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Options for Rural Telecommunications Development

Rogati Kayani
Andrew Dymond

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No. 301 Mohan, editor, *Bibliography of Publications: Technical Department, Africa Region, July 1987 to April 1995*

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No. 310 Elder and Cooley, editors, *Sustainable Settlement and Development of the Onchocerciasis Control Programme Area: Proceedings of a Ministerial Meeting*

(List continues on the inside back cover)

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TABLE OF CONTENTS

LIST OF APPENDICES:

LIST OF FIGURES:

LIST OF TABLES:

FOREWORD

Compared to the industrial world, telecommunications facilities in developing countries are notoriously inadequate for their social and economic needs. However, the disparity between facilities in urban and rural areas within the developing countries is often even more acute. For instance, in Bangladesh, the ratio of largest city telephone density to rest of country telephone density is 340, and in Uganda it is 50. On the other hand, in Norway it is 1.4 and in Germany, 1.2. The lack of telecommunications facilities in the rural areas translates to denied opportunities for the rural inhabitants and increasing inequity between them and their urban counterparts. Strengthening rural telecommunications services is thus a vital ingredient of any effort designed to promote the welfare of the rural population.

The present unsatisfactory state of telecommunications services results from both inadequate financing and poor management. More fundamentally, however, these symptoms reflect underlying deficiencies in the institutions and policies that govern the sector. Recognizing these realities, many countries are now enacting comprehensive reforms designed to expand and improve their telecommunications infrastructure. These policies include opening the sector to private investors who would bring in the necessary capital and management, as well as privatizing the existing government-owned telecommunications monopolies that have proved to be incapable of meeting the demand. However, most of the attention to-date has been focused on improving urban services. As the telecommunications sector evolves toward a more competitive environment in which the private actors become the main players, it is essential to develop policies designed to reduce the disparities between urban and rural telecommunications services. This technical report, prepared by a team of consultants supervised by Bank staff, provides a comprehensive analysis of the technical and financial parameters that have to be considered in formulating such policies. The report presents an array of options for commercial operation of rural telecommunications and challenges the general perception that rural telecommunications services are unprofitable. The report demonstrates that services can be economically delivered to rural areas at affordable prices while at the same time providing reasonable financial returns to investors. A planning tool kit to assist in the design of the various options is also presented.

We hope this report will be useful to policymakers as well as telecommunications operators all over the world.

Richard Stern
Director
Industry and Energy Department
Finance and Private Sector Development

PREFACE

The World Bank retained the services of a consultant (*Intelecon Research and Consultancy Ltd. of Canada*) to review relevant international experience, to draw out the lessons to be learned, and to provide an overview of the policy options for effective commercial service development within the context of the ongoing sector reform process. The focus of the study has been to answer the following four pertinent questions:

- Is there an ideal policy environment and regulatory framework for the development of rural telecommunications services in developing countries on a commercial basis?
- Are current technology and cost trends significant enough to change the financial equation, which has until now been viewed as unfavorable?
- If the technology and cost trends are positive, what are the limits of feasibility and what policy interventions would be required beyond these limits?
- Can rural service programs be established that combine commercial viability with enlightened policy intervention, in order to attract sufficient finance to accelerate the infrastructure and service deployment?

The Bank also retained Professor Heather Hudson of the University of San Francisco to review the social and economic benefits of rural telecommunications.

Methodology

The consultant used a wide range of desk research methods in this study and was also able to draw on some related field research. Useful case study data were collected from more than 26 developing countries: 10 in Asia, 9 in Latin American countries and 7 in Africa. The consultant had undertaken assignments in several of these countries and was able to obtain recent reports from others. Also, during the course of the research, the consultant collected up-to-date information on active projects in Bangladesh, Paraguay, Peru, the Philippines, and Sri Lanka.

Basic statistics were gathered on the development of rural telecommunications in many other countries, utilizing such resources as recent studies and papers of the International Telecommunications Union (ITU), conference proceedings in Asia and Latin America, and numerous other related publications and articles. At least seven member countries of the Organization for Economic Cooperation and Development (OECD) provided relevant information on strategic policies, pricing, and funding. In addition, materials from the European Union's Special Telecommunications Action for Regional Development (STAR Program) and other initiatives for Objective 1 (less-favored) regions were consulted.

To assess technology trends and ascertain their costs, the consultant contacted a number of key suppliers, who provided valuable assistance. Recent information on costs and technical applications, written submissions, and application documents and technical papers were obtained from more than 20 suppliers worldwide.

The consultant then constructed a rural telecommunications commercial feasibility model, which, together with the comparative analyses, served as the basis for determining a range of options for commercial supply of rural telecommunications. The first stage of this effort was the design of a "policy tool kit" a framework for decision making on commercial viability, policy direction, and regulatory/licensing requirements. This "tool kit" will assist Bank borrowers as they begin to devise policy strategies and measures for their own unique situations.

ACKNOWLEDGMENTS

It has been possible to complete this report because of valuable contributions from various individuals in the World Bank, Intelecon, and others. We particularly wish to thank those who participated in the workshop of June 1995 where the original draft of this report was thoroughly discussed.

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We also like to thank Barbara Malczak and Helene Masson-Bruno for editing the report; and Teresa Saldana, Beatrice Massoussi, and Arturo Castro who assisted in compiling the report.

RURAL TELECOMMUNICATIONS GLOSSARY OF TERMS

(Key terms are italicized in the definition for easy cross-reference.)

Access (policy definition)	Refers to the policy objective or target of establishing a certain level of telephone service to meet the needs of populations and communities where the existing telephone penetration is low because of income level and/or remoteness. Typical access target examples are 1 public telephone (payphone) per center of 500 population or 4 to 5 telephones (1 payphone plus 3 to 4 business/ institutional lines) per village.
Access (technical definition)	The provision of connectivity between the subscriber telephone terminal and the local exchange (could be via wire or a wireless/radio technique). The term is basically equivalent to the term *Local Loop*.
BOT, BTO	Build Operate Transfer and Build Transfer Operate - Forms of a revenue-sharing agreement in which telecommunications operating companies invite the participation of the private sector (often consortia including major equipment suppliers, operators, and commercial banks) to finance projects and to provide the operating expertise for a stipulated period of time, as defined by the agreement.
Digital	The form of electronic processing and transmission in which all information, including analog waveforms (e.g., speech and video) and control data, is converted to binary format, which is basically the same format used by computers.
Erlang	A measure of telephone traffic intensity. Networks are designed assuming a certain average volume of traffic from each subscriber during the "busy hour" of the day. One Erlang indicates a 100 percent busy condition *during one busy hour*. It is normal to assume a network-wide average traffic of 0.03 to 0.08 per subscriber, although business lines typically average 0.10 to 0.15. Public call offices in developing countries sometimes greatly exceed this average. Rural systems that are designed for optimal commercial operation may average between 0.10 and 0.15 Erlangs per line.
Fixed Cellular	The first generation of *wireless local loop (WLL)* systems. These were essentially cellular systems adapted to the fixed service market by removal of the expensive mobility software. They can offer economic solutions in a "single cell", urban and suburban environment, although the voice quality and the data and facsimile transmission speed capabilities of current generation cellular systems are limited.
GOS	Grade of Service. A design parameter used in the public switched telephone network *(PSTN)* to define the number of call attempts per 100 that are likely to be blocked (uncompleted), given a certain average subscriber calling rate (in *Erlangs*). The GOS is expressed as a

probability. For example P.01 indicates a 1 percent probability of blocking, P.02 a 2 percent probability and so forth. P.05 is considered to be the lowest acceptable design standard for rural telephone service in previously unserved areas (although P.01/P.02 is the international norm).

ISDN — Integrated Services Digital Network. A modern service in which a single subscriber connection is able to carry voice, data, facsimile and multimedia. ISDN service requires an advanced *digital* telephone exchange, a high standard (well-insulated) wire connection or high bandwidth *wireless local loop,* and a special subscriber interface unit that splits out the various service components. The combined "basic rate" digital transmission speed for ISDN service is 144 kilobits per second, comprising two 64 Kbps voice or data channels plus a 16 - Kbps control/data channel.

LEOs — Low Earth Orbit satellite systems, such as Iridium, Globalstar, and Odyssey. These systems are expected to offer fixed and mobile telephone service by the year 2000. In addition to having a potential cost advantage compared to current *VSAT* technology, these systems are not subject to the transmission delays confronting users of the high orbit geo-stationary satellite systems, which is a technical advantage.

M-SAT — Mobile Satellite services, such as recently commenced in North America. These services utilize a geo-stationary satellite that has been optimized to serve small portable or mobile terminals, which can obviously be installed as fixed terminals as well.

Multi-access — An operational feature of *point-to-multipoint (PMP)* radio or *VSAT* networks. Multi-access refers to a micro-processor controlled circuit allocation technique in which a large number of subscribers can be served on a small number of "radio trunks" or circuits. The design is based on statistical traffic averaging and concentration, whereby it is typically possible to concentrate up to 500 subscribers onto, say, 60 commonly available circuits. The concentration ratio actually achievable in practice depends on the calling rate of the subscribers (see *Erlang* for a discussion of the calling rate).

Outside Plant — See *Local Loop.*

PCM — Pulse Code Modulation. A common form of encoding and transmission in which analog speech signals are converted to *digital* format for the purpose of multiplexing (combining together) and transmission over distance. PCM is commonly used in multi-circuit inter-exchange trunk systems, or "subscriber carrier" systems in which a number of telephone subscribers along a route are served from the same cable.

PCO — Public Call Office (payphone). The traditional form of payphone is located in the PTT office, or is a coin telephone located in a public place. A more recent concept is to franchise payphone service to local business people to enable them to operate "phoneshops" or adjunct businesses within, for example, a retail store.

Penetration	See *Teledensity.*
PIN-based Service	Personal Identification Numbers (PINs), such as are used with direct debit banking and telephone calling cards. PINs can be utilized in rural environments to allow users access to long distance dialing from public or shared telephones. This would require pre-pay or credit pre-authorization. See *Virtual Telephone Service.*
PMP	Point-to-Multipoint. A form of subscriber radio system in which a number of outlying localities within line-of-sight of a single station or repeater can be connected into the telephone network at one central point. The central station is usually co-located or directly connected with the exchange and thus provides the technical network interface between the remote subscribers and the telephone exchange service. This system is commonly used in rural areas to connect widely dispersed subscribers into the network.
PSTN	Public Switched Telephone Network. The nation's main telephone services infrastructure owned by the PTT or telecommunications corporation(s).
RSU	Remote Switching Unit. An extension of a larger *digital* telephone exchange, in which a number of telephone lines (in groups of up to 256) can be located remotely from the main exchange and connected via a transmission system. This obviates the need for a stand-alone rural exchange which may, under some circumstances, be more costly. RSUs are usually dependent on the main exchange for software functions such as long distance call detail records and statistics.
TDMA	Time Division Multiple Access. A form of the *multi-access radio, wireless local loop,* or *VSAT* system in which the circuit concentration and allocation function is achieved by means of *digital* time division techniques. This is the most common technique used in multi-access and circuit concentration systems.
Teledensity	The number of telephones or telephone lines per 100 population, ranging from less than 1 per 100 in many low-income countries to more than 60 in high-income countries.
Universal Service	A term traditionally used in the industrialized world to refer to the policy objective of providing telephone service to all households, regardless of their location and income level. The term is also frequently used to describe *Universal Access* policy objectives.
Virtual Telephone Service	A concept for providing wide access by the population to a limited number of telephone lines, such as may exist in the rural areas of developing countries, via non direct-line services such as *Voice-mail* or *PIN based long distance* calling.

Voice-mail

A stored voice message service to which individuals can receive and gain access, even though they do not have a dedicated telephone line. Subscribers are able to access their voice mailbox from any available public or shared telephone. Voice mail could be operated in conjunction with a locally operated paging service.

VSATs

Very Small Aperture Terminals. Satellite-based systems with low-cost VSATs can offer telephone service economically to the most remote localities (albeit still at relatively high cost compared to less remote locations).

WLL

Wireless Local Loop. Systems that use wireless technology (radio) to connect subscribers to the local telephone exchange. The vast majority of the world's exchange service customers are connected via dedicated copper wire. A range of recent WLL systems, with operating radii ranging from 1 to 2 km to 30+ km, now offer a basic service alternative. To date economics have limited WLL primarily to urban and suburban subscribers. WLL is increasingly seen as a cost-effective solution in developing countries, where meeting basic service demand through build-out of the wire network would take much longer to achieve. WLL systems are usually "single cell", that is, they do not extend beyond line-of-sight from the central station, without the expensive addition of further remote base stations. First generation WLL systems are also limited in their data and facsimile transmission speed capabilities, but this is changing, as some later generation systems have *ISDN* capability.

EXECUTIVE SUMMARY AND CONCLUSIONS

This report addresses the following five fundamental issues regarding commercial provision of rural telecommunications services:

- *The implications of the various sector reform models on rural telecommunications development,* and how these implications are being addressed.
- *Technology and cost trends,* and their application to various demographic, geographic and economic environments.
- *Pricing and tariff setting options,* how they apply to different demand/supply situations and how they relate to the various options for establishing interconnection agreements between operating entities.
- *Commercial viability and revenue generation potential,* and whether there are any good examples of how this can be improved in rural networks.
- *Funding issues,* including what is happening in this area and what strategies are available for mobilizing investment finance for rural telecommunications.

The Study Findings on Technology and Cost

There is indeed significant downward pressure on the cost per line, though there is a very wide range, because costs are very sensitive to subscriber distribution and density. In the ideal environment, where subscriber densities in excess of 0.5 per sq. km. can be achieved within 40 km of an urban center, capital costs can be lower than $1,000 per line using wireless loop technology. This kind of service can be commercially feasible if annual revenues per line are in the $300-400 range.

Over a more widespread area, for example 200 km radius from the urban center, costs are significantly higher. Wireless loop and multi-access subscriber radio (and various hybrids) compete, with costs in excess of $1,500 and usually in the $2,000 - $3,000 range. Costs are dependent on such factors as:

- The calling rate per subscriber (wireless loop costs triple from 0.01 to 0.10 Erlangs).
- The degree to which subscriber lines can be concentrated in villages and towns (multi-access radio costs are very sensitive to the number of lines per station).
- The terrain and environmental conditions (whether radio repeaters, solar power, or special antennas are required).

Per-line capital costs of up to $5,000 are still not unusual in situations where subscriber lines need to be widely spread-out, such as in much of sub-Saharan Africa, or where communities are fairly remote. The total annual operating costs (including equipment amortization) in these situations can exceed $1,500. Some countries face even higher costs because of terrain and remoteness. When capital costs are above $10,000 per line, satellite solutions become cost-effective but these systems are not likely to change the supply economics significantly in the near term at least. It is possible that several years from now mobile satellite operators e.g., low earth orbit (LEO) satellite systems such as *Iridium,* could be offering lower-cost solutions for rural services; however, this is far from certain and may not improve on solutions that will, by then, be feasible with a combination of conventional wireless and multi-access technology. All costs are dropping by at least 5 percent per year.

Affordability and Willingness to Pay

It has been broadly assumed, based on experience and selective case study data, that rural users in developing countries are able to *collectively* pay 1 to 1.5 percent of their gross community income on telecommunications services. Telecommunications operators in rural areas have rarely achieved this level, but the reason for this failure has more to do with poor distribution, poor access, and unreliability of the service than with people's readiness to use the facilities and pay cost-based prices. Nevertheless, this target level of revenue has been reached in some instances, but these best-case scenarios can be replicated only with careful deployment and marketing that takes all relevant social, economic, developmental, and infrastructural factors into account.

Economic studies have shown that achieving the highest socio-economic benefit is consistent with revenue maximization, within a tariff regime where charges reflect the underlying costs of supply, so long as the subscriber line deployment provides broad access to the community. The proposed strategy for serving villages and rural population centers is to provide lines to (a) institutions and businesses that are engaged in activities related to trade, commerce, and the delivery of social and economic structure, whose economic benefit from telephone use and estimated call revenues exceed the incremental cost of supply; and (b) public payphones, preferably operated as franchised "phone shops" or part of 24-hour communications/information agencies with facsimile and other facilities. If outside coin or card phones are used, they should at least be near public or commercial centers, and responsibility for maintenance or fault reporting should be taken at the community level.

The demand for residential phone lines may be limited at first, if the incremental cost of supply and expected revenue are far apart. The study developed a model that assists planners to estimate the minimum number of lines which are commercially feasible per community or population catchment area. The model is based on estimates of rural per capita income and the cost of supply. The number of lines deployed per community will depend on its:

- Population
- Economic activity and level of development
- Regional administrative importance
- Aggregate income level.

The study has shown that many regions in developing countries, in all continents, could receive a basic level of service commercially. The penetration in most cases will be below *1 line* per *100 inhabitants*, but access to the network would be available. As the level of use increases, penetration increases and per-line costs decrease such that growth can be self-sustaining.

Nevertheless, service is still not commercially viable in various large areas and localities and thus must be "subsidized" from the more lucrative parts of the network. However, even though subsidization is required for these remote communities, well-planned rural investments represent far less of a resource drain than is commonly assumed.

The Real Costs and Revenues, and Policy Implications

The report argues that the locally generated revenues from rental and call charges represent the *minimum* cash flow from which to calculate viability. Many localities may be loss-making or barely cover costs if only outgoing call revenues are counted. But most rural lines - even many public payphones - generate at least as much incoming revenue, from urban originated calls and reverse-charging. If separate urban and rural operators exist, to whom does this urban-collected revenue belong? Or in the case of a national monopoly, how should this revenue be apportioned in making its investment decisions?

Because of the higher costs and risks associated with rural service provision, the report argues that the total revenues be distributed between rural and urban locations in a skewed fashion, to reflect the asymmetry. If this were done, then most rural operations would become more attractive to investors and would receive funds sufficient to expand the envelope of commercial viability. In establishing the kind of policy environment that would foster this arrangement, the report further argues that options are available whether the sector is dominated by a state-run or a privatized monopoly, and whether or not private rural operators are in existence. There is more incentive to "get it right" in a liberalized environment however, where incremental-cost-based pricing and tariff re-balancing are being taken seriously.

Multiple Operator Environment

In a multiple operator environment, models for cost-sharing or revenue-redistribution can be devised within an interconnection framework which has either: (a) nationally averaged tariffs and access charges, where special repayments are made from the toll settlement account to operators which have higher per-line costs (as in the United States), or (b) interconnection charges based on cost causality, where the high-cost and low-cost operators settle with one another on the basis of asymmetric per-minute charges for the traffic exchanged between them, to reflect their differing cost structures. If call record accounting proves to be too complex and therefore impractical, then inter-company settlement can take place on the basis of estimated traffic levels and average costs. These figures can be periodically checked and updated by means of traffic studies.

Single Operator Environment

In a single operator environment, it is strongly recommended that the operator apply a similar cost-causality analysis to determine the true financial costs and benefits of rural network investment. Looking at the total incremental costs of carrying the total *(bothways)* traffic caused by rural investments would yield higher returns than conventional analysis, which discounts incoming revenues. The argument for "cross-subsidization" could perhaps be modified from one of justifying support for non-profitable lines to one of recognizing a positive internal benefit/cost relationship, internalizing some of the so-called externalities.

Even if the operator is not doing so, regulators are able to enforce accelerated rural investment targets onto newly privatized monopoly operators and new entrants, as an integral part of their license agreements. Virtually all of the Latin American privatized carriers, for example, are obligated to extend service to rural communities above a certain size. Some Build-Operate-Transfer (BOT) and Build-Transfer-Operate (BTO) schemes, which are successfully attracting private finance in Asia and Latin America, also have built-in rural service obligations.

As an additional means of supporting conventionally nonviable service from internal revenues, at least one country (Peru) has established a *rural telecommunications development fund* to which the monopoly privatized operator contributes. Its purpose is to finance service extension to communities not covered under the operator's license obligation.

Basically this internal support argument can be pursued to the point where the rural operation becomes profitable with the enhanced revenue stream. Beyond this, the operation should be recognized as bona fide loss-making and a candidate for additional support in the form of capital or operating cost contributions, low interest loans, or fiscal and tax incentives. It is recommended that such operations be identified and, as far as possible, separated from the commercially viable operations in order to qualify for government support and external concessionary finance.

Monopoly or Competition?

Conventional wisdom argues that a high cost and marginally profitable service such as rural telecommunications needs to be supplied as a monopoly, even though there may be competition for territorial licenses. Most countries seem to agree with this, the closest they come to competition being through tacking rural components onto BOT & BTO projects. Six of the countries studied have either introduced or plan to introduce direct competition. The following three scenarios compellingly challenge the status quo in an increasing number of places and situations:

- Competitive entrants can give what inefficient operators deserve - a lesson in "how to do it more effectively and at lower cost". There are a few cases in which rural service costs have been reduced significantly and customer options changed radically through competition or the threat of competition. Some of these cases involve community-based groups or cooperatives that buy trunks or "community lines" from the operator and provide the local subscriber connections.
- The next development in commercial "phone shops" and local communications agencies (franchised payphone operators) could be the establishment of small community networks involving switching and subscriber technologies such as cordless PABX, personal communications, paging, voice mail and e-mail. While generating competition at the customer level, they can also bring about innovation, increased penetration, traffic growth, and revenue enhancement for the operator.
- New technology on a wider scale (e.g., wireless, VSAT, and/or digital voice on data options) can in some cases be deployed as alternative or premium services by, for example, a new entrant or an existing corporate network operator. There is still some question whether such players should be forced to act as a carrier's carrier and deal only with the main operator, or be able to provide alternative service direct to subscribers, with the well-known risks of "cream skimming" and "by-pass". Some countries are allowing entry by this class of operator because of the potential for accelerated development.

Whether or not policymakers embrace competition in basic service at this time, technological change and liberalization ultimately go hand in hand. The report recommends that *regulators should use whatever transition period they have, leading up to competition, to rebalance tariffs and design their interconnection settlement systems so as to encourage the commercial viability of rural as well as urban networks.*

Policy Balance and Funding Approaches

Commercially viable operations are able to attract both private equity and loan finance. The study demonstrates that rural telecommunications provision is profitable or can become profitable within a certain envelope of geographical, cost, and revenue limitations. However, those limitations are less constraining if the basic policy environment is well defined and the regulatory machinery is present to:

- Identify and calculate the true incremental costs and revenues attributable to rural operations (in both the rural and urban segments)
- Facilitate and monitor revenue distribution or interconnection agreements that will provide the enhanced revenue flow that private sector rural operators need if they are to be attracted to invest and to be viable over a wider geographic-economic envelope
- Enforce certain rural investment targets on monopoly operators, which at least correspond to the limits justifiable on the basis of the cost-sharing or enhanced revenue analysis recommended by the study.

The senior policy or telecommunications development authority must also have a capability to:

- Decide what level of service is needed at the village level and can be justified from a socioeconomic and developmental perspective.
- Evaluate those projects or operations which are not commercially viable, even with enhanced revenues.
- Organize, coordinate and promote a range of minimally distorting mechanisms such as low interest finance and fiscal incentives.
- Support community-based and cooperative initiatives that could reduce investment costs.

The report surveys a wide range of new entry and private funding mechanisms that are used in various policy environment, and places them in context. It is argued that in a well-organized policy environment, a focused rural telecommunications development fund can become a vehicle or magnet for encouraging private sector investment, for collecting or administering both commercial and concessionary finance, and for providing a range of equity and loan options tailored to the characteristics of each project. Such a fund could be established nationally or regionally. Fully profitable operations would borrow at commercial rates, while those that are socio-economically justified but, for reasons of cost, are more marginal or loss-making could have access to low or zero interest money and other concessionary finance.

