operating agencies.

2. "Hard" Regional Operating Organizations

There is presently in Africa only one operating "hard" regional telecommunications organization. This is the common telecommunications administration of Kenya, Uganda, and Tanzania which operates corporately as the East African Posts and Telecommunications Corporation, and which is an integral part of the East African Community (EAC).¹ The EAC is much more than a telecommunications organization. It is, in addition, a common market under which there is planned to be, among other things, a common external tariff and internal freedom of transit. The EAC has also undertaken to harmonize monetary policies

¹ The EAC is the successor to the East African Common Services Organization (EACSO).

among its members. The EAC has succeeded in attracting the applications for membership of Zambia, Ethiopia, Somalia, and Burundi.

Another African organization, the Transequatorial Communications Agency (ATEC), was organized to be responsible for the maintenance of international surface communications among the Central African Republic (CAR), Chad, Congo (Brazzaville), and Gabon. However, ATEC has apparently not fully accomplished this purpose.

3. "Loose" Regional Affiliations

African organizations which are involved with regional telecommunications, other than the East African common telecommunications administration, may be termed "loose" affiliations. To date, their contributions to regional telecommunications growth in Africa have been limited. Such organizations include the following:

- Organisation Commune Africaine et Malgache (OCAM)

This organization, which includes the 14 ex-French and ex-Belgian territories of Cameroon, the Central African Republic, Chad, Congo (Brazzaville), Congo (Kinshasa), Dahomey, Gabon, Ivory Coast, Malagasy Republic, Niger, Rwanda, Senegal, Togo, and Upper Volta, is affiliated with France mainly for technical assistance purposes.

The telecommunications coordinating organization attached to

the OCAM is the Union Africaine et Malgache des Post et Telecommunications (UAMPT).

- Council de l'Entente

This organization, comprised of the Ivory Coast, Dahomey, Niger, Upper Volta, and Togo, is a regional organization within OCAM. It is charged with, among other things, the coordination of the economic and foreign policies of its member nations in the field of communications.

- Regional Economic Organization of the Maghreb

This organization, comprised of Algeria, Libya, Morocco, and Tunisia, is devoted to furthering community action in all economic spheres, and thus has the potential for effective telecommunications cooperation **similar** to that of the East African Community. Meanwhile, the Maghreb commission dealing with Transport and Communications is working toward cooperation in the field of communications.

- Union of Central African States (UEAC)

This organization, comprised of Congo (Kinshasa), Central African Republic, and Chad, but with membership open to all African states, is organized to provide for the progressive attainment, among other things, of common transport and telecommunications organizations.

- West African Regional Group (WARG)

This organization, still in the process of being created, is comprised of Gambia, Ghana, Guinea, Liberia, Mali, Mauritania, Nigeria, Senegal, and Upper Volta. It is designed to foster a West African Economic Community, and would contribute, hopefully as successfully as the East Africa Community, to cooperation in telecommunications.

4. Choice of Regional Organizations

The choice of the appropriate form of regional telecommunications organization to foster cooperation in telecommunications development requires a careful assessment of existing international relationships, as well as of the nature of the regional telecommunications systems envisioned. A regional organization can be ineffective because it is too "hard" for the situation, just as it can be if it is too "loose". A very careful evaluation must be made as to the degree of cooperation which is likely to exist among regional neighbors, as well as to the organizational imperatives which may flow from an analysis of the characteristics of a particular regional telecommunications system.

C. REGIONAL ORGANIZATIONS AND THE DESIGN OF TELECOMMUNICATIONS STUDIES

Exhibit Six lists a number of regional designations considered in the Checchi study of a satellite earth station for Ethiopia. These regional groupings were based on geographic, ethnic, economic, and other