1. INTRODUCTION

1.1 Background

On average, 70 percent of the population in developing countries lives in rural areas, and most of these inhabitants are engaged in agriculture. There is great disparity between urban and rural economies, with the rural areas becoming more and more dependent on the urban areas and increasingly marginalized. A number of problems face the rural areas, including lack of job opportunities; long distances from major commercial and administrative centers leading to the migration of much of the young population to urban areas; and lack of essential social and economic infrastructure such as health, education, electricity, clean water, roads, and telecommunications. As a result, most of the poorest people live in rural areas and hence should be the main focus of any efforts to alleviate poverty. The industrialized countries have started to do this through deliberate policy decisions that would ensure that the rural areas are brought into the mainstream of the national development goals. As the structure of urban economies changes with services growing much faster than the other sectors, this structural change is also being reflected in rural economies. Information-based services account for much of the growth in services (expected to reach 70 percent in OECD countries by the turn of the century), and other sectors are becoming increasingly information intensive.

Although this trend may not yet be evident in rural economies in many developing countries, rural activities are being drawn more and more into the global economy. Manufacturers must now be able to respond to changes in demand; suppliers must be able to produce small orders for quick delivery; merchants must be able to update inventory and accounts records instantly. To stay internationally competitive, farmers must also resort to increased specialization and react to shifts in consumer demand. In order for this to happen, the information infrastructure has to be extended to rural areas. The provision of telecommunications services, a major component of this infrastructure, is therefore critical to the development process. However, there is an inherent conflict between the need to invest in areas of maximum return to satisfy investors, repay loans, and accumulate capital to expand, and national policies that seek to encourage regional and rural development. Left to the marketplace, rural service provision will continue to lag because of the perception that rural investments represent higher risk and lower returns.

Given careful strategic planning, rural telecommunications *can* be made profitable for many regions, but it is still less attractive to reach out to hinterlands than to serve the increasing demand expressed in the densely populated urban areas, where the cost of supply is lower and the returns appear to be more assured. The most high-cost locations are, in any case, financially loss-making under most scenarios, even though they may be economically beneficial.

What, therefore, is the answer? A decade of Maitland[1] awareness has actually achieved very little toward alleviating the disparities between urban and rural communities. The average imbalance, in terms of telephone penetration, in Asia, for example, is over 10 to 1 and is often as high as 20 to 1.[2] This means that a country whose urban markets have a penetration of, say, 4 telephone lines per 100 inhabitants (e.g., India and Pakistan) has a rural penetration of less than 0.2 per 100. The situation is more acute in most African countries and in some parts of Latin America. The disparity tends to lessen as a country's per capita income rises, with some notable exceptions. By comparison, the disparity in average income level between urban and rural residents in the developing world is usually less than 4 to 1.

The difference between telecommunications disparity and income disparity is almost always significant. Through the work of the Maitland commission and others interested in new technology solutions and the socioeconomic benefits of telecommunications, there has been hope that the situation could improve dramatically. It hasn't happened yet, although a breakthrough appears eminent, at least in wireless loop technology and, in the near future, low earth orbit satellite systems. Given the fact that the cost structure has already begun to change radically, it remains to be seen whether these technological changes will really make a difference to many rural areas. The question then becomes whether low revenues, financial constraints, and other structural problems such as sector management and manpower availability are the real issues.

What, then, are the implications of sector reform and commercialization? In that context, what are the underlying conditions required to make the difference and encourage rural telecommunications to develop? A wide-ranging action agenda has been cited, which includes:

- Special rural telecommunications strategies at the national level
- Better integration between the planning of telecommunications projects and the development programs of other sectors
- The imposition of strict rural service obligations on monopoly suppliers
- The creation, encouragement, and protection of a new class of small rural operators
- A "serve-it-or-lose-it," fully liberalized and competitive market, including price deregulation for operators serving rural areas
- Public-private joint ventures, build-transfer schemes, and revenue-sharing contracts
- A stronger cooperative movement
- Special subsidies or capital funds that national or rural operators can draw on
- Fundamental cost-based tariff reform linked with interconnection agreements that favor small rural operators
- Strong fiscal and other financial incentives directed at rural service provision.

[1] The Maitland Commission was a Commission set up by the International Telecommunications Union (ITU) under the chairmanship of Sir Maitland of the United Kingdom to study access of telecommunications services in developing countries. The Maitland report was published at the end of 1984.
[2] Minges, Michael. *Rural Telecommunications in Asia-Pacific.* Pan-Asian Rural Communications Summit, Hong Kong, 24 to 26 October 1994, Telecommunications Development Bureau, ITU.

All of these actions are being proposed or tried in some form, or in combination, in various places throughout the world. The challenge is how a country decides which policy option might be the most appropriate for its situation.

1.2 Focus of This Report

The World Bank retained the services of a consultant to review relevant international experience in rural telecommunications, to draw out the lessons to be learned, and to provide an overview of the policy options for effective commercial service development within the context of the ongoing sector reform process. The focus of the study has been the following:

- *The implications of the various sector reform models on rural telecommunications development*, and how these implications are being addressed
- *Technology and cost trends*, and their application to various demographic, geographic, and economic environments
- *Pricing and tariff setting options*, and how they apply to different demand/supply situations and relate to the various options for establishing interconnection agreements between operating entities
- *Commercial viability and revenue generation potential*, and whether there are any good examples of how they can be improved in rural networks
- *Funding issues*, including what is happening in this area and what strategies are available for mobilizing investment finance for rural telecommunications.

A wide range of desk research methods were used in the study. The consultant was also able to draw on some related field research. Useful case study data were collected from more than 30 countries. These include several countries in which the consultant had undertaken other assignments, as well as those for which reports were obtained from other sources. Case study material was used from the following countries:

Bangladesh	Argentina	Botswana
India	Bolivia	Gambia
Indonesia	Brazil	Guinea
Malaysia	Colombia	Kenya
Nepal	Ecuador	Malawi
Pakistan	Mexico	Uganda
Philippines	Paraguay	Zimbabwe
Sri Lanka	Peru	
Thailand	Venezuela	
Vietnam		

Up-to-date information was collected on active projects in Bangladesh, Paraguay, Peru, the Philippines and Sri Lanka. A tabular summary of the commercial aspects of the rural telecommunications development programs in most of the above-mentioned Asian and Latin American countries is provided in Appendix A -- it is possible that some of the information in this Appendix would have changed by the time of publication given the rapid changes taking place in the sector.

Basic statistics were gathered on the development of rural telecommunications in many other countries, drawing on recent studies and papers by the International Telecommunications Union (ITU), and conference proceedings in Asia[3] and Latin America,[4] and numerous related publications and articles. Relevant information on strategic policies, pricing, and funding was also obtained from the following industrial countries: Australia, Canada, Finland, Spain, Sweden, the United Kingdom, and the United States. In addition, materials from the European Union's Special Telecommunications Action for Regional Development (STAR Program) and other initiatives for Objective 1 (less-favored) regions were consulted. In order to assess the technology trends and ascertain costs, the consultant contacted more than 20 suppliers worldwide. They provided recent information on costs and technical applications, written submissions, and application documents and technical papers. These suppliers are listed in Appendix B.

1.3 Contents of the Report

The international and rural telecommunications environment is reviewed in Chapter 2. This chapter includes a summary and discussion of the various types of reform policies and regulations, their potential implications for rural telecommunications development, and the kinds of policy instruments that encourage or hinder rural service provision.

Chapter 3 provides a brief overview of essential knowledge regarding the role and impact of telecommunications on the rural economy. It highlights those factors which are recognized as having a relatively undisputed bearing on benefit/cost considerations and on the type of rural telephone service provision that should be pursued, i.e. on how demand and willingness to pay should be interpreted, what pricing strategy is feasible, and what conditions justify the policy interventions.

Chapter 4 reviews current technological developments and trends and their costs. It then introduces the components of a technology/cost comparison model, which depicts the cost trends in absolute terms and the technology niches. The comparison issues, the factors that influence cost, and the relationship between type of service and technology choice are discussed.

Chapter 5 outlines the fundamentals of rural telecommunications viability. It discusses the demand and supply issues, the strategic options for commercial supply, and ways that the policy and regulatory environment can help or hinder development, using country examples as illustrations. Also included is a consideration of the options for commercial enhancement, specifically the opportunities and potential strategies for increasing revenue generation on rural networks. The vital role of the private sector in achieving viability is emphasized.

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[3] ibid.

[4] International Telecommunications Union. *Telecommunications Manual/93 for Rural Areas and Low-Income Strata (Americas Region).* December 1993.

Pricing and tariffs are discussed in Chapter 6. The discussion highlights issues from the perspective of cost recovery and incremental cost pricing, demand and willingness to pay, and the intercompany interconnection regime. Specific examples from both industrial and developing countries are cited and interim conclusions are drawn.

The funding issue is addressed in Chapter 7. The chapter first reviews the trends in market size and type of finance available. It then examines the various financing strategies discerned during the study, the challenges faced, and possible ways of meeting these challenges.

2. THE CURRENT ENVIRONMENT

2.1 General Overview

This chapter presents an overview of the general state and progress of rural telecommunications development, region by region. It also reviews the various sector reform and privatization models, identifying their apparent impact on rural telecommunications and the issues they raise. Each country studied has addressed these issues in various ways, which often raises secondary issues and challenges, particularly with regard to providing effective network access for the smallest and most remote communities. This chapter categorizes these issues, their potential solutions and the unresolved questions, based on the country examples.

2.2 The State of Rural Service Today

The relationship between telephone penetration and GDP per capita at the national level is well known and does not need to be restated here. More important for this study, a recent ITU study demonstrated a statistically significant relationship between rural teledensity and rural incomes in 13 Asia-Pacific countries.[5] As noted in Chapter 1, however, worldwide statistics reveal that the lower a country's per capita income and telephone penetration, the greater is its urban/rural imbalance.

Despite large-scale urban migration in many countries, well over 50 percent of the developing world's population continues to dwell in rural areas. This figure remains 70 percent in some of the most populous Asian countries, for example, Bangladesh, China, India, Myanmar, Sri Lanka, Thailand and Vietnam, as well as in most of sub-Saharan Africa. Available statistics do not readily allow a breakdown of the existing telephone lines into urban and rural categories because of questions regarding how townships are defined or how many lines in some exchanges serve urban versus rural subscribers. It has been conservatively estimated that less than 17 percent of Asia's total lines terminate in rural areas.[6]

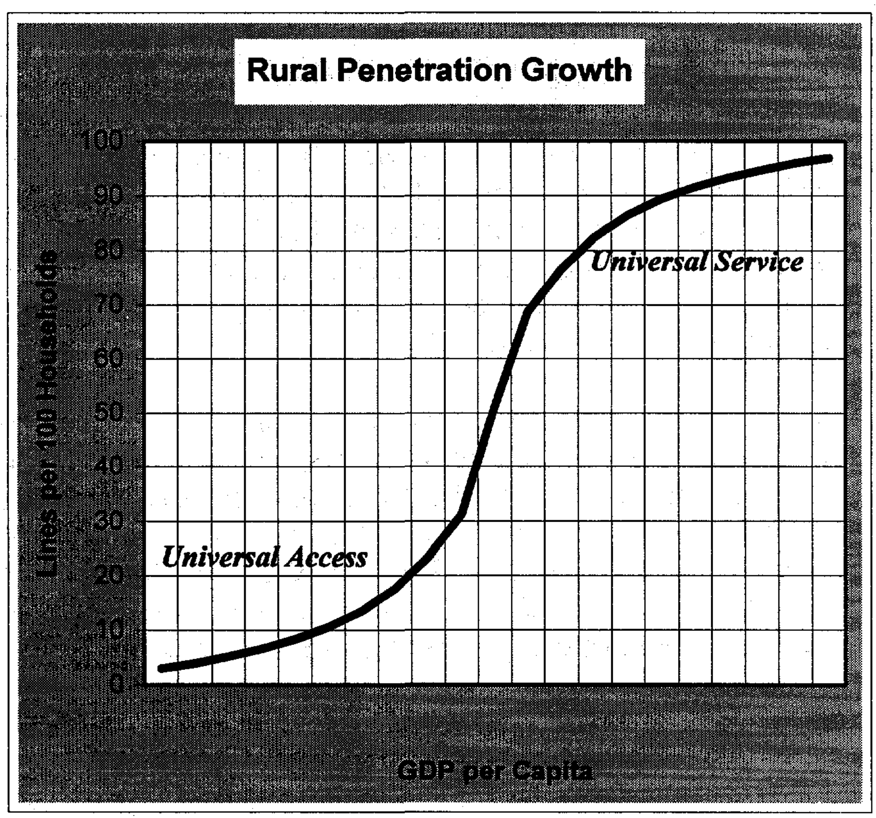
The difference between urban and rural penetration is at least partially due to relative incomes. Agriculture, the dominant economic activity, rarely accounts for more than one-third of GDP, and average incomes are usually significantly lower. The added burden of the much higher per-line costs in most rural areas also accentuates the problem. Thus, when a large portion of the population is below the income threshold where they could afford a private telephone line, special strategies are required to provide *access* to service. These strategies will not result in high teledensity levels although they can improve coverage significantly.

[5] Minges, Michael. *Rural Telecommunications in Asia-Pacific.* Pan-Asian Rural Communications Summit, Hong Kong, 24 to 26 October 1994, Telecommunications Development Bureau, ITU.
[6] ibid

Historically, higher-income countries are better able to overcome the cost burden than low-income countries, through some form of cross-subsidization or revenue redistribution. The approach adopted by the United States, Canada, and European countries leads many to the conclusion that similar policies can be pursued in the developing world. Although there are major lessons to be learned, the exact approach of advanced countries is not so easily transferred to those less advanced. The problem must be defined in a different way from one environment to the next. For example, most OECD countries are striving to serve the last 2 to 10 percent of their rural households, while countries such as Bangladesh, India, Indonesia, many other Asian countries, and much of sub-Saharan Africa can hope for little more than achieving one line per 500 people in many areas. For these countries, telephone service is often targeted in terms of distance or time (e.g., 20 km or five hours walking distance to the nearest phone). Even Latin American countries, most with per capita incomes well above $1,000, are striving to place one line per 500 in some regions.

From a policy perspective, the advanced country *universal service obligation,* to serve all potential demand, yields to the much more modest *universal access obligation,* to bring the network within reach of the populace through points-of-presence at the community level. As shown in Figure 2-1, somewhere in the middle-income range (between $5,000 and 10,000 per capita) depending on a country's demography, geography, and income distribution, the goal of achieving a high penetration amongst residential users becomes a reality.

Figure 2-1. Penetration Targets



Even a few lower middle-income countries, such as Malaysia, are able to set a rural target of, say, 20 lines per 100 (for year 2000) based on expectations of strong economic growth. The achievement of this target will depend on the incentives to be given to the dominant carrier - Telekom Malaysia, in this case - since average rural revenues, even at the current level of penetration of 4 lines per 100, are below cost. Also, Malaysia's actual penetration will be an uneven one, since it still has the challenge of placing just one payphone -- at a cost of up to $16,000 per line -- in some 11,000 rural villages. Other middle-income and transitional economies -- Poland is one example -- are attempting to achieve high rural penetration levels commercially through aggressive policies that allow competition and promote low cost wireless solutions.

2.3 Technological Advance and "Leap-frogging"

The high income member states of the Organization for Economic Cooperation and Development (OECD) generally developed local networks in rural areas over many decades based on old and relatively costly technology. As has been noted in the literature, and explained in detail in this report (see Chapter 4), recent technological advances provide opportunities for developing and transitional economies to accelerate rural telecommunications development and thereby avoid waiting decades, even generations, to increase rural teledensity to some minimal standard of access.

The current proliferation of technical options from which to choose, particularly radio-based systems, is illustrative of the speed at which technology is changing. To be sure, examples of high average cost per line can be found in many regions or subregions of the world. However, because of technological advances, scale of procurement, international competitive bidding, and the resulting lower average cost per line, even low-income countries now have opportunities to enhance rural teledensity beyond what had been previously feasible. A nation that recognizes and seizes such opportunities is thus able to leap-frog the industrialized economies, at least in the way rural and other telecommunications services are provided, if not in the level of penetration actually achieved, which might realistically still have to be fairly modest.

2.4 Establishing a Realistic Level of Penetration

A country's capacity to support telephone service in rural areas can be determined from basic economic principles and business case analysis. Well-known statistics[7] indicate that at the national level countries usually spend between 1 and 2 percent of GDP on telecommunications services. The average rises with per capita income and economic diversification, although it is important to note that the majority of low-income countries with statistics available spend above 1 percent, and almost half spend 1.3 percent or more. The average for the developing countries

[7] International Telecommunications Union. *World Telecommunications Development Report*, World Telecommunications Indicators, 1994.

in the study group is 1.5 percent. The OECD average is 2.2 percent and many countries -- even middle-income ones -- exceed this limit.

Recent unpublished analysis carried out in India showed that a similar GDP/expenditure relationship also exists at the state level. Indications are that any major subnational region can display a willingness to pay between 1 and 2 percent of its total economic product on telecommunications services *if they are appropriately deployed.* Table 2-1 illustrates this expenditure based on secondary research obtained from both in-country and published sources. The statistics show that rural communities spend between 60 and 125 percent of their national average, in relative terms, on telephone service.

Table 2-1: Telecommunications Expenditure/GDP[8]

Country	National	Rural/Regional
Malaysia	2.3%	1.3%
Botswana	1.6%	1.3%
Tanzania	2.1%	1.9%
Peru	1.2%	1.5%

Rural expenditures in remote areas can, in fact, often exceed urban levels because of the high cost of alternative forms of communication. Recent unpublished research in Canada[9] has indicated that residential households in the far north are spending, on average, several times the national average on long distance telephone service.

The full revenue potential can, of course, only be derived when telephone lines are supplied in a way that addresses the communication access needs of government, business and the general public. Some averaging across regions and between urban district centers and villages is inevitable, and the full revenue potential may not be achievable in many rural areas because of a lack of economic diversification, which drives demand for service. However, as a general target for calculating commercial revenue potential, 1 to 1.5 percent of total income should be a reasonable starting point.

On this basis, it is possible to calculate the potential revenues available to a telephone service provider in any community, and from this figure, a reasonable teledensity level. For example, assuming the revenue potential is 1.5 percent of income, then rural Botswana with an estimated rural per capita income level of approximately $1,300 could support up to five telephone lines in a village of 500 if the total annual operating cost per line (including capital depreciation) could be kept to $2,000, which was the figure estimated in 1990-91, when capital costs were $7,000 per line. Rural Kenya, on the other hand (with average incomes perhaps one tenth of Botswana's), could support only one such line per 700 inhabitants, with rural operating

[8] Based on revenue statistics from the telecommunications operators and countrywide estimates of rural income levels (using World Bank income distribution data) and known average rural revenue levels.
[9] Undertaken by Teleconsult Ltd. for NorthwesTel in Yukon and Northwest Territories, 1996

costs close to $1,500 per line, unless some form of policy intervention is available. In Indonesia, where rural incomes are estimated at around $400, the potential commercial limit under similar conditions would be around one line per 200 inhabitants.

In some countries that have large areas with low population density, capital costs can rise to more than $20,000 per line (Bolivia, Indonesia, Mexico, Peru, and the Philippines all have such cases) and consequently, the annual operating costs are also very high. Most small communities of 500 people cannot support these costs. In many situations adequate service will not be provided without policy intervention.

On the other hand, in Bangladesh where rural per capita income is less than $200, the level of commercially viable rural penetration (more than one line per 200 inhabitants) is better than many higher-income countries, because the high population density and flat terrain allow lower-priced technical solutions and low operating costs. Two private operators have been licensed to serve most of the country's rural areas, and early indications are that this approach is commercially feasible.

A methodology for calculating the commercial opportunities and their limits is presented in Chapter 5. The main questions for rural telecommunications policymakers are how the commercial realities can be complemented by an appropriate universal access obligation and what policy interventions are necessary. Other questions to be asked are who should supply the service (a national or regional operator), how should the lines be distributed, what is the appropriate pricing structure, and what supplementary financial or funding mechanisms are required to enable the strategy to work.

2.5 Overview of Sector Reform Approaches

The general issues surrounding sector reform, privatization, and liberalization have been well documented.[10] The chapter focuses on the implications of the various reform strategies for rural areas, the specific initiatives that have been or could be taken within each strategy to accelerate rural telecommunications development, and the required policy initiatives.

There are obviously different approaches to reform, and these may be subject to change in the future. One policy, such as the first listed below, may be an initial step toward broad liberalization which may come later. We have concentrated on basic service provision. In general, eight discrete options can be identified, namely:

- Public sector reform and corporatization, with liberalization limited to cellular, data, and value added services
- Capitalization and/or privatization of the main operator with retention of monopoly status as a single company
- As above, but multiple companies with exclusive regional territories

[10] Wellenius, Bjorn, and Peter A. Stern, eds. *Implementing Reforms in the Telecommunications Sector.* Washington, D.C.: The World Bank 1994.

- Introduction of competition from new entrants on a national or region-by-region basis
- Creation of monopoly regional rural operator concessions
- Liberalization/competition in rural area service provision
- Provision for joint venture, risk-sharing and outsourcing schemes
- Provision for community-level cost-sharing or cooperative provision.

Figure 2-2 provides an overview of the reform status of each of the 27 developing countries for which case data were used in the study. The figure shows both the current and planned environments.

Figure 2-3 traces the characteristics of the six options that are considered to represent fundamentally discrete policy environments. Two of the previously mentioned eight options, i.e., the multiple operator monopoly model and the community risk-sharing model, are assumed to be variations or components of one or the other of these six major policy environments.