EXHIBIT SIX
SELECTED REGIONAL DESIGNATIONS

<u>Designation</u>	<u>Number of Countries In Region</u>	<u>Composition</u>	<u>Designator</u>
Coptic Plateau and Horn of Africa	3	Ethiopia, French Somaliland, Somali Republic	<u>Oxford Regional Economic Atlas</u>
Northeast Africa	4	Ethiopia, French Somaliland, Somali Republic, Sudan	<u>Africa, A Hand- book of the Continent</u>
Earth Station Regional Study Area	5	Ethiopia, French Somaliland, Somali Republic Sudan, Kenya	Checchi and Company
Intercontinental Traffic, Zone 15	5	Ethiopia, French Somaliland, Sudan, United Arab Republic, Libya	International Telecommunica- tion Union
East African Economic Community	5	Kenya, Uganda, Tanzania, Ethiopia (applicant), Somali Republic (applicant)	East African Economic Community
Eastern Region, Africa	8	Ethiopia, Somali Republic, Kenya, Uganda, Tanzania Malawi, Zambia, Malagasy Republic	U. N. Economic Commission for Africa

Sources: Africa, Oxford Regional Economic Atlas, 1965, p. 8.

Africa, A Handbook of the Continent, 1966, pp. 71-104.

ITU, General Plan for the Development of the International
Network, 1964-1968, 1964, p. 32.

"Survey of Africa's Economy", The New York Times,
January 2, 1968, p. C49.

relationships. They reflected the particular set of purposes which the designators had in mind.

The international regional analysis contained in the Ethiopia study was concerned with the regional traffic and technical implications of the installation of a satellite earth station in Ethiopia, and with the contribution to regional economic development which might stem from such a project. Based on an assessment of present and potential economic and telecommunications relationships among Ethiopia and neighboring countries, a grouping consisting of Ethiopia, Sudan, French Somaliland, the Somali Republic, and Kenya was selected for study. These five countries have a spatial proximity which gives rise to the possibility of common earth station use. It was this spatial proximity, combined with existing transport, trade and telecommunications relationships, which served to define the international study region. It should be noted that the grouping designated by Checchi for purposes of its satellite earth station study differed considerably from Zone 15 established by the ITU for other purposes.

An assessment of economic, political, and telecommunications relationships among the countries of the Checchi regional grouping indicated that there would be little likelihood that substantial volumes of traffic originating in or destined for countries contiguous to Ethiopia would be routed through an Ethiopian satellite earth station. Hence, a

consideration of new international regional arrangements was not critical to the study.

By contrast, new international arrangements were found to be needed in Checchi's study of an international microwave trunk route servicing Nigeria, Dahomey, Togo, Ghana and the Ivory Coast. As shown in Exhibit Seven, these countries were found to differ greatly in size, wealth, European orientation, and ethnic composition. The various arrangements which exist in West Africa for the organization and management of telecommunications were found to represent well-established interests of a financial, political and organizational nature. It was determined that successful operation of the proposed microwave link requires closer collaboration among these interests than had existed before. However, it was suggested that the participating countries should be left as much freedom as possible to negotiate mutually satisfactory arrangements, rather than being tied down to specific details of organization in advance.

Fundamental changes in existing institutional arrangements in West Africa were not found to be required as a prerequisite for establishing the proposed telecommunications system. An attempt to set up a multinational service agency along the lines of the East African Community might not prove successful in West Africa, and could lead to misunderstanding and delays. It was recommended that

EXHIBIT SEVEN
FIVE WEST AFRICAN COUNTRIES
SELECTED DATA

Country	Population (millions)	Area (square miles)	GNP Total (million \$)	GNP Per Capita (\$)	Principal European Orientation	Major Ethnic Groups
Nigeria	42.7	356,700	4,370	102	Great Britain	Hausas Ibors Yoruba Fulani Ijaws Kanuri Ibibios Efiks
Dahomey	2.2	44,700	154	70	France	Fons Yoruba Baribas Sombas Peuls
Togo	1.6	22,000	144	90	France	Ewe Adja-Watyi Kabrai-Lasso
Ghana	7.5	92,100	1,890	251	Great Britain	Ashanti Fanti Ewe
Ivory Coast	3.7	127,500	795	215	France	Agni-Ashanti Krou Senoufu Mande

Source: Checchi and Company, A Study of the Economic and Technical Feasibility of Improving International Telecommunications in West Africa (1968), p. II-3.

international arrangements for operating the proposed system be limited to those requirements which are clearly essential to the trunk route itself.