Figure 2-2: Status of Basic Services Markets

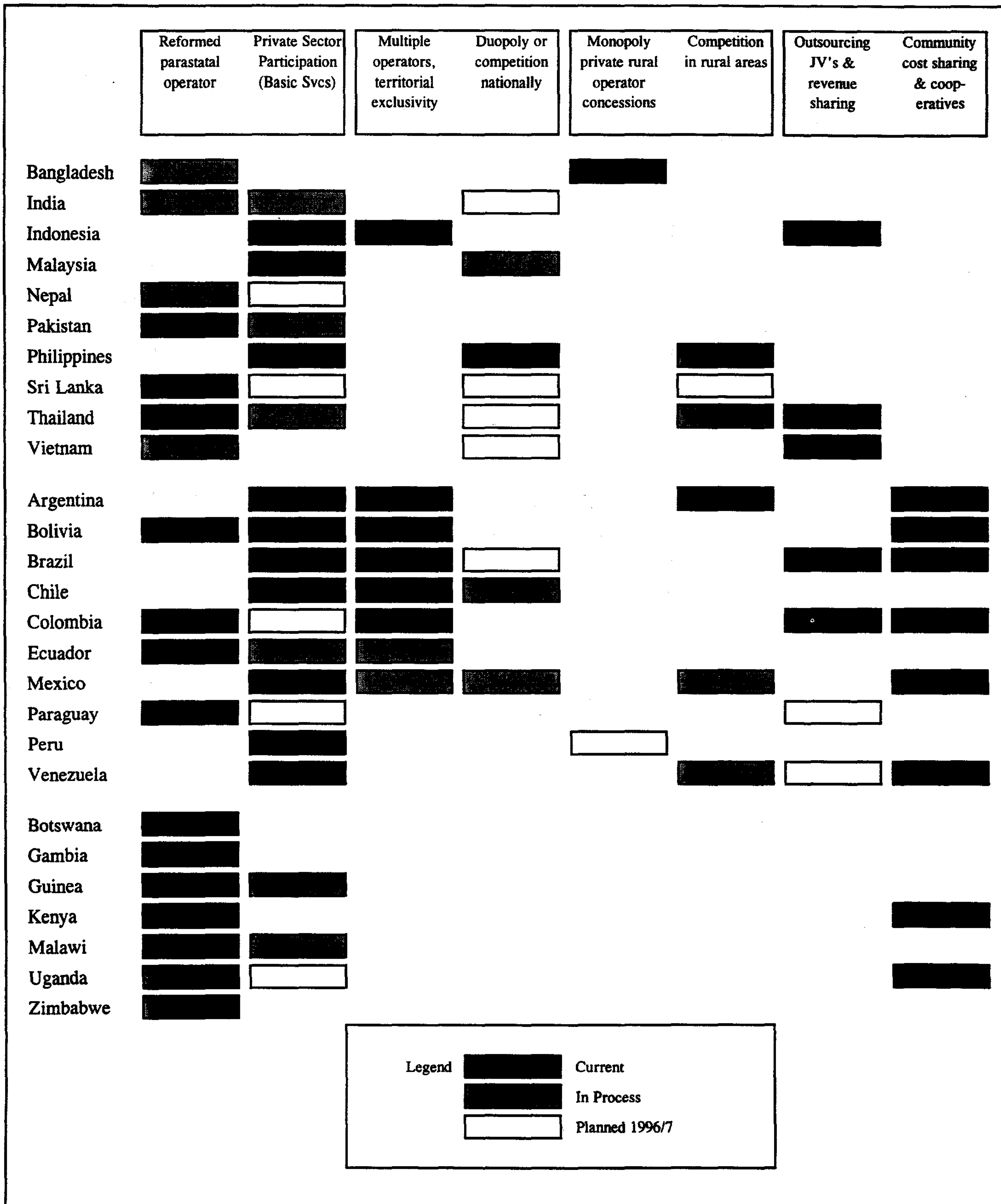


Figure 2-3: Policy Characteristics

Reform environment	**Reformed public sector operator**	**Privatized monopoly operator**	**National competition & new entrants**	**Outsourcing JV's & revenue sharing**	**Monopoly rural operators**	**Competition in rural areas**
Common Requirement	Clear sector policies	Regulatory rules & procedures		License Documentation	Policy implementation process	
Initiatives	Corporatizations Investment obligations Gov't subsidies National rural telecom programs	Tender for strategic investor Public share offering Establish investment targets Quantified rural service & PCO targets Tax credits & incentives	Tender for operating license by major investors & operators Local ownership regulations Investment obligations Rural investment targets Interconnect agreements	Tender for private investor & finance revenue sharing BOT, BOT, etc. Provision of only commercially justifiable services Rural components (urban-rural cross-subsidization) Interconnect agreements	Tender exclusive rights within territory Service obligations & targets Private investment & financing Operators selects customers to maximize profit Interconnect agreements	Rural service deregulation Competitive long distance may be included, depending on type of operator Interconnect agreements
Common Initiatives	Tariff reform & rate rebalancing		Service provision targets		Service obligations for rural areas	
Implications & results	Improved efficiency Increased internal funds generation Insufficient resources for rural programs Rural funding delays Look to private sector finance (e..g. BOTs)	Accelerated investment but with urban bias Access to private finance, technical & management resources Highest cost areas left for subsidized service provision or community cost-sharing	Efficiency gains Competitive spur Commercial rural telecoms New technology Service may cream skim from existing operator	Acceleration of network growth Access to private sector finance & technical & managerial expertise	Efficiency gains & innovation Commercial rural telecoms Service focus on high revenue subscribers, but leverage to provide public access	Reductions in per-line costs More subscriber options & new service offerings Local entrepeneurial activity & investment Service may cream skim from existing operator
Common issue	Determine need for complementary subsidies & incentives required for high cost communities				Establish funding pools & mechanism	

The various initiatives that are typically associated with each policy environment, and the issues which arise, are identified. Four general requirements/issues are common to all policy environments. These are as follows:

- Formulation of the basic policy/regulatory framework, which includes the passage of a new or revised telecommunications law, establishment of operating license conditions, and an independent regulatory authority operating according to clear rules and procedures
- Pursuance of tariff reform with migration to cost-based prices and rate rebalancing
- Establishment of service obligation targets for rural areas
- Determination of appropriate complementary cost/revenue sharing, financing, and subsidization mechanisms required for high cost subscribers.

Although the policy issues and options related to rural telecommunications are fairly universal, the combination of basic reform package, specific sector initiatives, and implementation strategies tend to be highly country-specific. The following sections discuss issues specifically related to each of the main policy environments.

2.6 Public Sector Reform with Limited Liberalization

Along with reorganizing telecommunications operations as state-owned commercial companies, governments have applied a range of instruments to advance rural service extension. One frequently used measure is to formalize service access and investment obligations as part of the corporation's mandate. This has been the case, for example, in Thailand where the national operator, TOT, has assumed the primary responsibility of connecting every village and sub-village in the country to the network,[11] and in Vietnam where the publicly owned PTOs (which together comprise the state monopoly) are required to direct 30 percent of investments to rural telecommunications.

Botswana and Gambia represent two successful corporatizations in Africa. In Botswana, where the rural areas of the country are relatively high cost, the state-owned Botswana Telecommunications Corporation (BTC), under a clear government mandate, set itself the target of serving all identifiable demand in villages with a population of more than 500 by the year 2000.

In some ways, the setting of such targets is nothing new, as many state-run telecommunications administrations have done the same. In the best cases, however, improved efficiencies from sector reform are generating additional financial resources. These resources might still be insufficient to meet the combined challenge of service penetration (in the economically more advanced communities where demand is extensive) and basic access to the most rural regions. Resource constraints -- finance and manpower -- are still limiting factors.

[11] The introduction of competition in Thailand could change the nature of TOT's obligations.

On the financial side, public sector organizations still tend to require concessionary finance, at least for the highest-cost areas. Bilateral and multilateral sources of finance are declining. In addition, project justifications and loan negotiations are frequently slower than expected, and as a result, implementation lags. The rate of growth is also often limited by manpower. For example, in Botswana an even higher rate of rural service growth might have been achieved, were it not for BTC's manpower constraints.

On balance, even the best examples face difficult choices between meeting high return urban demand or lower return rural needs. An additional injection of resources is needed if a real dent is to be made in the requirements for services. In this environment, then, policymakers are increasingly turning to privately funded "risk-sharing" schemes as an alternative to privatization of the main carrier or competition.

2.7 Joint Venture, Risk/Revenue-Sharing and Outsourcing

Particularly in countries with a large unmet demand, turn-key project finance, with a revenue-sharing component, is a means to attract additional resources and new entities to extend the reach of the national network, while maintaining the monopoly status of the main carrier(s). The regulatory agency authorizes the construction of local networks, which are then interconnected to the national network, subject to an agreement that sets out technical interface standards and the division of revenue.

Indonesia and Thailand, followed by Vietnam have permitted private investments through Build-Operate-Transfer (BOT) and Build-Transfer-Operate (BTO) schemes. These arrangements provide access to private sector financing as well as technology and technical expertise. The participating companies frequently include the equipment supplier, plus a group of commercial banks and the quasi-commercial funding arms of development agencies. A large number of BOT schemes are also in place in Latin America, including domestically privatized Brazil, as well as Colombia.

Appropriate service or investment obligations can serve to ensure that the benefits of these schemes extend to rural areas. "Piggy-backing," which includes some forced urban-rural cross-subsidization, has been more successful than rural-only schemes. *This is primarily because the challenging issues of tariffs, cost-sharing, and interconnection fees for the rural environment frequently remain unaddressed.* The following examples illustrate this point:

- In Indonesia, 20 percent of lines funded by the private sector have to be in rural areas. Under the country's (BTO), scheme consortia, which include at least one private Indonesian company and a foreign partner, operate their system in exchange for 70 percent of the revenues generated from monthly service fees and tariffed traffic, and 100 percent of the revenues from installation fees.
- In Thailand, BOT schemes have been successful in the urban centers but have failed in the rural sector, as no private investors could be found for rural projects, with the result that TOT is undertaking a major rural initiative.

Although the principle of piggy-backing often works for rural areas that are in the vicinity of more profitable urban zones, the more remote areas are left untouched. Furthermore, the bundling of rural network investments into large schemes may not be the best way to proceed, since the investor's risk is increased and potentially viable opportunities may be hidden. Heavy loss-making components can often outweigh the viable sections and make the whole rural development program appear unattractive. As described in Chapter 5, we believe that by tying potentially viable and loss-making rural sections together into major packages, Thai authorities may be missing an opportunity to develop rural services more rapidly.

Segmentation of the program into commercially viable and nonviable packages can thus provide a much clearer picture of the pricing and funding issues, both highlighting the commercial opportunities that may exist and pointing out the areas where financial support or more innovative solutions are still required.

When telecommunications operators limit themselves to commercially justified services (as in much of Latin America), they are given incentive to search for other innovative forms of private funding for high-cost locations. These include cost sharing schemes with cooperatives or other joint venture agents. Brazil is but one of many examples in Latin America. In Brazil, individual line service is provided on demand to entities such as rural businesses, cooperatives or associations. 'Collective' lines (trunk groups) are provided to towns and villages when requested by the municipal authorities. The entities requesting the service (i.e. the municipality or the end users) must cover the initial incremental costs of service extension. Similarly, Kenya has established a program of cost-sharing with coffee growers in rural areas.

The examples cited above indicate that service provision is often based on "high value" user-pay schemes. To ensure that basic service access levels to the general public are met, however, it is important to establish quantified public call office (PCO) targets, which are now a common feature of established policy in many countries. Often the PCOs, as well as additional lines to the community, can be supplied at much lower incremental cost once the initial lines have been funded by the corporate user on a cost-sharing basis.

2.8 Privatization of Main Carriers

Major privatizations have now taken place on all continents including Africa (Cote d'Ivoire, Ghana, and Guinea). Several other African PTTs, including Congo, Madagascar, Mozambique, Sierra Leone, Swaziland, and Uganda are slated for full or partial privatization in the 1997 - 98 time frame. In most cases, the government is looking for a single strategic investor.

In Latin America, the most prevalent privatization strategy has been for the government to sell-off a major or controlling share of the national carrier(s). In the cases of Argentina, Chile, Mexico, Peru, and Venezuela, the sales were made to private multinational corporations or consortia, and in Brazil to national investors. Cuba has sold a major share to a Mexican led consortium. Ecuador, and possibly Colombia and Paraguay are also seeking strategic investors over the next year or so (although Colombia and Paraguay are pursuing BOT financing in the meantime).

The operating territories of the privatized entities generally consist of the whole nation. In the case of Argentina and Ecuador, separate northern and southern companies have been created. In all cases, the new entities were given a monopoly over basic telephone exchange service in exchange for operating licenses that require them to meet a set of investment or performance goals which *include, in most cases, rural service targets.* The transition period in which the carrier continues to operate as a monopoly or near monopoly was intended to ensure profitable operations and to provide a period of time for tariff rebalancing prior to competition.

Privatization has generally accelerated investment levels, although the rate is significantly lower in rural areas. None of the referenced Latin American countries appear to be allocating more than 5 percent of their gross investment to rural areas, and most are well below it. Some state-owned monopolies are investing, or intend to invest, far heavier in the rural sector. As already noted, however, the reduction in bilateral and multilateral resources and the delays associated with concessionary finance often reduce the final figure to much less than planned.

Privatization is not an investment panacea when the financial environment is difficult. For example, due to the macroeconomic situation and devaluation, Venezuela's privatized carrier, CANTV, had to trim its 1994 and 1995 construction budgets in half and is turning to alternatively financed risk-sharing schemes. Mexico, which will soon face competition in its market as the monopoly period expires, may confront a similar financing crunch.

In a discussion of price and subsidization issues in Chapter 6, it is pointed out that governments must take advantage of the monopoly period to address the issues raised by various pricing strategies, in order to prepare for both competition and commercial rural service provision. Several mechanisms can be used to equitably share the costs and revenues between urban and rural operations, even in a competitive environment. These mechanisms should not necessarily be considered "cross-subsidizations," although some situations that do require subsidization will remain.

Subsidies need not be totally government or development funded. Peru, for example, has established a rural telecommunications fund, FITEL, that receives 1 percent of gross revenues from the country's newly privatized monopoly operator. FITEL specifically funds the extension of service to communities with fewer than 500 inhabitants, which are not covered under the privatized carrier's obligation. While this is classified as a subsidization fund, Chapter 6 argues that this "investment" by the national carrier also yields benefits in terms of incremental urban-to-rural revenues.

2.9 Regional Rural Operators

Several countries, e.g., Argentina and Venezuela, have liberalized rural service by allowing public or privately owned rural operators or cooperatives to provide service in rural areas not covered by the national monopoly or dominant carrier. The rural operators in Bangladesh provide service on an exclusive basis. There are benefits if independent and rural operators or cooperatives are organized nationally to increase their competitive influence in long distance and value added services, and in bulk purchasing of equipment.

Bangladesh is an example of a country having profitable rural operations. Bangladesh Rural Telecommunications Authority (BRTA), the first of two licensed rural operators, is generating a healthy profit. Although they are obligated to provide at least one PCO in every village that requests one, Bangladesh's rural operators basically select whom they serve and charge a substantial up-front subscriber connection fee. By selectively choosing their customers, the rural operators can focus initially on the most financially attractive customers in order to maintain a positive internal generation of funds. Although this is a sound approach to building a commercially viable operation, regulatory issues must be addressed and monitored, namely, whether the operator's approach is fair and whether a minimal or socially acceptable standard of public network access is being provided in its operating territory.

In order to encourage rural operators to survive and thrive, the regulator must address the question of where (in terms of the economic/geographical environment and provision cost) commercial service ceases to become viable. It must also select the most suitable form of intervention. Without complementary special incentives or favorable interconnection agreements, the goal of universal access for high-cost subscribers will not be achieved. For example, the Bangladesh revenue-sharing arrangements (discussed in Chapter 5) would not prove successful in Peru because of the higher costs; hence, the need for a subsidization fund or other form of incentive.

2.10 Competitive Rural Operators

Deregulation of rural services aims at improving service provision by increasing efficiency and reducing costs for serving rural areas. Argentina allows rural operators to compete with the country's two privatized monopolies. The two dominant carriers have to extend services to communities with a population above 300, yet they are in competition with rural operators for the smaller communities. As many as 135 rural cooperatives have been formed to provide telecommunication services, based on financial and other resource pooling initiatives.

Several governments are beginning to allow cellular or other wireless-based carriers to compete with the main carrier for rural customers. The Sri Lanka government is planning to license one or more wireless carriers for rural areas.

In contrast, Finland's and Bolivia's local cooperatives have traditionally provided local service mainly to cities and towns, while service to rural areas was provided mostly by the state-owned long distance carriers, Telecom Finland and ENTEL, respectively. As Finland's government has been permitting competition in value added and long distance services, and now finally in basic services, the association of telephone companies recently created several jointly owned entities that provide a comprehensive range of rural, local and long distance services in their concession areas, in competition with the national carrier.

The common wisdom is that competition in rural areas is not the best solution, in view of the challenges operators already face in achieving sufficient scale economies. The most useful scenario is one in which a new entrant can upset the status quo of an underperforming national carrier through the introduction of new technologies and approaches. Indeed, even the threat of competition often spurs improved performance (lower investment cost and faster network build-out) by the incumbent operator. This has happened in Argentina, India and elsewhere. However, these results are most achievable close to urban centers, as the analysis in Section 4 indicates. In higher-cost environments and where revenue potential is limited, scale economies are essential and the incentive for urban operators to agree to favorable interconnection or revenue sharing arrangements based on the asymmetric costs of urban and rural networks (see Chapter 6) may vanish if the environment encourages high costs and inefficiency.

2.11 Summary

The varying reform initiatives show that rural service provision can be accelerated in a viable manner under various circumstances. However, neither liberalization nor privatization is in itself sufficient to adequately increase rural investment levels. In most cases these measures need to be complemented by establishing service extension or investment targets, as well as incentive or cost/revenue-sharing schemes. Although several of these schemes help to address previously unmet demand, very high-cost subscribers may continue to remain without service.

To reach these areas often requires deliberate policy objective including financial subsidy or resource pooling. Even though deregulation may contribute to increased rural investments, policy interventions will continue to be necessary. The specific mechanisms are discussed in more detail in Chapters 6 and 7.

3. THE ECONOMIC ROLE OF RURAL TELECOMMUNICATIONS

3.1 Background

The last decade has heightened the understanding of the socioeconomic benefits of telecommunications in rural areas. However, even though such investments have accelerated markedly, the promise of economic benefits, largely in the form of *consumer surpluses,* has done little to convince commercial financiers to fund essentially loss-making projects.

Operating companies have continued to collect relatively low revenues from the majority of their rural customers, although *some* rural lines have attracted high revenues. Many others could have been far more attractive if the institutional aspects -- supply strategy, marketing, and operation and maintenance (O&M) -- had been better organized, or if the service had been better able to translate knowledge about economic benefits and willingness to pay into a commercial footing. Unfortunately, rural telecommunications still have a reputation for high costs and low revenues.

In this Chapter, we cover some well-traveled ground for the simple purpose of constructing a scenario that incorporates knowledge about economic benefits into the development of a strategy for commercial viability. Our basic hypothesis is that the evidence indicates that the maximization of revenues and economic benefits go hand in hand.

A separate report on the economic and social benefits of rural telecommunications was carried out in parallel with this study.[12] A summary of that report is provided as Appendix D, and insights from its findings are included in this chapter.

3.2 Economic Benefits

The benefits that are enjoyed by public and private sector users of telecommunications services in rural areas far exceed the costs. The benefits include but are not necessarily limited to the following:

- Economic savings and increased productivity through substitution of telephone usage for more expensive forms of communication, such as travel, by business, government, and the general public
- Increased public access to health and other services in times of emergency
- Improved market efficiency and competitiveness for businesses and farmers through better information flow on prices, products, and attributes

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[12] Hudson, Heather. *Economic and Social Benefits of Rural Telecommunications: A Report to the World Bank,* March 1995. Professor Hudson, Director of the Telecommunications Management and Policy Program, McLaren School of Business, University of San Francisco.

- Increased business efficiency and profitability in the areas of client/customer relations, ordering, stock control, improved distribution channels, and the like
- Access to markets previously barred physically by distance and cost
- Better and more efficient coordination and delivery of administrative and social infrastructure services, e.g., in health, education, and other public sector activities
- Increased possibilities for expansion of other business and economic infrastructure services and facilities, as a result of the availability of telecommunications
- Increased employment opportunities, including positions for women looking for alternative employment outside the home (and potentially reduced rural-urban migration), from expansion and development of the business and infrastructure activities.

The benefits of rural telecommunications can be summarized as facilitating increased opportunities for economic diversification, employment, and regional integration, and contributing to increased efficiency in most social and economic activities. Both the basic development and future position of rural society largely depend on economic diversification as well as on integration into the national and international community and markets. Although not the sole facilitator of these benefits, telecommunications complements and interacts with other infrastructure facilities and services to ensure that the process of economic diversification and economic growth can take place.

The report summarized in Appendix D describes the role of telecommunications, in terms of the economic production process, as helping to improve:

- *Efficiency*, or the ratio of output to cost
- *Effectiveness,* or the quality of products and services
- *Equity,* or the distribution of benefits throughout society.

Another way of looking at telecommunications relates to information, which is a key factor in the development process. It is now understood that the collection, processing, and dissemination of information and the emergence and growth of the information sector -- the people and activities that are primarily concerned with information -- are critical to development. In that process, telecommunications, as a means of sharing information, is not simply a connection between people but a link in the development process itself. The role of telecommunications is particularly significant in rural and remote areas, where alternative means of obtaining and conveying information and of communicating are likely to be less accessible and/or much more expensive. In this context, telecommunications contributes to economic growth, diversification, and social development by reducing the cost of information flow and opening up new opportunities for more effective production and service delivery, and by providing equity in the marketplace.

3.3 Distribution of Benefits

Numerous studies throughout the world have indicated that the economic benefits of telephone service in rural and regional areas can be derived from both subscriber lines and public payphones. For businesses and organizations who subscribe to full service, high cost/benefit ratios of the following order are not uncommon: agriculture, 44; health, 33; and other, 21.[13]

Although these figures were derived from the Philippines, similar results have been demonstrated in many countries on all continents. Businesses and institutions involved in manufacturing, trade, commerce and services receive greater economic benefits than those in primary activities. Agricultural distribution and marketing, for example, need communications for efficiency reasons. This presupposes a certain degree of development, commercialization and other infrastructure development. The most undeveloped regions may derive lower benefits than those with significant market and socioeconomic infrastructure activities.

A study of rural regions in Ireland, Italy and the United Kingdom reached similar conclusions, demonstrating that although the most rural/undeveloped regions could *potentially* gain the most from investment in telecommunications (including significant employment gains) the highest benefits are actually derived in those areas which possess complementary activities and infrastructure and are ready for sustained economic take-off[14]. This has lead to the general understanding that telecommunications is a necessary but not sufficient condition for rural economic development. As an investment, it is most productive when planned and coordinated with other physical and social infrastructure elements.

On the other hand, telecommunications is an important *enabler* of and *catalyst* to other economic activities. Once business potential exists and basic infrastructure is available, the absence of reliable telephone service can be a critical hindrance to economic growth. Studies in Botswana[15] and Zimbabwe[16] found that despite an abundance of natural resources and educated people in certain rural areas, there were virtually no productive enterprises if no telephone service was available. Conversely, in rural areas with telephone service, business activity flourishes. The availability of telephone service fosters business development, which in turn creates further demand for service. The Zimbabwe study indicated that the telephone was proving vital to the emergence and growth of small business, diversification of the local economy, creation of job opportunities for women (through having access to a phone in the locations used by them for emerging businesses) and the success of a wide range of government programs and services.[17]

Whereas the Zimbabwe study heard shopkeepers and business owners say that they wouldn't know how to operate or stay in business without the telephone, another study showed this empirically. The consultant calculated that the net benefit of telephone service to business users in rural Kenya was equivalent to 5 percent of business turnover, probably sufficient in

[13] ITU "A Study of the Economic Benefits of Improved Telephone Service in the Philippines."*Information, Telecommunications & Development,* ITU, Communications Studies and Planning, 1986.

[14] Hansen, Cleevely, Wadsworth, Bailey, and Bakewell. "Telecommunications in Rural Europe: Economic Implications." *Telecommunications Policy,* June 1990.

[15] Clarkstone, Dymond & Mrazek, *Rural Telecommunications Development in Botswana: Socio-Economic and Strategic Issues.* IEE International Conference on Rural Telecommunications, London, October 1990.

[16] Study undertaken for CIDA by Intelecon Research & Consultancy Ltd., November 1990.

[17] Dymond and Mrazek. *"Making Rural Telecommunications Profitable".* Paper presented by CIDA at the ITU Americas Regional Telecommunications Development Conference, Acupulco, April 1992.

many cases to make the difference as to whether those businesses could exist profitably in certain locations[18].

3.4 Telephone Line Affordability and Payphones

The Philippines study showed that the net cost/benefit ratios from telephone usage rise with the size of the organization (the revenue and number of employees). One explanation, is that the relative cost of the fixed line charge decreases with business size. The smallest businesses, which would use the phone infrequently, are not able to justify the price of the installation and rental charges. It was also recognized and has been confirmed by many other studies that the strategic implementation of payphones in small towns and villages is able to facilitate significant benefits for these very small businesses.

Several payphone studies have shown that even the most remote and undeveloped areas derive high benefits *on a call-by-call basis*. They also show that the benefits derived by rural users are higher than those in urban centers, that they typically increase with distance, and that all income strata of society benefit.[19] Thus, high benefit-to-cost ratios exist, even though the average user may make only a few calls per month, or, in many cases, just a few calls per year. In a typical village, there may be very few users who could justify the cost of renting their own line even though high utility is derived from the infrequent calls they make.

An evaluation of public payphone projects in several African countries indicated that 80 to 90 percent of calls from villages and 66 percent from provincial towns in Kenya, Malawi, and Zimbabwe are long distance. Whereas 60 to 65 percent of calls from urban payphones were social in nature, with 30 to 35 percent related to business and 5 to 10 percent for personal or family emergencies, the pattern often changes in rural areas. In rural Malawi, 50 percent of calls involved business or other money transactions, another 10 percent were for family or personal emergencies, and almost 25 percent were for arranging visits and travel.[20] In the Senegal study, 34 percent of calls involved financial transactions and 37 percent involved urgent personal matters. These kinds of results have been repeated elsewhere.

The degree of importance placed upon calls is reflected by the fact that in Malawi and Zambia, 40-50 percent of sampled callers had traveled more than 5 km to make their call, an experience that is shared by rural users in developing countries throughout the world.

In Botswana, on the other hand, where rural communities have less agricultural activities and rural-urban migration is more of a factor, over 75 percent of calls are for personal reasons and the effective catchment area for most payphones was shown to be relatively small. However, an interesting factor is that 38 percent of users had only primary education or none at all, 78

[18] World Bank. *Telecommunications and Economic Development.* 2nd Edition. Washington, D.C.: The World Bank, 1994.
[19] Nordinger, Christopher W. "Uses of Public Telecommunications Facilities and their Benefits in a Developing Country: a Case Study of Senegal." *Information, Telecommunications and Development.* ITU, February 1986.
[20] Danida, *Evaluation Report: Public Telephone Projects, Synthesis.* Ministry of Foreign Affairs, November 1991.

percent were women, but well over 30 percent of the calls had economic benefits associated with travel substitution. Despite the very different situation in Botswana, annual revenues per payphone were still high, at almost $1,800 (this has since risen to well over $2,000), and the *overall* economic benefit was calculated at 8:1 for the first payphone in a community and 2:1 for subsequent ones[21].

3.5 Planning and Deployment Implications

Rural communities in developing countries cannot support the extensive level of telephone service which is justified in urban areas because of the combined effect of the cost of supply and the practical limitations of income level and business size. However, the socioeconomic benefits derived by users of the telephone are significant. Irrespective of the policy instruments used to bring telephone service to rural communities, it is clear that a few lines are almost always justifiable, but should be prioritized on the basis of the following known principles:

- Businesses, institutions and government agencies involved in trade, commercial services, and/or the delivery of social infrastructure services derive the highest economic benefits and generate the highest revenues.
- Above a certain size, these organizations can afford the costs of telephone service and generate sufficient revenues (e.g., in excess of $1,000 per year) to make the provision of service commercially viable.
- Most small business people and the general public are willing to pay for the cost of calling from publicly available phones, derive significant economic benefit from doing so, and represent a significant *composite* demand and revenue generating capacity. When the placement of phones is carefully planned, to serve a large enough number of people, minimum revenues of $1,000 to 2,000 per annum are realizable, which can be sufficient to justify their placement.

Another factor is that the total (bothways) incremental revenues generated within the telecommunications infrastructure from the addition of each line can exceed twice the *outgoing* revenues which are collected locally. In Chapter 6, the question of whether the incoming (i.e. urban originated) revenues should be considered as part of the revenue base of the rural operator, and the policy issues this raises, are addressed.

In summary, economic considerations lead to the conclusion that the deployment of rural telecommunications service should be prioritized to serve community requirements on the basis of the following factors:

- Population of locality
- Economic activity
- Regional administrative importance
- Aggregate income level.

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[21] CANAC Telecom and Intelecon Research & Consultancy Ltd. *Feasibility Study for the Development of Rural Telecommunications in Botswana.* June 1990.

The benefits and potential revenues are best realized when the service deployment takes all socioeconomic factors into consideration, including first focusing on high benefit subscribers, i.e., business, institutional, and public payphones and then integrating the supply strategy with the complementary developmental activities of government and local authorities, in order to ensure that the telecommunications service both contributes to socioeconomic development and stands the best chance of financial viability.

Particularly in the least-developed areas or regions, the placement of telephones, in accordance with the principles described, is most likely to generate a commercial or cost-supporting level of revenue when planned in such a way as to complement other development activities in the social, educational, agricultural, and business sectors.

4. TECHNOLOGY & COST RELATIONSHIPS

4.1 Introduction

Are the costs of rural telephone systems undergoing a radical change? Are the latest wireless access and fixed cellular solutions less costly than traditional technologies, and are they technically equivalent? Will very small aperture terminal (VSAT) satellite services and low earth orbit (LEO) and other mobile satellite systems obviate the need for terrestrial networks?

In the past few years, numerous developing countries have begun implementing wireless systems for both urban and rural service. Major systems are either planned or in service in Argentina, Brazil, Cambodia, China, Ghana, India, Indonesia, Malaysia, Mexico, the Philippines, Russia, Sri Lanka, and Thailand. In some cases, the telephone administrations are said to be installing systems for under $1,000 per line.

There is also an acceleration in the use of VSAT networks for telephony applications (e.g., in Mexico and Brazil) whereas in the next few years, satellite operating companies plan to launch hundreds of LEO satellites which will facilitate instant communication to handheld radios anywhere in the world.

In-depth investigations were undertaken to answer the questions which arise from these developments. These included a comparative analysis (technical and cost) of technologies which are widely used today for rural telecommunications, as well as emerging technologies which might be used in the future.

Generically, the main technologies examined were as follows:

- Outside plant cable
- Multi-access radio
- Fixed cellular and wireless local loop systems
- Rural exchanges
- Satellite (fixed and mobile)
- Low capacity radio.

The results of our investigations provide clear guidance as to where new and traditional technologies fit and what level of cost to expect. The analysis demonstrates that significant changes have indeed already taken place, but that the most difficult and remote areas still await the arrival of radically different cost structures based on mobile satellite systems (MSS) and low and medium earth orbit (LEO and MEO) technologies, which are not expected to be fully in service until 1998. Furthermore, if more advanced nonvoice services are required, there are still limits to the newest technology, although costs are dropping significantly for even the higher performance systems.

4.2 Technology Overview

Outside Plant Cable

The traditional method of connecting a subscriber to the exchange is via the copper loop. (Optical fibers do not yet offer any cost reductions for subscriber connections, although fiber is increasingly used for secondary cabling at least.) The nominal maximum distance due to technical constraints is approximately 10 Km. Beyond that distance, other technologies must be used to reach the subscriber. The economic cross-over is usually at 8 Km or less.

Multi-Access Radio

Multi-access radio systems facilitate transparent radio extension of telephone service to remote subscribers. The system components include central stations, outstations, and repeater stations. Subscribers access central office exchange lines via a limited number of trunks. As such, multi-access radio systems include a circuit *concentration* function.

The first multi-access radio systems, which were introduced in the 1970s, used analog technology with 15 (or fewer) trunks, accommodating up to 100 subscribers. Fully digital versions using time division multiple access (TDMA) techniques emerged in the late 1980s. TDMA multi-access radio systems typically have 30 or 60 trunks and accommodate 500 to 1,000 subscribers. Multiple repeaters can be employed to collect subscribers from locations which are very far from the central office exchange. Outstations can vary in size, from a few subscribers in an outdoor enclosure to several hundred subscribers in an indoor enclosure.

Modern TDMA multi-access radio systems utilize either PCM (64 Kbps) or ADPCM (32 Kbps) voice coding and offer toll quality voice service. Facsimile transmission at 9.6 Kbps and data transmission at a variety of rates up to 64 Kbps are possible.

Current and near-term developments in TDMA multi-access radio systems already include:

- 2 Mbps interface between the central station and exchange
- Increased number of system trunks
- Reduced power consumption at outstations and repeater stations
- Cordless extension from outstations to subscriber premises.

Fixed Cellular and Wireless Local Loop (WLL)

Analog cellular radio systems were developed in the early 1980s to provide improved service over earlier mobile radio systems. Analogue cellular technology has had unprecedented worldwide success. The next generation of digital cellular radio systems is now in the early stages of implementation. Two competing techniques are being used, time division multiple access (TDMA) and code division multiple access (CDMA).

Conventional cellular radio systems have also been used for fixed subscribers. However, such applications tend to be relatively expensive because of the system features required to support a mobile customer environment. Consequently, the industry has optimized the design of cellular radio systems for fixed customers. Fixed cellular developments have occurred primarily because of the emerging urban wireless loop access market, rather than the rural market. But the technology can obviously be used for rural telecommunications service. The primary advantages of wireless technology, additional to cost, are its modularity, rapid deployment characteristics and its flexibility in being able to serve demand anywhere within the line of sight radius.

The voice quality of cellular-style wireless systems is lower than in PSTN and generally is not considered to be toll quality. Facsimile and data transmission are possible, although at greatly reduced rates, and digital voice is delayed due to low bit rate coding. However, some recent systems, which are purpose-designed for the WLL market offer a vastly improved circuit quality and data speeds up to 64 Kbps. Whereas these systems are primarily designed for "single cell" urban use, their range can be extended somewhat to serve rural communities in the urban perimeter at least.

The overwhelming advantage of wireless systems for some situations is the short period of time needed to implement service, allowing operators to deploy new service or to reach previously unserved areas rapidly. A single cell system colocated with the exchange can be implemented within a few months, and subscribers can be added immediately thereafter.

Rural Exchanges

Small exchange switches with conventional wireline subscriber connections are another option for smaller rural communities. They can be stand-alone exchanges (either purpose-designed public switches or lower-priced modified PABXs) or remote switching units (RSUs) from a large urban or sub-urban main exchange. In either case, part of the system requirement is a transmission connection to the rest of the network, via:

- Light route radio, e.g., 2 Mbps microwave
- Cable carrier
- Optical fiber
- Satellite.

With a remote switching unit (RSU), a portion of the main exchange is physically remote from the main exchange. Hence, if the transmission system fails, the RSU becomes non-functional.

Stand-alone exchanges on the other hand continue to function, even if the transmission system is out of service. But, because of the smaller size, stand-alone exchanges are generally equipped with less capability. Some of the more inexpensive stand-alone exchanges, which are essentially modified PABXs, might themselves have lower reliability than a purpose-developed rural switch; for example many have no system redundancy to cover a main processor failure.

Hybrid switches, an RSU with some stand-alone capability, are also available. A cousin to small exchanges is the concentrator. With concentrators, subscribers' calls are simply multiplexed onto the transmission facility and transported to the main exchange.

Fixed Satellite

Small aperture and very small aperture (VSAT) earth stations can be used to provide telephone service directly to remote subscribers. Typically, this would be appropriate for a small cluster of subscribers, e.g., up to three. Where there are greater numbers of subscribers, the telephone administration would typically place a small exchange in the remote community and utilize the satellite circuits as trunks.

Three main satellite access or modulation technologies are available:

- Single channel per carrier (SCPC)
- Multiple channel per carrier (MCPC)
- Time division multiple access (TDMA)

Transponder capacity is divided into channels which are accessible by earth stations on one of two bases, the permanent assigned multiple access (PAMA) and demand assigned multiple access (DAMA). Also, various digital voice encoding rates can be used. In order to reduce transponder requirements, 64 Kbps pulse code modulation (PCM) voice transmission is generally not used; 32 Kbps ADPCM is used where toll quality is required, and other low bit rate voice coding schemes (16 Kbps or less) are used in other applications.

Recently, some suppliers have begun to transmit voice over packet data, frame relay or other digital data networks, using VSATs. The voice is given highest possible priority in order to guarantee quality. These systems have not generally been considered adequate for telephone company purposes, although the use of VSATs for rural telephony is currently increasing along with the increasing efficiency of digital encoding techniques.

Mobile Satellite

In parallel to advances being made in cellular radio, mobile satellite is a rapidly advancing technology. Several different orbital approaches are planned, including geostationary orbit (GEO), low earth orbit (LEO), medium earth orbit (MEO), intermediate circular orbit (ICO), and high elliptical orbit (HEO). Generally, the lower the orbit, the more satellites required in each constellation, but the lower the power required. MSAT, a North American GEO service in planning for over a decade, became operational in late 1995. Several other GEO-based mobile satellite service operators, including the INMARSAT/COMSAT Planet 1, the ASEAN

Cellular Satellite System (ACeS), Asia-Pacific Mobile Telecommunications (APMT), and Afro-Asian Satellite Corporation (ASC), are already in service or close to operation, while LEO and MEO systems, including Iridium, Globalstar and Odyssey, are promising service by the late 1990s. Almost all will certainly experience delays and teething problems. In most cases, the services proposed are comparable to those of the cellular operators. In some cases, such as Motorola's Iridium, the mobile satellite services will be marketed as extensions to terrestrial cellular radio services.

Mobile satellite service could potentially be used to link unserved remote areas to the main telephone network, at least until other infrastructure is established. Some prospective service providers appear to be targeting their service for rural telecommunications.

Low-Capacity Radio

Low-capacity point-to-point radio, such as single or double channel VHF or UHF radio links, is a practical technology where only a few remote telephones are needed over a distance of up to about 60 Km. Greater distances can be achieved with repeaters. The links directly replace the copper pair. The interface equipment in the radio links must emulate conditions found at the exchange line and the subscriber end. The technology becomes impractical in wide scale applications for the following reasons:

- The technology is wasteful of radio frequency spectrum, and generally telephone administrations only have access to a few hundred duplex frequencies.
- When many VHF or UHF links are used at one site, careful design is needed to avoid intermodulation products.
- The cost of combining multiple VHF or UHF channels into a single antenna system rises sharply as the number of channels increases.

However, the technology is practical when only a *handful* of channels are needed, e.g., a few remote PCOs emanating from an exchange.

4.3 Cost Analysis

Detailed cost estimates were made, under, as far as possible, comparable parameters and conditions. Technical and cost data were collected from numerous suppliers. A very helpful level of response was received. A list of the suppliers that provided information is included in Appendix B.

Special care was taken to ensure that *suggested list* prices of one supplier were not compared with *highly competitive* prices of another supplier. We attempted to obtain prices which would be typical of a small order under nominal competition; thus, potential discounts in the order of 30 to 50 percent are possible under high volume and highly competitive situations. In all cases, the factory costs were increased by 35 percent to arrive at the installed cost, which includes services such as planning, system design, and procurement; installation, commissioning, and testing; shipping; and project management.

It should also be borne in mind that the cost analysis relates to prices and market conditions pertaining in 1994-95. We have attempted to make adjustments for market dynamism. In some cases relative market and cost positions are changing fundamentally.

Total costs to the telephone administration will also include equipment maintenance. As discussed elsewhere in this report, maintenance is typically in the range of 5 to 10 percent of equipment cost per year. Differential maintenance costs between terrestrial technologies were not considered in the cost analysis. In the case of satellite solutions, it was assumed that the ongoing cost of the space segment (transponder) can be partially offset against lower O&M costs.

Outside Plant Cable

The total cost of an outside plant cable system is a function of the cost of cable, drop wire, poles, mounting hardware, underground ducts, labor, construction, and the like. These costs vary from country to country. However, an average cost per line for industrial countries is considered to be about $150 plus $0.10 per meter, *not including the cost of the exchange line and telephone set*. This formula yields the following results:

- Distance of 1 km $250
- Distance of 10 km $1,150

TDMA Multi-Access Radio

The cost to implement a TDMA multi-access radio system was investigated under two geographic scenarios:

- An area of 5,000 km², i.e. a radius of about 40 km
- An area of 50,000 km², i.e. a radius of about 125 Km requiring multiple repeaters.

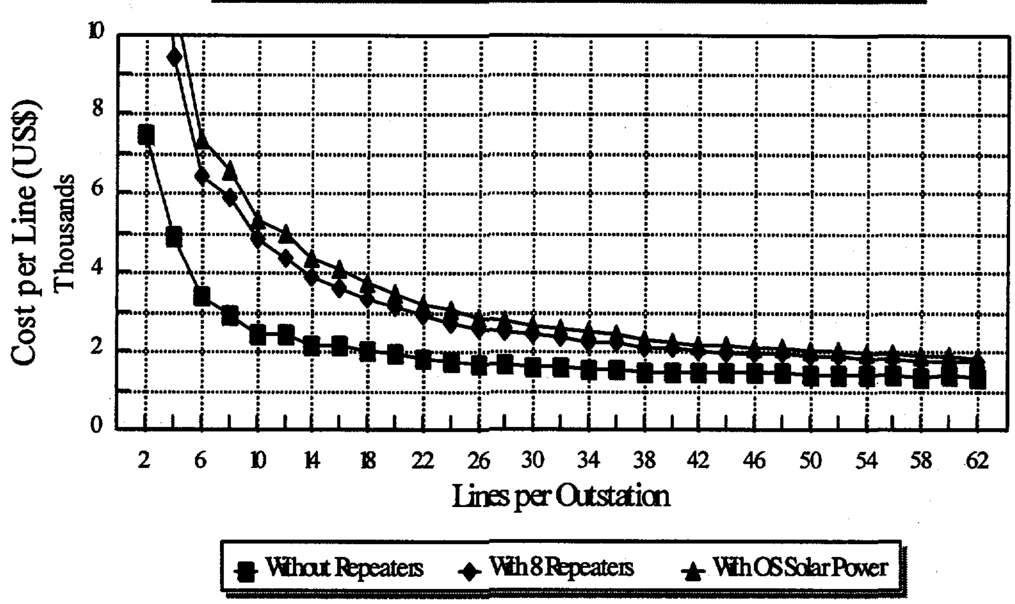
Both geographic scenarios were tested under varying traffic conditions:
(a) 0.1 busy hour Erlangs per subscriber (includes heavy business usage) and (b) 0.01 busy hour Erlangs per subscriber (very low residential and cellular calling pattern).

Other parameters assumed for the base case analysis were as follows:

- 1 percent call blocking (P.01 grade of service)
- 60 trunk system
- 2 Mbps interface with central office
- Central station and repeater redundancy used above 250 subscribers
- Essentially flat terrain
- Solar power required at all repeaters and at 10 percent of outstations.

Figure 4-1 illustrates that the installed capital cost per line of TDMA multi-access radio systems decreases drastically as the number of subscriber lines at each outstation increases. Hence, the analysis was conducted using outstations of several sizes.

Figure 4-1: TDMA Multi-Access System Cost Analysis
Based on Outstation Capacity



In each case, the total number of subscribers in the system was increased from 0 to 5,000 and the cost per line was calculated. Two representative results are shown in Figures 4-2 and 4-3, and the following observations are made:

- The cost per line is relatively insensitive to the subscriber traffic level; the cost at 0.01 Erlangs per subscriber is only slightly lower than at 0.10 Erlangs per subscriber.

- For the small geographic area (5,000 km²), the cost per line reaches its minimum after about 500 subscribers. For the large geographic area (50,000 km²), the cost per line does not reach its minimum until about 3,500 subscribers due to the cost of extra repeaters needed in the larger geographic area. *The same effect would be observed in the small geographic area if a large number of repeaters were required due to terrain constraints.*

The minimum installed capital cost per line varies considerably from approximately $3,500 (with 5 lines per outstation) to approximately $1,500 (with 60 lines per outstation). From Figure 4-1, it can be seen that, with only two lines per outstation, the cost per line was at least $7,500.

Figure 4-2: TDMA Multi-Access System Costs
5,000 Km² Coverage Area & 0.10 Erlangs per Line

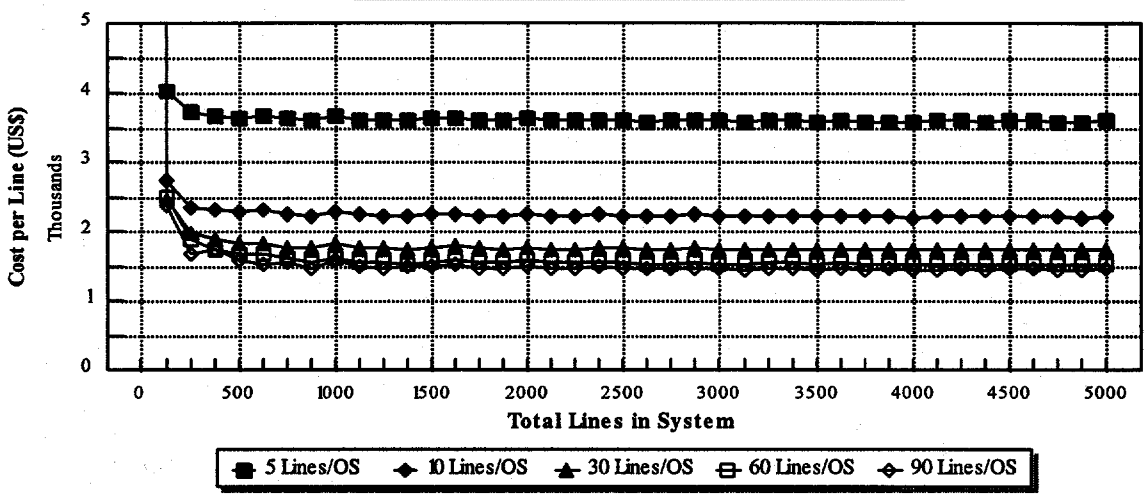
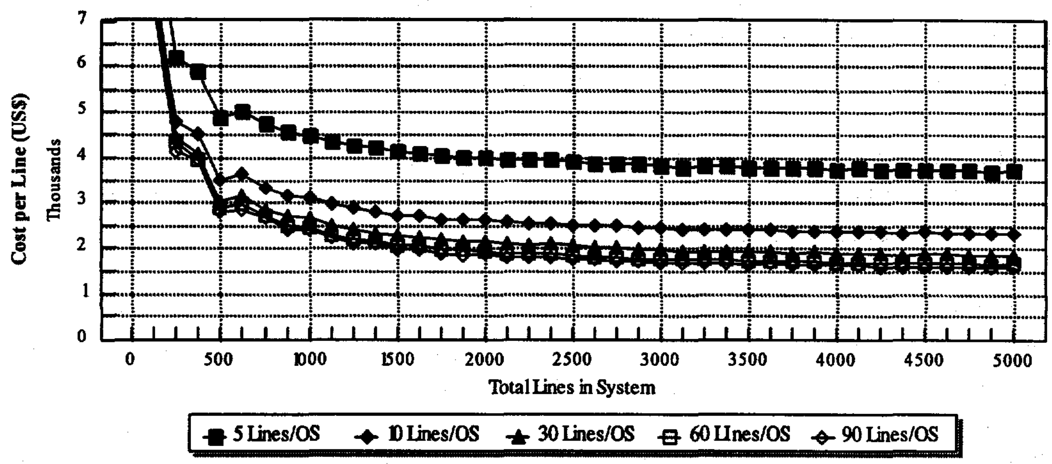


Figure 4-3: TDMA Multi-Access System Costs
50,000 Km² Coverage Area & 0.10 Erlangs per Line



The cost per line is affected by the number of repeaters required. As shown on Figure 4-1, however, even in terrain requiring a large number of repeaters, the effect of the repeater cost becomes minor when the total number of subscribers is high, i.e., in excess of 2,000. At the low end, e.g., 500 subscribers, the cost of the repeaters has a significant effect on the cost per line and can easily double it.