The proposed international telecommunications system was envisioned as providing in itself a basis for a modest and feasible step toward attaining regional cooperation in West Africa. Such a step forward was viewed in terms of cooperation among managers and technicians in national telecommunications agencies. It was deemed unwise to encumber the proposed microwave link with a highly elaborate international organization structure, or to tie it too closely to other plans for regional economic and political integration. An international committee structure concerned solely with multinational aspects of the proposed link was deemed to be sufficient.

The results of the Ethiopia and West Africa studies suggest that the following considerations are pertinent to the design of telecommunications studies:

1. Importance of Regional Organizations

The designer of telecommunications studies should not, in general, attempt to prejudge the form which regional international organizational arrangements should take. In most instances, however, he will have enough information available to him to evaluate in advance the relative importance of this type of analysis to a given study. The technical

characteristics of the telecommunications system to be evaluated, the number of countries in which it may be located, and the relative importance of regional traffic will normally provide good indicators of the importance of a regional international organization to the study results. A brief review of the most recent ITU international traffic matrices,¹ a brief examination of alternative system characteristics,² and a review of the circumstances which have given rise to the study will usually be sufficient for this purpose.

2. International Relationships

International political relationships between developing countries can be quite mercurial. Disputes may stem from disagreements over boundaries, differing orientation toward industrialized countries, or disagreements concerning internal political affairs. Like commercial air transport and postal relationships, telecommunications relationships among neighbors may be isolated, to a degree, from political difficulties. Nevertheless, where international problems are of a longstanding or particularly bitter nature, they can complicate organizational arrangements with respect to regional telecommunications, and can require substantial analytical effort in order to formulate approaches to solutions.

¹ See discussion in Section B of Chapter Three.

² See discussion in Section D of Chapter Five.

3. The Relative Size and Importance of the Countries Under Study

An integrated network usually requires (1) agreement as to which nations are to serve as transit centers for their neighbors and (2) agreement on the part of some nations to accept a higher degree of dependence on the telecommunications systems of neighboring countries than would be the case with a non-integrated system. It is usually easier to work out such agreements between nations whose wealth, population, and telecommunications development are unequal than it is between nations of similar size. Small nations can more easily accept a position of dependence upon the facilities of a large neighbor than on a neighbor of equal size. Two large neighbors can be vigorous competitors for the prestige of providing central facilities, the more so because each may have the resources to proceed independently. Agreements between equals often call for hard and sophisticated bargaining, and will usually impact on organizational arrangements. The study designer will usually have enough information available on potential regional partners to make reasonably good guesses concerning the complexities which may emerge from such considerations.

4. Geographical Location

The relationships between countries which are not contiguous will differ from those which adjoin each other. Normally, non-contiguous countries will be less willing to establish relationships of mutual dependence

with contiguous countries. On the other hand, there may, in such cases, be fewer immediate irritations of the type which arise from proximity. On the whole, however, the more non-contiguous countries included in the study, the more difficult the organizational problems will be.

5. Organizational Problems

If the study designer perceives the existence of a significant problem of regional international organization, he should decide whether he wishes the analysis to (1) establish a framework within which the problem can be solved by the parties, and/or (2) suggest in some detail the nature of an organizational solution. In developing a scope of work, he should recognize that the details of an organizational solution are inextricably connected with the nature of the technical and financial arrangements which are made among the countries concerned. Moreover, developing detailed plans for regional organization requires activities on the part of the analyst which take on the character of preliminary negotiations. A two-phase organizational study should be considered in such circumstances. The first phase would consist of the preparation of an economic, technical, and financial feasibility study which establishes the framework for an organizational solution, and relates it to other pertinent aspects of the proposed improvements. The second phase would commence after the principal interests concerned had had an opportunity to review the study and to react to it. Taking these

reactions into account, the analyst will then be in a position to make detailed suggestions which are pertinent to bargaining realities, and which can expedite the process of achieving constructive results.