The effect of remote power availability was also examined with respect to outstations. The impact of using solar power at the outstation is relatively minor; at 10 lines per outstation, the cost per line increased by about $500, but at 60 lines per outstation, the cost per line increased only about $125.

Fixed Cellular and Wireless Local Loop

The cost to implement a fixed cellular or wireless system was investigated under the same two geographic scenarios; (a) an area of 5,000 km², i.e., a radius of about 40 km and (b) an area of 50,000 km², i.e., a radius of 125 km, requiring several cells.

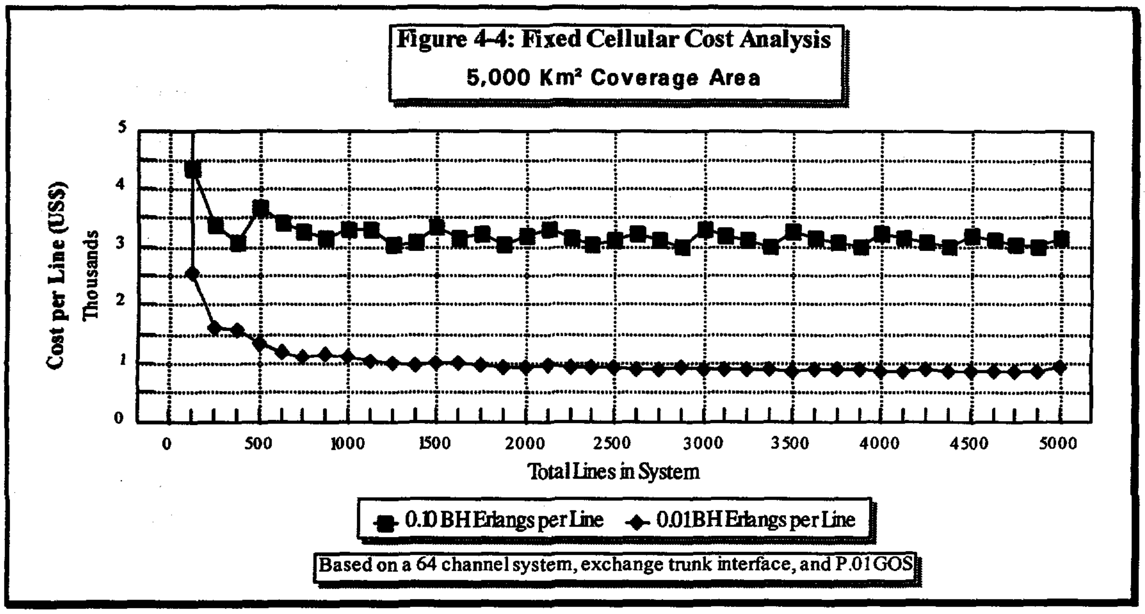
Both geographic scenarios were also tested under the same traffic conditions as for the TDMA multi-access solution, i.e., over the range 0.01 to 0.10 Erlangs per subscriber. Because fixed cellular systems vary widely in terms of size and exchange interface, the analysis was conducted for two different types of systems: (a) a system accommodating 64 channels per cell and using a trunk interface with the exchange and (b) a system accommodating 120 channels per cell and using a line interface with the exchange.

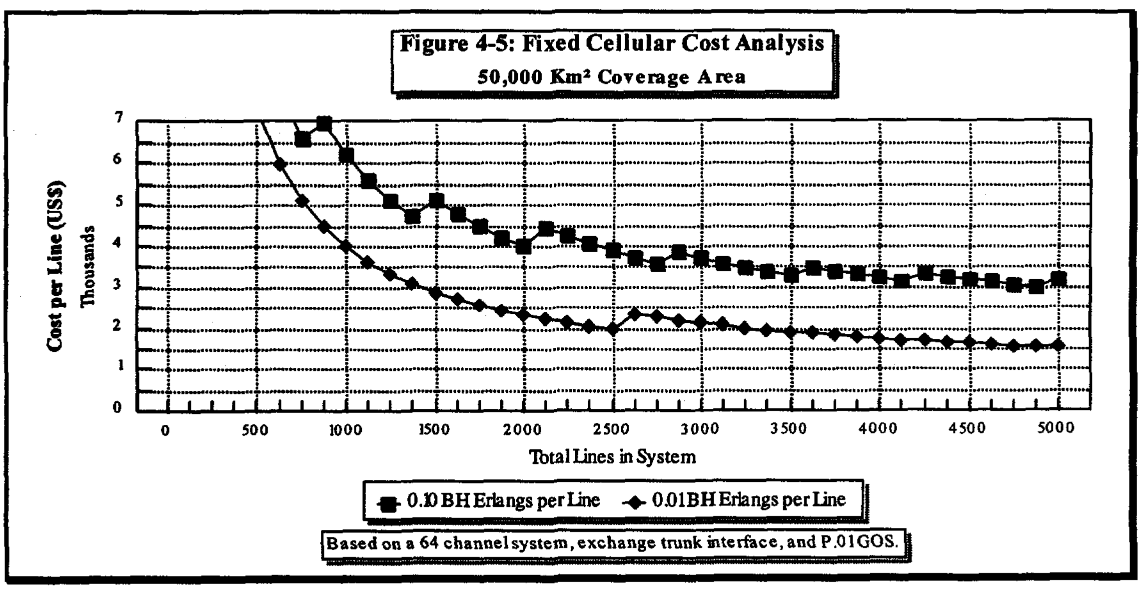
Other parameters assumed for the analysis were as follows:

- 1 percent call blocking (P.01 grade of service)
- Essentially flat terrain (no cell enhancers required)
- External antenna required at 10 percent of subscribers
- Solar power required at 10 percent of subscribers.

In each case, the total number of subscribers in the system was increased from 0 to 5,000. The results, which have similarities to the multi-access cost structure are illustrated in Figures 4-4 and 4-5 for the 64-channel system. They are as follows:

- The capital cost per line is very much a function of the average subscriber traffic level. The 64-channel system varies from about $1,000 per line at 0.01 Erlangs up to about $3,000 per line at 0.10 Erlangs per line; the 120-channel system varies from about $1,500 per line at 0.01 Erlangs to about $2,500 per line at 0.10 Erlangs per line. The smaller variation of the 120-channel system is a direct result of the greater traffic capacity of each cell.
- With the small geographic area (5,000 km^2), the cost per line reaches its minimum after about 500 subscribers. However, with the large geographic area (50,000 km^2), the cost per line did not reach its minimum until about 3,500 subscribers due to the cost of the extra cells needed in the larger geographic area. The same effect would be observed in the small geographic area if a large number of cells were required due to terrain constraints.





The cost per line of fixed cellular and wireless is also directly affected by two factors:

(a) the need for external subscriber antennas, estimated at about $350 per subscriber and
(b) the need for subscriber solar power, estimated at about $500 per subscriber.

Thus, if the majority of subscribers require an external antenna and a small solar panel to recharge the cellular radio, the average cost per line will increase by $850.

This analysis was repeated using a lower grade of service (5 percent blocking or P.05). This resulted in a decrease in cost of about 10 percent. The detailed fixed cellular analysis was based on analog cellular systems. TDMA or CDMA digital systems would currently yield comparable results, but are likely to reduce more rapidly over time. Over the past 12 months, wireless access costs have moved aggressively lower, at least in the potentially largest markets of Asia and Eastern Europe.

Rural Exchanges

In the rural exchange and wireline option, it was assumed that each exchange would be linked to the main network with 2 Mbps microwave. The following assumptions were used:

- 1 percent blocking (P.01 grade of service)
- Subscriber traffic level of 0.10 Erlangs
- 25 percent of subscriber traffic exiting each exchange.

The solution was investigated for varying sizes of exchanges, from 30 to 300. The total number of subscribers in the wide area system was varied from 0 to 5,000. This analysis found that:

- The cost per line varies considerably, from $1,500 with 300-line exchanges to $5,500 per line with 30-line exchanges
- The cost per line reaches a minimum at about 1,000 subscribers.

The per-line costs vary little from one size of area to the next, since the trunk-to-local-line ratio remains basically constant as the number of exchanges increases. The analysis was repeated using an average subscriber traffic level of 0.01 Erlangs. Again, however, there was negligible difference.

Fixed Satellite

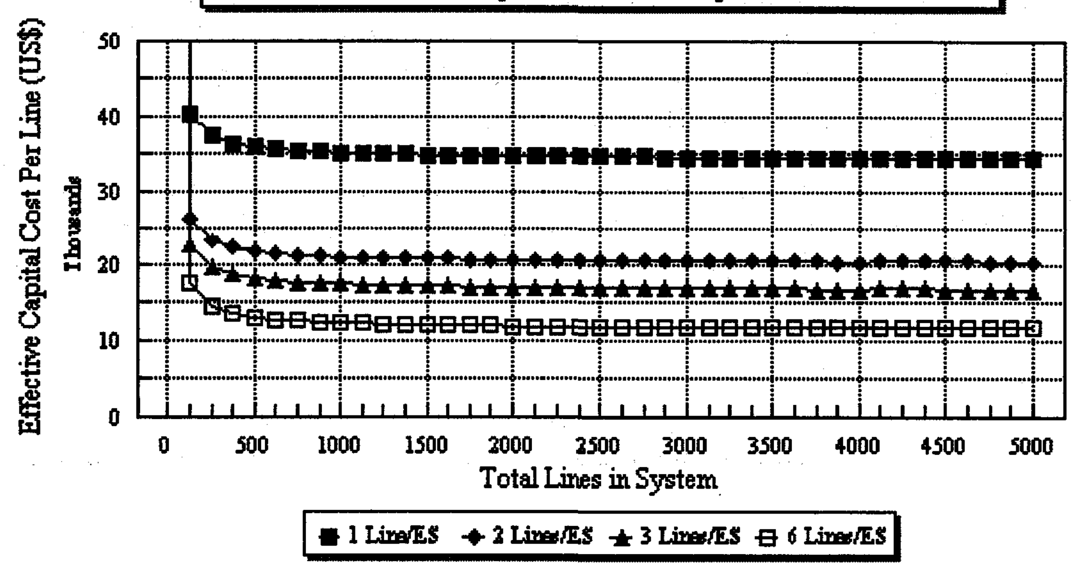
The cost to implement SCPC-DAMA satellite facilities was investigated under the following two scenarios:

- Using 32 Kbps digitized voice
- Using lower-grade 16 Kbps digitized voice.

Both scenarios were also tested under the same range of traffic conditions, namely, 0.01 to 0.10 Erlangs per subscriber. In each case, the total number of subscribers in the system was increased from 0 to 5,000. The number of lines per earth station was varied from one to six. The annual cost of transponder rental, if capitalized (using a discount rate of 8 percent and a 15-year period), would be equivalent to an additional 15 percent in capital cost although it is reasonable to assume that part of this cost will be offset by lower O&M costs on satellite-based systems.

The results are illustrated by Figure 4-6 which depicts the low-traffic, low-bit rate case. In summary, the scenario shows the cost per line varies considerably, from a high of around $30,000 per line with one line per earth station to a low of about $10,000 with six lines per earth station. The cost per line reaches a minimum at about 1,000 subscribers.

Figure 4-6: Analysis of SCPC-DAMA Satellite System Costs
0.01 Erlangs Per Line & 16 Kbps Voice



Although detailed analyses of multiple channel per carrier (MCPC) and time division multiple access (TDMA) satellite systems were not undertaken, discussions with industry representatives indicated that:

- The costs of TDMA earth stations are higher than SCPC earth stations when the number of channels per earth station is less than four or six, but under some scenarios, TDMA systems could be considerably less costly above this range.
- MCPC earth station costs are less than those of SCPC earth stations when the number of channels per earth station is less than four or six.
- SCPC-DAMA systems utilise transponder space more efficiently, so less capacity is required; efficiency increases as the traffic per subscriber decreases.

In summary, few satellite based systems would cost less than $10,000 per line when all ground and space segment costs are included. However, where distances are large, satellite solutions can be more economical than their chief competitor, TDMA multi-access radio. In general, the most appropriate use for satellite solutions is still for trunking small exchanges into the main network from large distances. [More recent developments seem to be leading to a greater degree of competitiveness for VSAT solutions through lower ground station prices and more efficient, lower cost use of the space segment. These could bring the effective cost of "micro VSAT" solutions to a cost equivalency closer to $5,000 than $10,000.]

Mobile Satellite Systems (MSS)

Mobile satellite services are just beginning to come into being. Projections as to terminal cost and usage charges are being advertised by prospective service providers. Initial MSAT service commenced in late 1995, with *luggable* terminal costs of about $2,000 and usage charges of about $1.50 per minute. Other providers will use hand-held radios, and costs in the long term could drop to approximate those of high end cellular radio. Initial *Iridium* rates are projected at $3.00 per minute for world-wide, end-to-end service, while other companies, such as *Globalstar,* are projecting much lower (less than $1.00) for subscriber-to-gateway service, which could be used by national operators for reaching remote rural areas.

If all of the proposed systems go into service, competition should be fierce and the cost per minute should drop as it happened in the terrestrial long distance market. Questions are being raised as to whether the systems will be commercially viable under such fierce competitive pressures.

Mobile satellite could potentially be used by a telephone administration for rural telecommunications purposes, obviating their need to build terrestrial equivalents. The administration would have to conclude a bulk usage agreement with the satellite operator, much as has already been proposed for the Iridium system.

To compare the effective cost of mobile satellite with traditional alternatives, given the cost uncertainties regarding usage charges, we analyzed the likely charges under varying levels of usage charges, from $3.00 down to $0.50 per minute. Annual usage was increased from 1,000 to 5,000 minutes (the latter is equivalent to 20 minutes per day, 5 days a week, 50 weeks a year). This approximates to 0.01 - 0.05 Erlangs of traffic. A fair comparison would capitalize only a portion of the annual usage charges, since this solution has very little O&M cost to the rural operator. It was therefore assumed that the first $500 - $1,000 is equivalent to the O&M costs of alternative solutions and a 15 year period was used, approximating their typical life.

The analysis is summarized as follows:

- If annual usage is 5,000 minutes and the usage rate is $0.50, the effective cost was $15,000 to $17,000, and at $1.00 per minute the effective cost was more than $30,000.
- The usage level was as critical as the charge rate. To be comparable to other options, the annual usage would have to be less than 2,000 minutes (0.02 Erlang) at a usage rate of $0.50. However, it is conceivable that higher usage levels could prove to be economical if the retail operator is able to charge customers a sufficiently high tariff.

At this stage, unless costs drop drastically, a mobile satellite system is likely to be a strictly premium service or only applicable in situations where distances are large enough to render terrestrial solutions beyond $10,000 per line. It is possible that LEO satellite operators would be willing to negotiate lower space segment rates, reflecting marginal costs, for developing countries where mobile traffic and capacity utilization would otherwise be very low. Existing precedent for lower or marginal cost pricing is in the rates which geostationary satellite operators charge for "pre-emptible" channels (typically around 50 percent of the full tariff). These represent temporary facilities or standby channels which can be pre-empted at any time to replace failed primary facilities or to meet additional capacity requirements from higher priority customers.

Marginal cost rates could prove to be economically beneficial for traditionally expensive remote regions. One problem with the concept of special deals, however, is that these could undercut the very commercial advantage which LEOs will have, since their primary market niche will be to serve those areas which are beyond the reach of conventional fixed cellular systems. Only time will tell.

Low-Capacity Radio

The cost of implementing low-capacity point-to-point VHF/UHF radio links (both single and double channel) was investigated. The installed cost of a single channel link is approximately $20,000; for a double channel the cost is $30,000, or $15,000 per channel. Repeaters can be used to extend the distance. Repeaters are back-to-back transceivers, and thus the cost of the repeater is at least that of the initial link.

Cost Comparisons

The above analyses have shown that, three technologies (TDMA multi-access radio, cellular/ wireless and rural wireline exchanges) can today provide rural telecommunications service for as little as $1,500 per line, under optimum conditions, dropping to $1,000 or less under ideal circumstances. The following analysis was undertaken to determine the optimum conditions for each technology.

TDMA Multi-Access Radio versus Fixed Cellular and Wireless

The TDMA multi-access and cellular/wireless cost data were compared for the same coverage and call traffic ranges as used previously. Figure 4-7 represents the 5,000 km^2 area and higher call traffic level of 0.10 Erlangs per line. The TDMA multi-access radio is less costly as long as each service point has 10 or more subscribers. Otherwise, wireless is less costly.

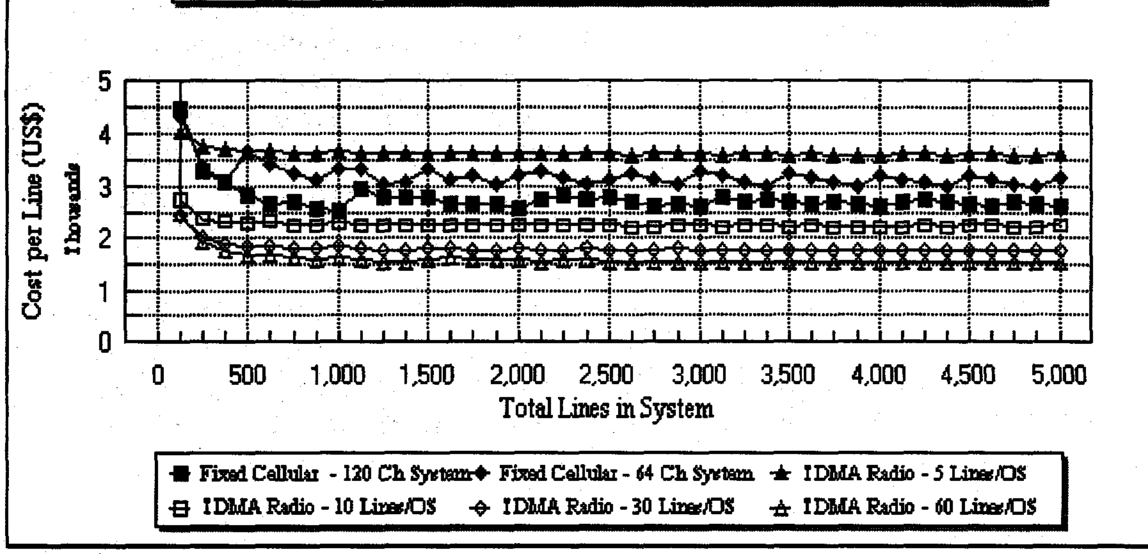


Figure 4-7: Comparison of TDMA and Fixed Cellular System Costs
5,000 Km² Area & 0.10 Erlangs per Line

Figure 4-8 represents the 5,000 km² area with the lower subscriber traffic of 0.01 Erlangs per line. *In this case, the 64-channel fixed cellular radio system is less costly in all cases.* The 120-channel fixed cellular radio system is at about the same level as the TDMA multi-access radio with 30 lines per outstation.

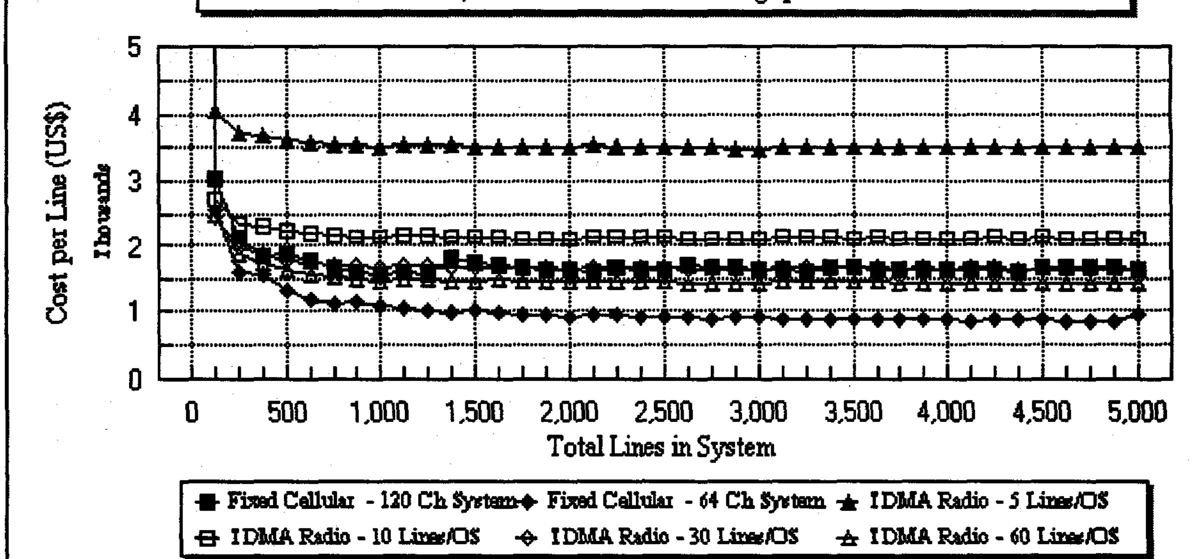


Figure 4-8: Comparison of TDMA and Fixed Cellular System Costs
5,000 Km² Area & 0.01 Erlangs per Line

Figure 4-9 represents the 50,000 km² area with subscriber traffic of 0.10 Erlangs per line. *In this case, the TDMA multi-access radio is less costly in almost all cases.*

Figure 4-9: Comparison of TDMA and Fixed Cellular System Costs
50,000 Km² Area & 0.10 Erlangs per Line

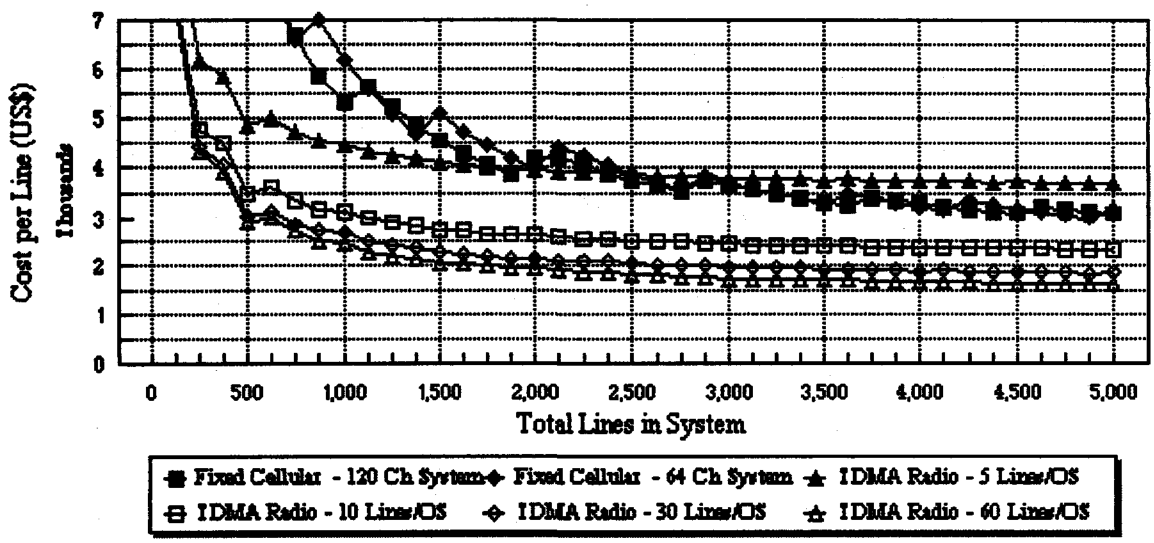
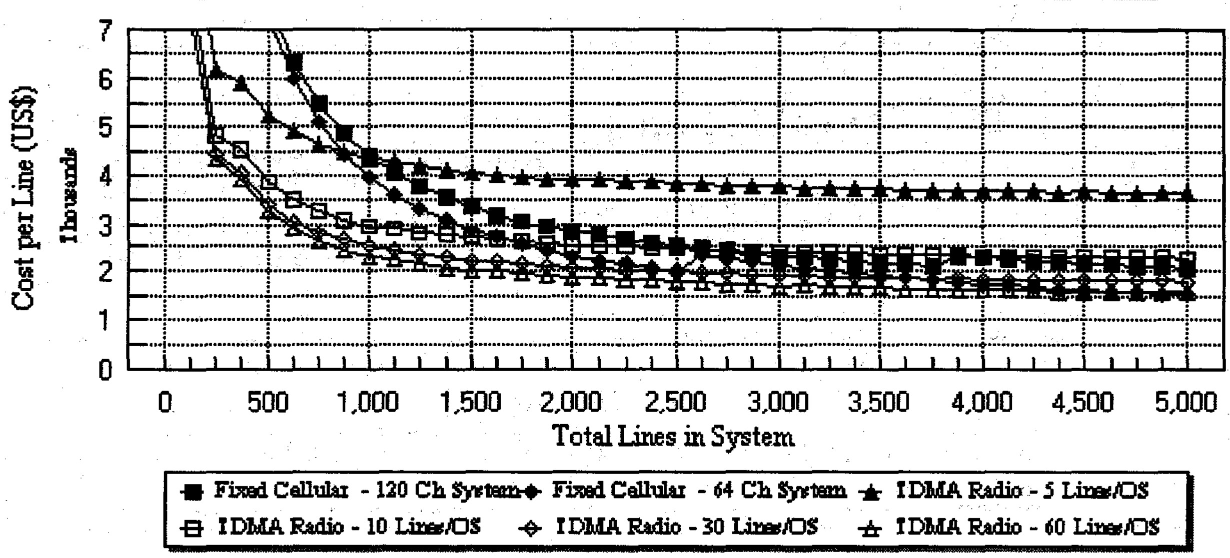


Figure 4-10 represents the 50,000 km² area with subscriber traffic of 0.01 Erlangs per line. *In this case, TDMA multi-access radio is less costly in systems with less than 1,000 subscribers.* In larger systems, it depends on the number of subscribers per service point.

Figure 4-10: Comparison of TDMA and Fixed Cellular System Costs
50,000 Km² Area & 0.01 Erlangs per Line



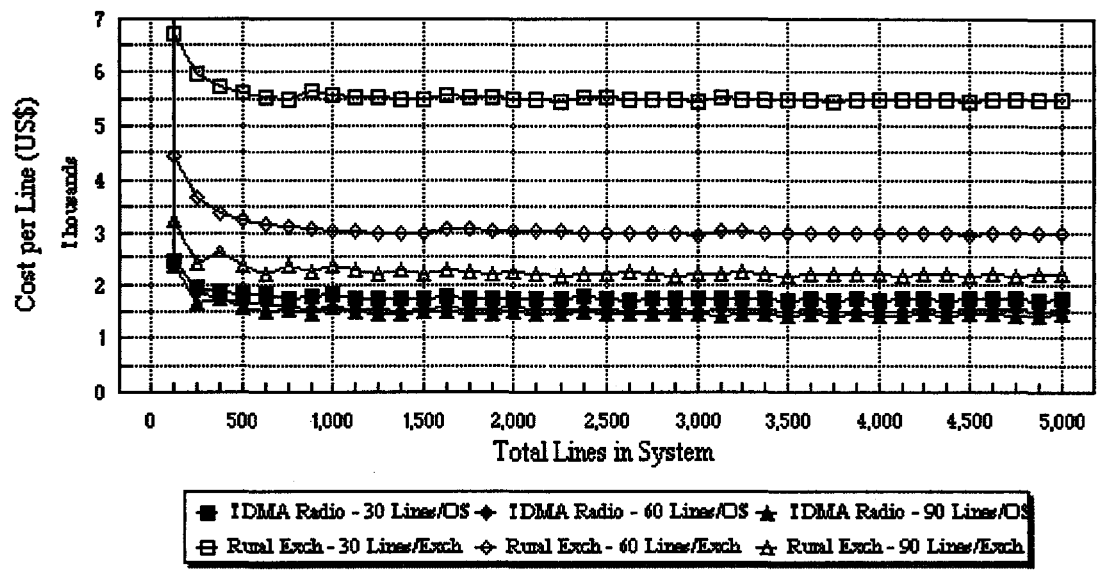
It must be noted again that if fixed cellular/wireless subscribers require external antennas and solar power units, the cost per line could increase by a total of perhaps $850. This would shift the cross-over point in favour of TDMA multi-access radio. Note also that absolute cost reductions of 35 percent or more, resulting from volume discounts and other competitive factors, are likely in future.

One situation which wireless will almost always be less costly than multi-access radio is when subscribers can be served by an existing commercial cellular radio system. In this case, the marginal capital cost per line can be as low as the subscriber equipment. However, it must be noted that commercial mobile cellular radio systems typically charge for air time. If an operator is contemplating adding fixed subscribers to a commercial cellular radio system, then the issue of air time charges must be addressed. There are cases in which differential (lower) air time charges are being levied for fixed subscribers.

TDMA Multi-Access Radio and Rural Exchange Deployment

The TDMA multi-access radio cost data were compared with those for the wireline-based rural exchange. The results, shown in Figure 4-11, indicate that it would be less costly to install a TDMA multi-access radio outstation than a small rural exchange with wireline service.

Figure 4-11: Comparison of TDMA Radio with Rural Exchange Costs



The rural exchange option becomes costly because of the cost of the point-to-point transmission system required to link the exchanges to the main network. In contrast, this transport function is integral to TDMA multi-access radio technology.

This is not to say that there is no place for small exchanges in a rural telecommunications environment. TDMA multi-access radio systems have a limited ability for local connections (calling between subscribers within the same site). When the level of local calling increases beyond the practical "intra-calling" capacity of a TDMA multi-access radio system, a small exchange can be provided. Then, rather than providing a separate transmission system to link the exchange to the main network, the TDMA multi-access radio can be used for trunking purposes. The incremental cost is that of an outstation equipped with the required number of trunks.

4.4 Summary

Technology Niches

The relative niches of the technologies examined are summarized in Table 4-1. Nevertheless the telephone administration must undertake detailed cost and technical analysis based on its own particular mix of requirements and conditions. It is expected, however, that the results will generally conform to the cost/application pattern illustrated in the table.

Table 4-1. Application/Rural System Cost Guideline

Technology	Density/ Application	Geography/ Distance from PSTN	Traffic	Cost Range (in economic niche)
Cable direct from urban switch	High & clustered	Max 5-10 km radius from PSTN exchange	Low to high	$250 to $1,200
Rural exchange or concentrator with outside plant	Low/medium & clustered (small town)	As above, at least 10 km from nearest PSTN exchange	Low to high	$1,500 to $3,000
Fixed cellular and wireless	Medium/high, not clustered	Medium area (<30 km radius per cell)	Low-medium (e.g., < 0.05 Erlangs/line)	<$1,000 to $3,500
TDMA multi-access radio	Low but clustered (e.g., more than 5 subs per location)	Wide area (radius of (several hundred km)	Low to high	<$1,500 to $5,000 +
VHF/UHF single links	Low, with little or no clustering	Medium-long distance (>25 km)	Low to high	$20,000 +
Satellite/VSAT	Low, but most economic with some clustering	very large area, long distances (>200 km) and any terrain	Low to high	$10,000 + equivalent
Mobile satellite (MSAT & LEOs)	Low, with no clustering	very large area & long distances	Low-medium	$10,000 + equivalent

Developing Country Products

Several developing countries are now manufacturing telecommunications equipment, in some cases at less cost than equipment found on the international market. Reductions of 30 - 50 percent are sometimes achievable (e.g. on local exchanges and TDMA multi-access radio). The equipment varies in quality, however.

In order to ensure an apples-with-apples comparison, the foregoing analysis was based on costs provided by suppliers of international stature. We are not suggesting, however, that products manufactured in developing country should not be considered.

If the cost analysis is repeated using equipment from both developing and industrial countries, the conclusion could be somewhat different, depending on which options are available locally. In any case, per-line costs below $1,000 per line are currently achievable in some situations.

Project Scale & Competition

As indicated earlier, the price data collected are believed to be typical of small orders under nominal competition. However, considerable savings can be achieved when the scale of the project is large and the level of international competition is high. Again, under such conditions, equipment unit prices could be reduced by 30 - 50 percent yielding the same $1,000 minimum per-line costs under ideal conditions. However, this generally applies only to the higher-density areas.

Rural Telecommunications Strategic Plan

Prior to undertaking detailed planning of any rural telecommunications network, it is strongly recommended that the telephone administration establish its own rural telecommunications strategic plan. Technical issues that should be dealt with at an early stage include the following:

- The grade of service that is appropriate to the rural service
- The equipment reliability standards that are appropriate at various subscriber levels; e.g, the point at which TDMA multi-access radio repeaters and central stations should be duplicated
- The appropriate propagation reliability under different situations
- In digital systems, the voice coding to be used, i.e., 64 Kbps, 32 Kbps, 16 Kbps, and the like
- Whether developing country suppliers should be considered for equipment, or whether the equipment would be purchased only from the international marketplace.

Since rural telecommunications systems generally do not support the same subscriber levels as do main networks, some reduction in design standards (and resultant cost) can be tolerated, for example a grade of service of P.05 (5 percent blocking), reduced propagation reliability, etc., are not unreasonable to consider. However, if compromises are to be made, they should be made in areas which can be easily changed in the future, if needed. For instance, equipment redundancy can be readily added in the future, while it may not be so easy to upgrade the grade of service or propagation reliability at a later date.

4.5 Current and Future Trends

There are at least three major driving forces behind the trends evident in the rural telecommunications market place, namely:

- The ever-increasing role of computing electronics in telecommunications systems (e.g. processing, switching and circuit concentration replacing physical plant such as cable and radio channels)
- Economies of scale, as rural systems increasingly make use of wireless, with ever more sophisticated TDMA and CDMA modulation techniques and more efficient digital voice encoding algorithms, which are initially designed for high volume urban markets
- The underlying reform process which provides an environment which accelerates the market deployment of innovative use of new systems and applications.

These trends will increase the geographic range in which wireless-based solutions are preferable to traditional wireline exchange services. For example, personal communication systems, using cordless technology (e.g. DECT), will compete with wireline services much closer to the main exchange (well below the current 5 to 8 km break-even point). Because these offer much better voice quality and data transmission capability than cellular systems, they can compete with wireline for quality, as well as offering some limited degree of mobility.

Flowing from and superimposed onto these developments are the specific developments and trends in current rural technology discussed below.

Fixed Cellular Radio and Wireless Local Loop

The growing market for wireless loop products is driving down the costs quite rapidly. The trend to be expected is for reductions of around 5 percent per year, resulting in prices down a further 40 percent from current levels within less than 10 years.

There is intense competition between technologies, i.e. between analog (the AMPS, TACS and NMT standards) and digital (the GSM/DCS1800, D-AMPS and CDMA standards). Since the market size is growing, it is probable that all will have a niche in the marketplace for a few years. The average international installed cost per line will drop well below $1,000 per line in their particular niche applications, because of market size and high competition. Installed costs well below $1,000 are being reported, however these usually represent urban and sub-urban rather than rural areas. Also, reported costs often do not include the cost of switching and all other required incremental network elements, hence quoted figures can sometimes be misleading.

At present, a major limitation of fixed cellular is its reduced voice quality and fax/data handling ability, though some of the more recent purpose-designed wireless loop products, such as CDMA, offer considerably better performance. A few, especially those based on CDMA technology, are offering 64 Kbps data or full ISDN within the next 1-2 years, although they are optimized for single cell urban and sub-urban applications to a maximum of 20-30 Km radius.

TDMA Multi-Access Radio

TDMA multi-access radio suppliers are closely watching developments in the fixed cellular/wireless loop market. Despite legitimate claims that TDMA multi-access radio provides a better quality solution for rural telecommunications, and especially where fax and data services are required, there is considerable concern within the TDMA multi-access radio community regarding the future. This is stimulating innovative thinking and will bring advances more rapidly than otherwise would have been the case.

A major concern in the industry is the matter of frequency congestion and the future availability of the 1.5 and 2 GHz bands for TDMA multi-access radio, which will contribute to the emergence of innovative and alternative approaches using other frequency bands.

The use of cordless technology (e.g. using the Digital European Cordless Telephone - DECT - standard) between the outstation - the village terminal - and the rural subscriber will become commonplace in the near future. Instead of operating one-on-one, the cordless base station will function much as a wireless PABX. When this occurs, the TDMA multi-access system will effectively be providing exchange trunking, rather than direct subscriber connections. The effect should be to further reduce the overall cost per subscriber.

Current developments are tending towards the eventual emergence of hybrid systems, which combine features of traditional point-to-multipoint and wireless technology. There is already at least one new system in the market place which combines the features of multi-access radio, wireless local loop and trunk radio, plus integral nodal switching. This and other systems will offer both single subscriber terminal stations (as a fixed cellular solution) and multi-subscriber terminals (as traditional multi-access radio), depending on subscriber density and application. Also, depending on demand, systems will, in future, be able to combine simple narrow band voice-only service with medium and high speed data, fax and ISDN applications.

Exchanges

In the coming years, 2 Mbps line interfaces will become standardized. This will reduce the cost of exchange service by another 15%. There is considerable development in the exchange, PABX and PC based switch arenas in developing and newly industrialized countries. As these mature, they will influence pricing in the international marketplace, bringing the cost of digital exchanges well below $100 per line over the next few years. Full network costs (exchange line, trunking and wireless loop connection) of well under $1,000 per line are on the horizon for the more densely populated rural areas.

As noted in the previous section, some transmission based products may also integrate a switching capability into their designs at much lower cost than a stand-alone rural switch, making them able to perform whole regional network functions and to interface with the PSTN at just one point.

5. COMMERCIAL VIABILITY OF THE OPERATION

5.1 General

In this Chapter, the issues of costs, user affordability, and economic benefit are combined with the requirements for revenue generation and profitability, to investigate the conditions under which rural telecommunications service can be delivered commercially. A commercial feasibility model is introduced and tested against specific country examples in order to develop a useful conceptual tool for planning service provision.

5.2 Cost Structure of Commercial Operation

The world average financial performance of national and major regional telecommunications operators is approximately as follows.[22]

Annual revenues		$735	100%
Operating expenses	Administration, Operation & Maintenance (AO&M)	$368	50%
	Equipment Depreciation	$162	22%
	Financial & Other Charges	$81	11%
Pre-tax Profit		$124	17%

The level of profitability is usually lower in high-income markets than in the developing world, primarily because of strict monopoly regulation and, more recently, the influence of competition.

Another way of looking at annual operating expenses is to relate them to investment costs, which at the time of the study were approximately $2,000 per line. On this basis, the average operational costs can be summarized as follows:

AO&M	$ 368	18% of capital cost
Depreciation & Finance (amortization, 15 years @ 8%)	$ 243	12% of capital cost
Total Operating Costs	$ 611	30% of capital cost
Pre-tax Profit	$ 124	6% of capital cost
Required Revenue per Line	$ 735	34% of capital cost

[22] International Telecommunications Union. *World Telecommunications Development Report.* World Telecommunictions Indicators, 1994.

Using the world average, then, annual basic operating costs are around 30 percent of capital costs. This means that revenues need to exceed 30 percent if an operator is required to operate commercially, that is, to make a profit. The required payback period (when the accumulated revenues become equal to the invested capital) would thus be around three years, which is typical for telecommunications operations.

Although these average percentages will obviously not be representative of every situation (and also should not be used for pricing purposes), they are close to reality for most situations as well as being justifiably conservative. The incremental operating costs associated with new or expanded network segments may, of course, be lower than the company average because of economies of scale, new technology, and the like. However, in our experience, the cost of operating rural networks is often seriously underestimated, which makes for poorly maintained and operated systems and leads to lower-than-potential revenue generation. Hence, it is important not to underestimate costs. The required payback period could possibly extend to, say, four years, but should not be relaxed by very much when considering commercial requirements. This is because investors would, in any case, tend to seek a risk premium, thus replacing operating costs with an additional profit requirement to compensate for the perceived higher risks.

The percentages used in the model were derived from both the financial reports of Canadian operators and ITU world statistics, and checked against reports from a few developing countries in which the average costs per line differ significantly from the world average (e.g., Botswana's national average investment per line is $3,500), and were found to be consistent.

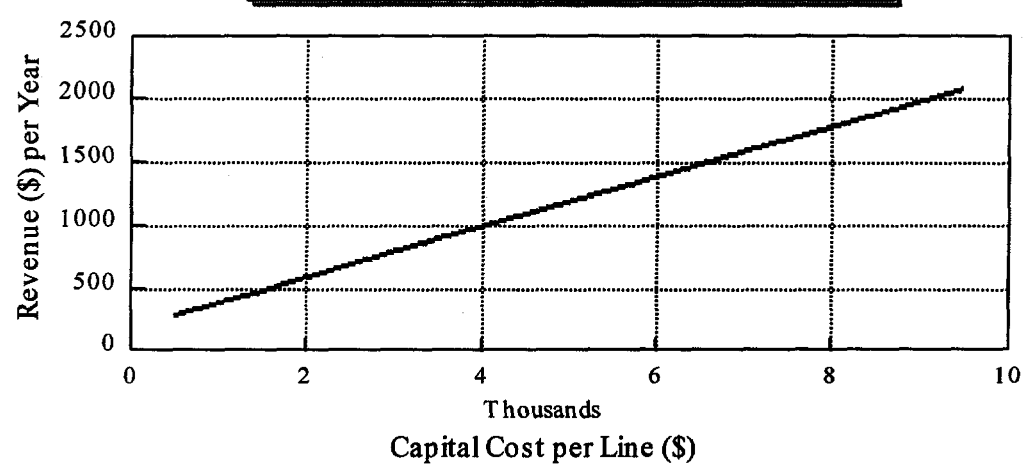
The 18 percent AO&M costs should be viewed as being made up of fixed and variable elements (not to be confused with non-traffic-sensitive and traffic-sensitive costs, which are used in pricing and revenue settlement calculations).

- The *fixed element* covers corporate establishment, administration, marketing and sales, and network management. Whereas it varies, to some degree, from country to country and may decline as the size and modernity of the network increase, it is (in principle at least) independent of the per-line capital cost. We have assumed this to be equal to $200 per line, or 10 percent of the average capital investment.
- The *variable element* comprises system operation and maintenance and tends to be directly related to the cost of the equipment. Higher cost-systems in remote rural areas require heavier expenditures on personnel, transportation, and customer follow-up because of the rural geography and environment. The cost of this is usually estimated in the 5 to 10 percent range, depending on whether the spares and test equipment are included. We have assumed a conservative figure of 8 percent. For some wireless systems, this figure -- the incremental recurring cost of O&M -- may be significantly below 8 percent. However, each case must be looked at carefully. For reasons already stated, underestimation is common, but this could be detrimental to rural service optimization.

The 12 percent depreciation and finance costs include approximately 8 percent depreciation and 4 percent in averaged interest payments: If the operator were given 15 year zero or low interest credit for capital investment purposes, then the annual financial savings could amount to a significant reduction of up to 4 percent per year.

Based on the model, a low-cost operation such as the Bangladesh Rural Telecommunications Authority (BRTA), which reportedly has average capital investments of under $1,000 per line, would be expected to have annual operating costs below $400 per line and a with-profit revenue target of around $460. On the other hand, high-cost operations (e.g., rural Bolivia, Brazil or Peru), where capital investments may be more than $10,000 per line and involve long distances and repeater stations, would have total operating costs exceeding $2,200. Most rural telephone systems in developing countries have capital investment costs in the $3,000 to 7,000 range, implying total annual operating costs of between $1,000 and $2,000 per line. Figure 5-1 illustrates these requirements.

Figure 5-1
Breakeven Revenue Requirement



5.3 Incremental Costs

The previous section recognized that long-run incremental costs (the theoretical basis for cost-based tariffs and interconnection agreements) may not necessarily conform to the percentages derived for this model because technological development and economies of scale produce changes as the network size increases. As described in Chapter 4, capital costs are declining. However, since *both* capital and operating costs are reducing because of advancing network management and supervisory technology, we expect the relationship between capital and operating costs to remain fairly constant. It is possible that networks dominated by wireless local loop technology may be achieving significantly lower operating percentages. Although, as noted in Chapter 4, wireless local loop is still the exception rather than the rule in truly rural areas, each case needs to be looked at individually.

5.4 National versus Regional/Rural Operation

Are large national operators or small regional companies better able to deliver cost-effective telecommunications services to rural areas? Who is more likely to maintain costs at a manageable level, provide an acceptable grade of service, and operate profitably? It can be argued that some of the incremental costs should be lower for national operators, because they already have wide area management and administrative systems in place, and therefore lower incremental costs. Experience in the developing world does not necessarily confirm this argument, however, as national operators invariably have critical resource constraints, are heavily centralized, and concentrate resources on meeting urban demand to the detriment of rural areas.

Another reason for favoring the large national operators may be that the real costs of rural investment and operation can be averaged out so that rural subscribers are more easily cross-subsidized by the urban network. For example, it was calculated that to cover the higher line costs and make up for the revenue shortfall in Botswana's rural program represents a cross-subsidization of just 3 percent of total revenue,[23] *excluding any accounting for the revenues generated from additional urban-to-rural calling, which reduces the net cross-subsidization considerably.* A British study calculated that British Telecom's universal service obligation costs just 1 percent of its total revenue base.[24]

Despite the fact that, when all additional revenues are considered, rural investments are not as unattractive as they first appear, any apparent cross-subsidization is increasingly unacceptable in the liberalized environment, especially where operators may be facing competition in their urban markets (discussed further in Chapter 6). It is also impossible for national operators to ignore the differential costs and rates of return with which they are confronted, and this often means that rural network development is given a lower priority.

Thus, on balance, there are some good reasons for licensing independent operators to provide rural service on a commercial basis. In several countries, an entrepreneurial approach has been shown to generate both the most cost-effective capital solution and an efficient and market-responsive operating organization. However, as will be seen, commercial viability is not possible in every situation without some form of policy intervention.

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[23] Clarkstone, Dymond & Mrazek. *Rural Telecommunications Development in Botswana: Socio-Economic & Strategic Issues.* IEE International Conference on Rural Telecommunications, London, October 1990.

[24] Office of Telecommunications (OFTEL). *A Framework for Effective Competition,* United Kingdom: OFTEL, 1994.

5.5 Matching Revenues with Costs: a Basic Feasibility Model

Can the costs of rural service provision be recovered from users in the local economy and the operator make a profit? In Chapter 2, we introduced the concept that the *aggregate* telecommunication demand amounts to users being willing to pay collectively between 1 and 2 percent of a community's total income. To be conservative and referring to the evidence in Table 2-1, in a rural economy it is not unreasonable to assume a minimum/maximum revenue potential of 1 to 1.5 percent on a regional basis, perhaps even on a community-by-community basis so long as some economic infrastructural development, people mobility, and market activities are taking place.

It is recognized that in some countries -- especially island communities for whom trade is important or migration is a large factor -- users may be willing to pay well in excess of 1-1.5 percent of community income. However, in the vast majority of cases, rural expenditures are lower than urban (and thus lower than the national average) because rural economies are less diversified and service oriented. The commercial supply of telecommunications service should be carefully balanced with user willingness to pay. Affordable telephone penetration levels can be estimated from a knowledge of a community's economy, its total income, and the per-line cost of providing service.

5.6 Rural Income Levels

A rough estimate of *average rural incomes* for the countries in the study group was made from a formula which included the following data:

- Per capita GDP
- Country purchasing power parity (PPP) income distribution figures
- Rural population as percentage of total.

It was assumed that for countries in the low and lower-middle income range, the rural population coincides with the lowest bands of the national income/expenditure strata. Clearly, not all of the lowest-income families are in rural areas, thus, the methodology is conservative (i.e., yielding slightly lower average incomes and potential penetration levels than might be achievable in practice). For upper-middle and high-income countries, which have much higher urbanization rates, it was assumed that the urban poor represent the lowest 10 to 20 percentile in the income strata (the actual percentage rising with the urbanization rate).

The calculated rural income levels (shown in Appendix C), imply that the ratio of average urban to rural income is in the range 2.4 to 5.9 for the lower-income countries in the group, between 2.0 and 4.0 for upper-middle-income countries, and 1.5 to 2.0 for the high-income countries.

5.7 Revenue and Penetration Potential

The potential rural penetrations achievable commercially in each of the 31 countries are shown in tabular fashion in Figure 5-2 on the next page. The penetrations are shown in the form of the number of inhabitants that can support the commercial provision of one telephone line and are based on outgoing (i.e., locally collected) revenues not exceeding 1.5 percent of total community income.

Figure 5-2: Tool kit Feasibility Model

RURAL TELECOMS PLANNING TOOL KIT

FEASIBILITY MODEL[25]

	Level of difficulty (subscriber density and geographical factors)									
	Peru Mexico	Brazil Bolivia	Colombia Uganda Australia	Botswana Paraguay Nepal	Ecuador Zimbabwe	Indonesia Kenya	Nepal Thailand UK (Scot)	Argentina Philippines	India Pakistan Malaysia S.Parag	B'desh Korea
Capital cost per line ($)	10,000	9,000	8,000	7,000	6,000	5,000	4,000	3,000	2,000	1,000
Required annual revenue per line, incl. AO&M, amortization, & profit ($)	2,640	2,400	2,160	1,920	1,680	1,440	1,200	960	720	480

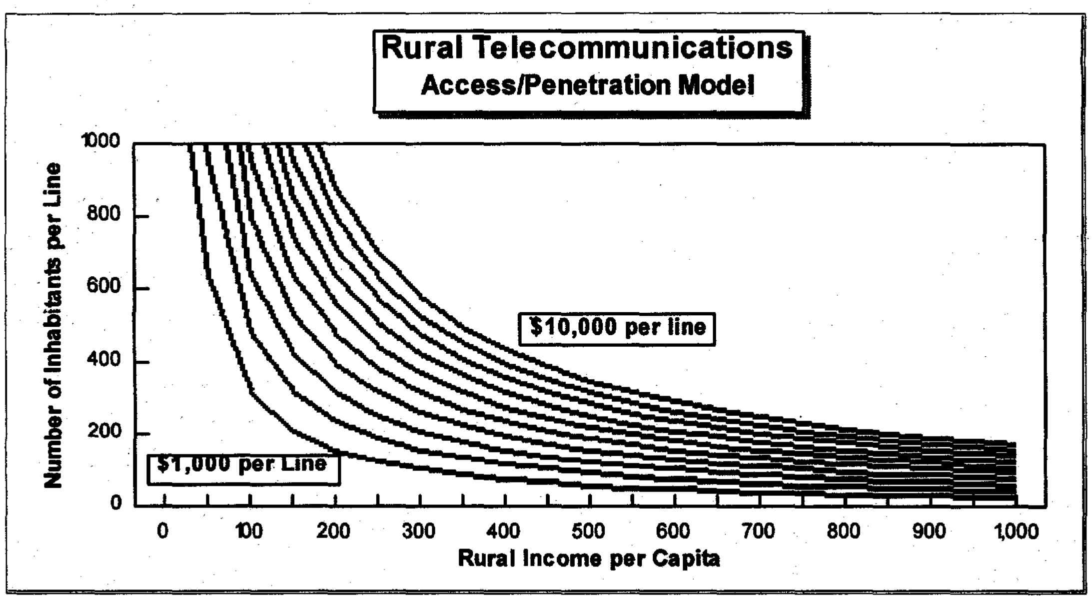
Rural income per capita		No of inhabitants required to support a single telephone line									
$134	Uganda	1,317	1,197	1,077	958	838	718	599	479	359	239
$139	Nepal	1,264	1,149	1,034	919	804	689	574	459	345	230
$140	Kenya	1,260	1,145	1,031	916	802	687	573	458	344	229
$171	Bangladesh	1,028	935	841	748	654	561	467	374	280	187
$220	India	802	729	656	583	510	437	364	291	219	146
$236	Zimbabwe	745	678	610	542	474	407	339	271	203	136
$275	Pakistan	641	583	524	466	408	350	291	233	175	117
$295	Peru	597	543	488	434	380	326	271	217	163	109
$299	Bolivia	589	535	482	428	375	321	268	214	161	107
$321	Colombia	548	498	449	399	349	299	249	199	150	100
$356	Sri Lanka	495	450	405	360	315	270	225	180	135	90
$386	Philippines	456	414	373	331	290	248	207	166	124	83
$444	Indonesia	396	360	324	288	252	216	180	144	108	72
$446	Ecuador	395	359	323	287	251	215	179	144	108	72
$812	Paraguay	217	197	177	158	138	118	99	79	59	39
$843	Brazil	209	190	171	152	133	114	95	76	57	38
$1,108	Mexico	159	144	130	116	101	87	72	58	43	29
$1,152	Malaysia	153	139	125	111	97	83	69	56	42	28
$1,212	Thailand	145	132	119	106	92	79	66	53	40	26
$1.315	Botswana	134	122	110	97	85	73	61	49	37	24
$2,327	Argentina	76	69	62	55	48	41	34	28	21	14
$3.526	Korea	50	45	41	36	32	27	23	18	14	9
$4.050	Greece	43	40	36	32	28	24	20	16	12	8
$5.158	Portugal	34	31	28	25	22	19	16	12	9	6
$8.985	UK	20	18	16	14	12	11	9	7	5	4
$9,551	Australia	18	17	15	13	12	10	8	7	5	3
$9,712	Spain	18	16	15	13	12	10	8	7	5	3
$12,803	Canada	14	12	11	10	9	7	6	5	4	2
$14,041	United States	13	11	10	9	8	7	6	5	3	2
$16,752	Finland	11	10	9	8	7	6	5	4	3	2
$17,894	Sweden	10	9	8	7	6	5	4	4	3	2

[25] Assume willingness to pay equals 1.5% of income.

The model includes calculations for a range of network per-line cost scenarios from $1,000 to $10,000. Some country cost examples are indicated in the table, however, it must be remembered that almost all countries have a wide range of rural telecommunications costs, according to the conditions described in Chapter 4.

It must also be recognized that no country has uniform rural incomes. Regional differences mean that the model can be applied only on a mean or an average basis. However, it should provide guidance as to the order of magnitude in telephone penetration that commercial supply should be able to achieve. The model is also shown graphically in Figure 5-3.

Figure 5-3 : Rural Telecommunications Access/Penetration Model

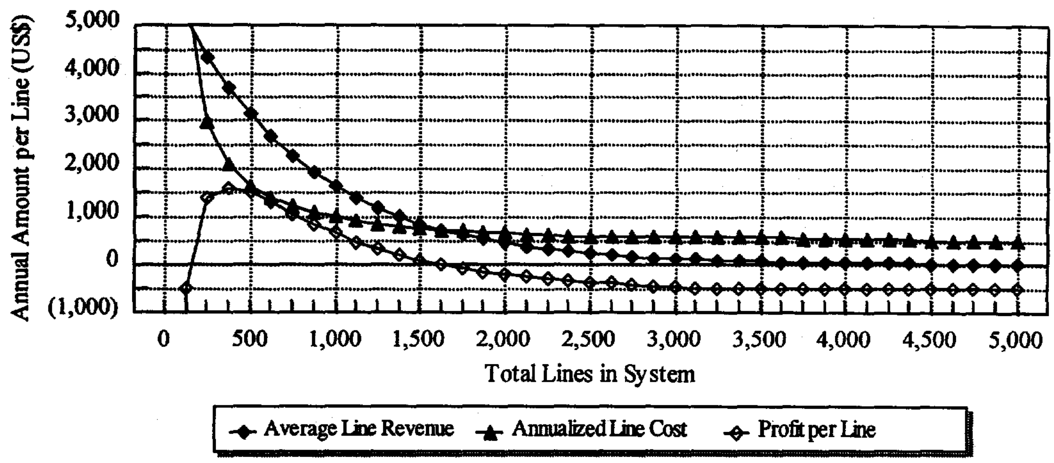


5.8 Combining Revenues and Costs

Figure 5-4 provides an overview of the cost/revenue and commercial profitability situation for the rural areas of many developing countries. There are separate curves for cost and revenue per line, indicating a falling trend as the number of subscribers increases. Whereas the first few lines in any system or network technology may not be commercially feasible because of the very high costs involved, a wider area supply strategy utilizing, say, TDMA radio or fixed cellular wireless can reduce the per-line costs to the point where the potential revenues exceed cost.

However, as described in the previous section, if supply is "overdone," then the per-line revenues will fall more sharply than costs, with the result that commercial viability, represented by the shaded area under the profitability curve, disappears. There is thus a commercial viability zone which should not be exceeded.

Figure 5-4
Commercial Viability Zone



The demand curve (and with it the commercial viability zone) will expand with time as the rural economy and telephone usage grow. Costs are also declining, hence, the operator is able to invest in providing service to some marginally unprofitable customers.

The curve is also interesting from a regulatory viewpoint. The regulator may decide to enable the operator to provide service down into the unprofitable zone, through the arrangement of tax/fiscal incentives, low interest loans, or provision of a favorable agreement (see Chapter 6 and 7). The regulator may also force the operator to serve marginal customers so long as a minimum overall return on investment can be maintained.

5.9 Application of the Feasibility Model: General Country Examples

Figure 5-2 indicated that, assuming a maximum of 1.5 percent of total economic income as a guide for affordability of telephone service, rural Kenya, with a per capita income of just $140, is unable to support, on average, more than one telephone line per 687 people (teledensity of 0.15 per 100 inhabitants). This is because, based on known costs of rural service provision in Kenya, the estimated annual revenue requirement is $1,440. Bangladesh, on the other hand, with not much more per capita income than Kenya, could support one line per 187 people (0.53 per 100) because of its much lower cost of provision. India's parameters yield a potential rural penetration of approximately 0.46 per 100 inhabitants and Pakistan, 0.57 per 100, although some areas in both of these countries should be able to achieve considerably better because of lower costs and higher than average incomes.

By using some known examples, the model explains why parts of rural Mexico, for example, despite having relatively high income levels by developing country standards, are unable to support penetration levels much better than Bangladesh because of the higher costs, and why many areas in Peru, Ecuador, Bolivia, Colombia and northern Paraguay (and probably other Latin American countries) are in the same position or can barely afford a single payphone per village of 500 inhabitants.

Among advanced countries, the commercially supportable service level is typically one telephone per 2 to 10 people in the expected cost range. For British Telecom to upgrade its facilities in Scotland at an estimated capital cost of at least $3,000 per line, the commercially viable penetration would be one telephone per 7 inhabitants (about 15 per 100). Even Sweden, which has been able to maintain rural capital costs in the region of $2,000 - 2,500, can only achieve a penetration of 30 to 40 lines per 100 inhabitants without cross-subsidization, whereas nationally it has a teledensity of 68 per 100.

5.10 Comparing the Model Against Specific Case Examples

The feasible supply strategy for low-income and rural areas which is described in Chapter 4 and illustrated by the model is as follows:

- Assume that aggregate revenues between 1 and 1.5 percent of community income are achievable; at least this can be assumed on a regional system basis if a district center is included.
- Balance total revenue potential against supply costs, in order to determine the number of lines which are commercially feasible.
- Deploy the lines appropriately for capturing a community's full communication needs and potential demand for telephone calling.
- Where high costs are a seriously constraining influence, concentrate service onto just a few high revenue / high-benefit customers and public payphones
- Achieve maximum service accessibility for the whole population (e.g., by encouraging key customers to facilitate public use or to operate a payphone through agency agreements, tariff discounts, or allowance of markups).

The following case examples investigate how closely the feasibility model can come to interpreting or guiding individual country programs. At this stage, just a few representative cases are discussed and the amount of detail which is provided varies. This is due to both the amount of data available and the purpose for each case's inclusion.

The revenues are primarily those resulting from rental charges and outgoing calls. The revenues due to incoming calls are, at this point, ignored, but they will be discussed in Chapter 6, which deals with interconnection and associated policy issues.

Thailand

Thailand has a rural population of 45 million, spread among 7,061 villages and 65,301 sub-villages. The average settlement size is just over 600. The communities have been described as follows:

- 30 percent are located in densely populated areas, are above average size, and are relatively well-developed economically
- 50 percent are in moderately populated valleys and coastal/island areas
- 20 percent are very small localities in mountainous or coastal/island regions.

Less than half of the rural settlements currently have telephone service. The Thai government has encouraged the emergence of a range of commercial opportunities in the telecommunications sector and has been prepared to offer private revenue-sharing concessions for rural services. However no offers have been received from the private sector, ostensibly due to the fact that the investments are seen as financially unattractive.

The Telecommunications Organization of Thailand (TOT) is therefore extending service under a program of "Long Distance Telephone Projects" which is largely justified from a socioeconomic rather than a commercial perspective and financed from bilateral and multilateral sources. In our view, however, commercial issues should not be ignored; otherwise, development opportunities may be lost, as indicated in the following examples.

Case #1: Under its Fifth Development Plan (1984-92), the TOT set out to extend service to 1,813 villages. The objective was to provide *three telephones per village*, comprising two payphones plus one other phone in the landowner's house. The landowner was encouraged to make this telephone available for public use by offering him a 10 percent discount on call charges.

The technology used was a mixture of TDMA radio, UHF point-to-point radio, and cable systems. The cost per line was $8,000, from which it can be assumed that the total investment cost, including exchange and other network overheads, was approximately $9,000. According to TOT officials, average revenues have been approximately $2,400 per line, which coincides with the amount required by the model for profitable commercial operation. The feasibility model projects a potential penetration of 1 line per 132 people at this cost level, i.e. 3-4 lines in villages of 500 inhabitants or 7 to 8 per 1,000.

The villages for this project were chosen on the basis of "high economic" and population density. It is likely that the population of most of them is well above the national average; hence, although these lines appear to be commercially viable, the full potential demand is probably not being met. It should therefore be possible to extend the TDMA systems, which would reduce per-line costs considerably, and to expand both the customer base and total revenues.

Case #2: A recent project -- TOT's Seventh Development Plan, 1992-96 -- is extending service to another 4,500 localities, including 3,500 villages and 1,000 "important places" such as tourist locations. The strategy is to place five lines in each village (one line at the landowner's house plus four other institutional or payphone lines). The technology is a mixture of TDMA radio (for 4,000 locations) and satellite (for 500 locations).

According to available records, the per-line capital costs for the 4,000 locations to be served terrestrially is approximately $3,700 (including TDMA radio and all associated towers, cable, etc.). It may be assumed that the total cost per line, including the exchange lines and other associated network investments, will be approximately $4,500. Thus, the revenue requirement for commercial service, according to the feasibility model, would be around $1,300.

At this cost level, assuming revenues equal to 1 to 1.5 percent of income, the model projects potential demand for 9 to 14 lines in a village of 1,000. Assuming the lower limit, this could be hypothetically established in the following representative fashion as shown on Table 5-1:

Table 5-1. Telephone Lines and Revenue for 1000-person village in Thailand

Type of line	Revenue per line	Total revenue
2 payphones/landowner	2,400	4,800
2 local gov't/institutions	1,500	3,000
2 high-use businesses	1,200	2,400
3 medium-use businesses	600	1,800
Total village	$1,300	$12,000

As already noted, villages have been given only five lines, although the TDMA systems were actually sized for expansion to at least nine. The average revenues per line on this project were stated by an official to be around $960 per annum, which would imply that the service is slightly below break-even. However, it is likely that many of the villages have much higher revenues.

If the systems were, in fact, expanded to the 9 lines per village, the average capital cost would drop to below $3,500, bringing the operating revenue requirement very close to the actual revenue realized per line. We expect that increasing the supply by an additional four lines per village and pursuing appropriate marketing policies would not reduce the per-line revenue by very much but would most likely significantly increase the total revenue catchment. In fact, under an expansion of this project, the government is now attempting to install a total of 46,000 lines in those villages accessible by the infrastructure.

Since the original project had not been planned for commercial operation, the capital costs were averaged with the satellite portion for very remote communities, such that the per-line costs for the total project are stated as $16,000. The cost of the satellite portion is much higher than for the terrestrially served localities, largely because of the high costs of the central control and "gateway" stations serving, as yet, a limited number of remote earth stations and subscribers. The average cost per line will obviously decrease as the number of remote stations is increased; however, Thailand's experience serves as an illustration of the continued very high cost of conventional domestic satellite solutions.

In conclusion, the terrestrially served network expansions appear to have been close to commercial viability and could possibly be made more so. With more aggressive line placement and service marketing, we believe that total revenues could be increased significantly and the network made to be self-sufficient. However, it is suspected that the satellite portion will need to be subsidized for a long time to come. The satellite portion should probably be considered as a special case and financed separately.

Case # 3: Under the Eighth Development Plan (1996-2001), the Government has called on TOT to accelerate its rural program by installing a further 135,000 lines in the 43,000 remaining sub-villages (mubans) still without service, plus 2,000 other important places, by 1998. The implementation plan thus calls for three telephones per locality, which will be provided by a combination of TDMA radio and fixed cellular wireless. It is currently expected that the overall capital cost per line will be under $5,000 and that overall the service will be profitable, as the model indeed predicts.

Botswana

In 1986, Botswana Telecommunications Corporation (BTC) embarked on a program to extend service to the 200 villages which had more than 500 inhabitants, by year 2000. These villages comprised 26 percent of Botswana's population, with an average of about 1,800 inhabitants. Providing service to these localities would also bring the telephone within closer proximity to the remaining 36 percent of the population who reside in villages below 500 inhabitants.

Consultants undertook a feasibility study[26] to investigate the program's revenue potential, to develop an implementation plan, and to make recommendations on the policy aspects. At the time of the study, only 30 of the targeted villages had any form of telephone service. The recommended program comprised 5,000 lines, at a cost of $7,000 per line. The technology includes a combination of electronic exchanges (RSUs and stand-alone switches), TDMA multi-access radio, and point-to-point radio systems.

Based on a user survey which included both existing and potential village customers, and a detailed analysis of BTC billing records, the demand for each village was projected individually, based on the number of dwellings, businesses and institutions. An "average" village of 1,800 people (in 1988) was projected to have a demand for approximately 13 lines, including 5 residential and 2-3 payphones, rising to a total of 20 lines by 1996. The demand penetration and revenues in the average village were as shown in the table following:

[26] CANAC Telecom and Intelecon Research & Consultancy Ltd. *Feasibility Study for the Development of Rural Telecommunications for the Republic of Botswana.* June 1990.

Table 5-2. Demand, Penetration, and Revenue for an Average Village in Botswana

Type of customer	Penetration	Revenue ($)
Gov't, institutions, & banks	75%	2,150
Productive enterprise (e.g., crafts)	67%	1,140
Retail & wholesale business	37%	1,140
Payphone	1 per 500 pop'n	1,770
Residence	2% of dwellings	590
Average village (1,800 pop'n)	13 lines	1,200

The composite revenue represented by the projected total demand amounts to approximately 1.3 percent of community income at the average per capita rural income indicated in Appendix C.

The average rural revenue of $1,200 per line, although as high as BTC's national average, was below the level required for profitable service provision because of the high costs involved. However, it was calculated that the financial "loss" due to the rural program represented no more than a 3 percent drain on BTC's annual revenue stream, whereas the economic benefits far exceeded the financial costs. Furthermore, since the level of incoming and reverse-charge calling is high -- often exceeding the outgoing volume -- the incremental financial benefits to BTC may actually exceed incremental costs.

Over the five years since the study was undertaken, BTC has made significant progress in implementing the rural development program. It now expects to add an additional 40 villages to the program -- all of those that have a population between 250 and 500 -- by the year 2000. BTC also reports that the demand for service from rural communities is more than twice that projected in the study, while per-line revenues do not appear to have decreased significantly. Some lines -- notably the village payphones -- appear to be earning up to 50 percent more than projected (i.e., $2,700 per line).

Peru

Under Peru's privatization strategy, Telefonica/ENTEL has contracted to provide service to the 1,486 villages with a population above 500 that do not yet have telephone service, within five years. However, approximately 6,000 sizable villages that have fewer than 500 residents will still remain without service. Telefonica/ENTEL will contribute 1 percent of gross revenues into a special rural telecommunications investment fund, FITEL, administered by Peru's Supervisory Agent for Private Investment in Telecommunications (OSIPTEL). The fund will finance the development of service to communities with less than 500 population, which lie outside of ENTEL's service obligation.

Private sector operators are invited to offer service to these localities and may apply to the FITEL fund for financing. The government is currently seeking interested parties to respond to a tender to provide service to the first group of villages.

It has been projected by planners[27] that the potential demand for usage of a public telephone in villages with 400 inhabitants (based on existing revenue data) will be approximately 5 to 6 calls per day and will result in total revenues of $1,800 per year. This amounts to 1.5 percent of the village's total income, based on our estimate of an average rural per capita income of $295.

The per-line capital cost would need to be kept to approximately $6,500 for commercial operation. If FITEL advances funds at, say, 3 percent interest rather than 8 percent, then profitable operation would be possible at a per-line cost of over $7,000.

Bangladesh

Bangladesh has embraced the concept of licensing private operators for rural areas on an exclusive (monopoly) basis. The initial experience, although not without some problems, is positive, in that parts of the country previously unserved now have service on the scale envisaged by the feasibility model, and the operation is profitable and able to expand.

With 120 million people, Bangladesh is one of the most densely populated countries in the world. It is also close to being the world's poorest, with a per capita income of around US$ 170 per annum. Its teledensity, at 0.25 per 100 inhabitants, is also one of the world's lowest.

Under its reform program, the government decided to license two independent private sector operators to serve most of the rural areas of the country. The Bangladesh Telegraph and Telephone Board (BTTB) retains monopoly status in the urban centers.

Rural Bangladesh has 464 "Thanas" (sub-Districts), which between them have over 68,000 villages.[28] The rural operating concessions have been allocated as follows:

- *Bangladesh Rural Telecommunications Authority (BRTA),* a small private company, was licensed to serve 199 Thanas in the northern part of Bangladesh. The license was granted in 1989, and BRTA was obligated to place an exchange in each Thana. However, its growth was suspended less than two years later because of disagreements with BTTB over physical interconnection, revenue division, and rights of competition. These issues were finally resolved in 1994 and BRTA resumed investment. It currently has exchanges in 40 Thanas and a total of 6,000 lines. It hopes to reach its target of serving all 199 Thanas by March 1996.

[27] unofficial data from OSIPTEL.

[28] Information on the Bangladesh market and the rural telecommunications operators was collected directly through filed research by an associate of Intelecon Research & Consultancy Ltd.

- A second company, *Integrated Systems Ltd. (ISL)*, was granted a license to serve 191 Thanas in southern Bangladesh in June 1994.
- *BTTB* has retained control of the remaining 64 Thanas.

Neither BRTA nor ISL is obligated to serve all who request direct exchange line service. BRTA's approach is that once it has surveyed the potential demand in a Thana, it first serves the high-revenue business and government lines and then franchises PCOs to small business groups, often composed of unemployed youths. There are very few residential lines as yet. Although BRTA is obligated to establish exchange service in all its assigned Thanas, no level of service provision is specified, except that it must provide a PCO if requested by a community, otherwise BTTB has the right to do so in competition.

BRTA's facilities in 1996 comprised 46 small exchanges (mostly modified PABXs), three microwave links, 4 trunk automatic exchanges (TAXs), and several multi-access or cable-based pair gain systems. Capital cost per line has been less than $1,000, which is made possible by the high population density, the sharply focused supply strategy (which neglects most of the costly remote customers located outside of the population centers), and the quite rudimentary switching technology utilized. To date, all exchange connections have been via copper wire but BRTA is going to be implementing wireless loop technology in the near future. It expects to eventually be using wireless for up to 75 percent of its total customer base.

BRTA's operation has been highly profitable thus far, although penetration is still low and is unlikely to exceed the limit prescribed by the feasibility model of 0.5 lines per 100 population. Revenues average just over $1,000 per annum, and BRTA is allowed to charge an advance payment connection fee of $500; hence, the operation is virtually self-financing. However, BRTA has been able to begin with the higher-income Thanas. It is expected that per-line revenues will fall as the areas of coverage and penetration increase to include economically weaker Thanas and more marginal subscribers. BRTA estimates that in the 5 to10-year horizon, their per-line revenues will drop to at least $600 and maybe as low as $400. However, so long as average capital investments remain below $1,300 and operating costs are controlled, the operation will still be profitable.

The rural operators are obligated to use the same tariff structure as BTTB, which yields approximately a world average cost ($280 per year) based on the "Siemens basket" sum of charges. Clearly, because BRTA's supply strategy focuses on business, government, and PCO lines and includes few residential subscribers, the average subscriber is a heavy user. The current revenue division with BTTB is as follows:

- "Sender keeps all" basis for all *domestic* long distance traffic interconnected between the two carriers (i.e., BRTA keeps all the revenue it collects from its subscribers and BTTB does the same - there is no payment for terminating each other's traffic).
- On outgoing international traffic, BRTA divides the net revenue 50/50 with BTTB, i.e., after payment of the settlement to the terminating country.
- On incoming international calls, BRTA receives 30 percent of the payment received by BTTB from the originating country. BRTA does not have its own international gateway.

Although BRTA's operating license is vague and carries few serious obligations, and although there have been problems in the negotiation of the interconnection agreement and the overall efficiency of the national infrastructure still depends on the improved performance of the national carrier BTTB, the situation appears to be infinitely better than having little or no service at all. It enables BTTB to concentrate on improving the country's urban networks, while private enterprise develops unique solutions for the rural regions.

It should be noted, however, that although these relatively low costs are achievable in Bangladesh, this level of commercial viability is not necessarily achievable everywhere. It would not be feasible in rural Peru or Mexico, for example, once the national carrier has covered all of the high-density areas, leaving only small communities for independent operators. In other situations, therefore, BRTA's "sender keep all" interconnection agreement would not be sufficient for the rural operator to be viable. In Chapter 6 we address the important issue of interconnection agreements and revenue redistribution.

Malaysia

The highly aggressive rural telecommunications policy of Malaysia is unique among developing countries and provides an interesting case. As noted in Chapter 2, we consider Malaysia to be attempting the transition from pursuing universal access to universal service (high penetration) for many of its rural areas. It is doing this at a relatively low per capita income level (approximately $3,000) as compared to industrial countries, although it will take the next 10 years to approach a measure of universal service, at which point its per capita GDP will have more than doubled.

The Government has an accelerated economic development plan (Vision 2020) under which the country is slated to achieve industrial country status. Rural development is a major feature of the plan, and telecommunications is viewed as an essential infrastructure element. Malaysia's economy has grown at over 8 percent per annum over the last seven years, and the growth rate is expected to be maintained close to this level over the next decade.

The partially privatized national carrier, Telekom Malaysia (TM), has obviously given the objective of reducing the urban/rural disparity more than lip-service. Over the period 1991-95, approximately $1.23 billion (over 22 percent of its total investment budget) was spent on rural telecommunications. The total number of lines in rural communities was set to rise from 274,000 (2.2 per 100 population) in 1991 to 561,000 (6.6 per 100) at the end of 1995. In addition to its overall rural penetration target, TM is aiming to place at least one payphone in each of the country's 17,125 villages, many of which are relatively remote and are served by TM's NMT fixed cellular radio system and by multi-access radio. The target for year 2005 is 22.5 lines per 100 population. Allowing for 30 percent of lines to be for businesses, institutions, and payphones, the year 2005 target represents a residential penetration of up to 70 percent.

TM reports its rural costs per line to have averaged $3,500 to date; however, the use of wireless technology is now reducing that figure to $1,500. Although Malaysia has a liberalized telecommunications environment, almost all of the new private sector entries have to date been in urban areas, with rural areas viewed as unprofitable. TM has therefore shouldered nearly all of the responsibility for building the rural infrastructure, although many rural businesses that are located within the coverage area of the cellular operator, Celcom, use its service at a far higher price than the basic telephone service.

TM's financial experience to date is that average rural per-line revenues are $176 per year, compared to $580 for urban lines. Most business lines and payphones, of course, provide TM with much higher revenues; the relatively low average is caused by TM's policy of seeking to achieve a high residential penetration in many rural communities. Although its rural service is quite heavily cross-subsidized at this time, TM is clearly counting on the bothways calling generated by rural customers, combined with economic growth, to increase the level of revenue across the whole network over time. With rapidly falling per-line costs resulting from the use of wireless technology and with per capita income set to double over the next ten years, TM believes that it is making a sound long-term investment, both for itself and for the country, which is benefiting from receiving a high-quality information infrastructure.

At least one private operator is following TM's lead with plans to install fixed cellular service throughout the country over the next five years. The government also appears to recognize that private investment in rural networks could be encouraged through negotiation of favorable interconnection agreements as proposed in Chapter 6.

How does Malaysia's experience fit with the revenue model in this report, and is Malaysia pursuing a policy that could possibly be replicated by other countries? Because Telekom Malaysia is attempting to remove all barriers to communication in rural as well as urban areas, it may be assumed that TM is achieving a high proportion of its rural revenue generation potential countrywide. This is only possible for an economy like Malaysia's, which is middle income and growing strongly.

ITU statistics indicate that total national expenditures on telecommunications are around 2.3 percent of GDP. Assuming that TM achieves its line target and maintains its average per-line revenue of $176 to the end of 1995, then total revenues represent approximately 0.9 percent of the total rural economic income, based on our estimate of an average rural per capita income of approximately $1,150. Although this is slightly lower than predicted by our model, it was expected since TM is undoubtedly not yet achieving full rural revenue potential countrywide. Assuming that TM is achieving, say, 70 percent of its potential, with the balance not realized for the time being because of unequal access or because of competition by Celcom and others, then the achievable revenues are around 1.3 percent of total rural income.

5.11 Experience with Payphones

The previous case studies have included evidence that strategically placed payphones have the potential of concentrating revenues in such a way as to achieve commercial viability for the operator despite the fact that the general income level and telephone use by the average person are low.

In addition to the examples already cited, we are aware of payphone revenues in *India, Malaysia, Mexico,* and *Nepal* that are at levels (several thousand dollars per year) sufficient to achieve the break-even point or provide commercial returns to the operator. The following African examples are also important case studies.

Danida Experience in Africa

In 1992, Danida undertook an evaluation of several payphone projects in Africa, with the results shown in Table 5-3.[29]

Table 5-3. Analyses of Payphone Projects in Several African Countries

Country	Number of payphones	Rural content	Revenue/year	Comments
Kenya	7,500	Included a rural component under KPTC's program to provide 1 phone per 10,000 rural inhabitants and to reach low income groups.	$865 - 1,450	Average rural revenue 70% of urban (only 20 percent if served by manual exchange). 5% rate of return on whole project.
Zimbabwe	1,330	Included rural towns and trade centers, but only 3 percent of payphones were in localities with less than 2,500 inhabitants.	$2,250 - 2,950	Revenue in rural towns with 5 or fewer payphones approx. 50% of urban. 14% rate of return on whole project.
Malawi	650	45% were outside the major urban centers. DPT's objectives included 1 phone within 19 km of 90% of all rural inhabitants.	$1,140	Revenue levels relative to the average were as follows: urban centers +10% district centers - 5% small towns + 5% villages and trade centers - 10% 5% financial rate of return of whole project.
Zambia	500	Low rural content at first, due to high unmet demand in cities, but included some rural locations.	$250 (potential considered to be $900-1,300)	Poor return due to coin problems and very low tariffs. Next phase to use tokens.
Swaziland	310	The majority were placed outside main urban centers.	Approx. $2,000	Rate of return not calculated but appears to be high.

Although not figured into the financial calculations, the volume of incoming calls was significant and a high percentage of the total traffic involved reverse charge calling. The report recognized that incoming calls may exceed outgoing. In Kenya, Malawi, and Zimbabwe, between 20 percent and 45 percent of users interviewed had received an incoming call during the

[29] Danida, *Evaluation Report: Public Telephone Projects, Synthesis*, Ministry of Foreign Affairs, November 1991.

previous month. Interviews with call attendants indicated that up to 60 percent of all outgoing calls involve reverse charges, i.e., revenues that do not officially attribute to the payphone.

All of the actual or potential revenues (except Zambia) placed the payphones within the "profitability zone." Although some of the rural phones may not have been profitable based on outgoing revenues alone, the revenues in some high-density low-income areas were above average. There was evidence that low revenues in rural areas are sometimes due to placing older and less reliable payphones in those locations.

The elasticity of demand, although not investigated specifically, appeared to be low. Differences in call unit costs did not seem to affect call volumes. Costs were $0.038 in Malawi, $0.054 in Kenya and 0.064 in Zimbabwe. Most users considered the cost of making their call to be cheap.

Revenues, Benefits, and Siting Issues

The important factors governing commercial objectives as well as social goals involve both "macro-siting" and "micro-siting," such as the following:

- Potential -- what is the total population and expenditure capacity within the effective catchment area of the site? (The answer varies by country, culture, and economy, e.g., how far will people walk to access a phone?)
- Noticeability -- does it make use of complementary facilities (e.g., close to the main road, travel depot, bus stop, market center, or industry)?
- Availability -- is it available on a 7-day, 24-hour basis and how will it be maintained in good working order?
- Accessibility -- can all members of the population gain ready access? Is it in a public or an open area, close to other facilities, or is it "restricted" by physical, cultural, or effective gender barriers?
- Environment -- does it provide adequate shelter, shade, privacy, and protection from vandalism or other security risks?
- Operability -- are the design features and mode of operation suitable (e.g., in some economies, coins are unavailable or impractical due to inflation or other factors)? are the instructions for use simple and easily understood?

In addition to the macro-economic calculation based on income and potential revenue, it is useful to run a cross-check based on the number of calls that can be reasonably expected, and the best means to guarantee that level of business. For example, an average of just three calls per day of 3 minutes duration, at US$0.30 per minute, can generate almost $1,000 per year and support a line that costs between $3,000-4,000 to install. If by franchising the telephone to a small business person and paying, say, a 20 percent commission, it is possible to better market the service, maintain the telephone in better, working order and increase the call average to five calls per day, thereby increasing the net revenue to the operating company to $1,400.

Depending on the physical environment, economy, social structure, and culture, the best solution could include any combination of the following options indicated in Table 5-4.

Table 5-4. Payphone and PCO Options

Type of service	Examples	Mode of operation	Comments
Public coin or card phones in a public space	Most cases	Coin, token, or card operated.	In principle, provides 24-hour service availability and best level of privacy, although maintainability and level of support are often unacceptable.
Franchised payphone or "phone shop" business	India Bangladesh Sri Lanka Indonesia Swaziland Thailand Kenya	Business operator collects standard tariffed fees and receives a commission (typically between 10-20%) from the telephone administration.	Availability depends on the business, since the operators select the most attractive locations first, but as a market-driven solution, this potentially yields the highest level of usage and revenues. O&M problems are followed up vigorously by the business operator in order to maintain viability.
Payphone or publicly available phone located in or adjacent to landowner's property, small business, school, clinic, or local government premises	Botswana Thailand others	With or without any fee collection responsibility or commission for the owner of the premises, but often involves some mutual favor with the telephone administration (e.g., receive a business line).	Provides security but may compromise availability and privacy.
"Unofficial payphone"	Zimbabwe India (Panchayats) others	Telephone operated as a regular business account by a shop owner, school head, clinic official, or local government agent, who allows the local populace to use the phone for a fee.	Compromises privacy and may not be free of discrimination, but works effectively in parts of rural Africa, since the locations and people are often available to public access on a 7-day and emergency basis. Not necessarily so in other countries.

The primary objective must be to find the optimal combination of public accessibility, maintainability, operability, and commercial viability. On balance, the service can probably grow more aggressively through agency/franchise arrangements than with unattended payphones. In Bangladesh, India, and Indonesia, payphones are also being offered to previously unemployed people or target social groups, with appropriate startup incentives such as low-interest loans and waiving of advance payment deposits and connection charges.

Revenue/Siting Problems

Examples of payphone/community phone placement under public sector programs that could be improved are in the Philippines and India. Under the Philippines' Municipal Telecommunications Project Office (MTPO) project, the infrastructure for community telephones was publicly financed and then was supposed to be sold to private operators. Costs were, on average, excessive, and many payphone site placings have not provided good public access. In addition, serious operation and maintenance problems have severely reduced system availability and revenue potential.

In India, whereas the franchised "STD PCO" phone shops have been successful, the "panchayat" village telephone program has failed to generate significant revenues because of availability problems related to cultural factors and operational reliability. Private PCO franchising has been successful because the owners/operators have a vested interest both in providing service that is as widely available as possible and in ensuring that their lines are well maintained. In contrast to India's panchayat phones, Thailand's scheme of placing a telephone on a landowner's property but with a formal business arrangement assuring that the phone would be made available for public use, and the landowner would receive a 10 percent discount on call charges, has been a success.

5.12 Other Forms of Revenue Enhancement

The franchising of payphone operations to private individuals or businesses, as described previously, also increases the opportunity for revenue enhancement through the use of facsimile machines and other forms of electronic communication and information technology, such as e-mail and computer data communications.

Phone Shops, Agencies, and Community Operators

Phone shops and "communications agencies" -- the latter handle telecommunications as well as conventional mail service -- are emerging in many countries. "WARTEL" phone shops in Indonesia, which operate several phone lines as well as facsimile and telex service, reportedly provide 24-hour service and typically have a very attractive rate of return on investment. Although most of the experience to date has been in cities, some WARTELs are operating successfully in village locations.

Combined communications/post office agencies exist in Sri Lanka, and network entrepreneurs are looking at the possibility of expanding the range of services to include other office and information technology services. India's "STD PCO" phone shops also typically offer facsimile as well as telephone service.

Integrated Subscriber Access Systems

Another step toward revenue enhancement would be to allow small emerging telephone businesses to operate switched wireless service, cordless PABXs, or key-phone systems which can tie together a number of customers in a small town or a large village, as the demand emerges.

Products are presently available that could provide wireless service within a small town or village, or within a small radius of the community. Some of the many telephone companies which exist in the United States, the Philippines, and elsewhere, for example, essentially began (albeit in the wireline environment) as such small-scale businesses. Some of the community systems and cooperatives in Latin America are also believed to be revenue-sharing schemes which eventually concentrate wide area demand onto a few lines or trunks. The advantage of these businesses is that they can often establish a local organization, including customer support, more cost-effectively than a larger operator.

While the widespread and uncontrolled existence of such-small scale and technically varied operations may do little to bring a high-quality infrastructure into existence, entrepreneurship should not be discouraged if the revenue potential justifies investment. In some situations, there is potential to pursue an open market policy, but this requires the national or rural operator to cooperate with regulators to develop the technical interconnection standards and to offer sufficient incentives within the revenue-sharing arrangements to encourage local entrepreneurship.

PIN-based Long Distance Service and Voice Mail

Some of the services offered by the community-based operators described above could include nonsubscriber line accounts ("near telephone service"), whereby users could access the service via any public or private telephone and make a call or receive a voice message by means of their own personal identification number (PIN), much as these services already operate in the urban areas in many countries. The primary difference is that the accounts would not necessarily be directly associated with a user telephone line which can be cutoff in the event of non-payment. The main challenge for operators is how to operate the financial aspect of the account, e.g., would it require prepayment or a collateral deposit as security? Once begun successfully, such accounts could increase the revenues per installed line quite significantly.

Mobile Payphones

One cellular operator in Pakistan has realized large revenues through the entrepreneurial use of motor-bike mounted phones, which are taken to suburban and rural localities within its coverage area on a regular or semiregular basis. At least one potential new entrant in India also proposed such a scheme. A well-organized mobile payphone licensee would be able to cover many communities which are too small to have permanent service. Collectively, these communities may be able to justify a significant number of mobile lines in some areas.

Community Teleservice Centers (CTSCs)

CTSCs or telecenters represent a convergence of the enhanced phone shops described earlier with the "telecottage" concept which emerged in Scandinavia, the United Kingdom and other parts of Europe in the late 1980s. Telecenters are multipurpose centers aimed at providing computers, telecommunications facilities, office equipment, and support for local communities in remote, rural, and/or low-income urban settlements[30]. Normally they contain the following:

- An office and meeting room
- A public area with access to computers, office equipment, and telecommunications services (telephone, facsimile, e-mail, database access, data network access)
- A class-room providing computer training, general training, and education supported by computers and telecommunications equipment
- Work facilities for users (students, teleworkers, local farmers, business people)
- small kitchen area and other supporting facilities.

Typically, the minimum staff comprises a manager and part-time assistant who run the center, serve the users, arrange training courses, and the like. The objective is to provide one-stop access to all available telecommunications and information services, thus bridging the technology access barrier for rural communities.

In 1994 there were approximately 270 telecenters in 11 countries, led by Britain with 57, Finland with 49, Germany with 47, Australia with 25 and Sweden with 23. Among developing countries, Brazil has made the most progress towards implementing telecenters, with approximately 40 installed in 1994 and with plans to establish more than 1,300 eventually. Several groups are interested in implementing centers in Sri Lanka, and pilot projects are in the planning stage, at least, in Benin, Bhutan, Costa Rica, Greece, Poland, and Tunisia.

Sixty percent of all telecenters are more than 20 km from the nearest town with a population of 10,000 or more. Nine percent of the existing centers have video conferencing facilities which affords the centers the opportunity for cost-sharing with educational and training institutions that wish to provide distance learning and extension services.

Although over half were public sector initiated and financed, 55 percent are now run privately. Those that are operated publicly are run by local or regional public authorities such as the local school, library, or town hall. Most of those run privately were started with public grants or initiatives and are also dependent on block funding or major user agreements from public sector agencies (e.g., by running computer classes for local or regional education authorities). On this basis, 50 percent of telecenters responding to a 1993 survey indicated they were breaking even and 27 percent were making a profit.

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[30] Qvortrup Lars. "Community Teleservice Centers: A Means to Social, Cultural and Economic Development of Rural Communities and Low-income Urban Settlements. Impact of CTSCs on Rural Development." *World Telecommunications Development Conference*, March 1994.

Do telecenters have the potential to bring vital "information society" services to rural communities and increase the revenues of rural telecommunications operators? The experience in Scotland, where most of the British telecenters are located, is that their financial viability is marginal at best, but they have had a positive impact on computer literacy and probably on the medium and long-term demand for data communication and information services. The typical capital cost of a center ranges from $50,000 to $200,000. World experience indicates that the costs have been justified as public investment.

The Brazilian program is an adaptation of the Nordic "telecottage" concept, with four pilot telecenters constructed by Telebras in 1991-92, with UNDP assistance. Locations included the town of Brusque in Santa Catarina and the rural town of Toledo in Parana. Telebras provided centers while the services are maintained by independent public or private entities. The capital cost was approximately $70,000 per center. Experience to date is that these centers could prove to be used more heavily than those in Europe, with several hundred users per week. Whether or not they yield a profit from their internal operations, telecenters in developing countries are likely to attract attention and create greater use of the phone and of "information society" tools such as facsimile, Internet, and local database access, and other informatics services. They will also provide a focus for the potential use of distance learning. Although the concept is in its infancy in the developing world, the ITU is promoting telecenters heavily. If development finance can be used for the initial investment, it has strong potential for facilitating modern information literacy and, ultimately, the use of data and media communications services on rural telecommunications systems.

6. PRICING, TARIFFS, AND INTERCONNECTION

6.1 General

Conventional wisdom is that the tariff regime should be cost-based and contain a balance between social, economic, and financial (commercial) objectives. Without challenging this basic premise, the following issues are addressed in this Chapter:

- The relation of prices to the cost of service provision
- The relation of price levels to user demand and willingness to pay
- Cost-sharing and revenue-sharing or cross-subsidy mechanisms in relation to national infrastructure goals
- The role of interconnection agreements in commercial viability.

It is usually not difficult for policy-makers and regulators to agree that tariff levels should be sufficient, on a national average at least, to cover the cost of service provision plus reasonable profitability. However, that is where agreement usually ends. Both the absolute value and the structure of tariffs vary widely, and their variation is not necessarily according to costs. Even in advanced OECD countries, the cost of a basket of international calls -- for which costs are fairly uniform -- varied from 72 percent of the OECD average to more than 130 percent as late as 1992.[31] On a world scale, domestic rates vary much more than this. In 1993, the cost of the "Siemens basket" of domestic telephone charges varied by a factor of six, not counting the lowest or highest countries.[32]

In many developing countries, domestic tariffs were traditionally kept well below cost and cross-subsidized by high international charges. Political pressure on government-controlled PTTs or monopoly corporations to keep tariffs low have, inter alia, resulted in underinvestment, lack of proper maintenance, overcongestion, and poor grade of service. Market liberalization and competition, on the other hand, require tariff rebalancing toward a cost-based structure; otherwise, competition becomes very selective and tends toward "cream skimming" in those service categories (e.g., long distance) which are overpriced.

Underpricing is usually the norm in rural areas, where provision is typically already inadequate, costs are high, and maintenance is more onerous. Realistic domestic tariffs are particularly essential to rural network development. However, too rigid an application of cost-based pricing could lead to unrealistically high prices in some places, thus still leaving problem areas which cannot be effectively serviced commercially.

[31] International Telecommunications Union/UNESCO. "The Right to Communicate - At What Price?", *World Telecommunications Development Conference,* March 1994.

[32] *1993 Siemens National Telephone Tariffs.* The "Siemens basket" is made up of the following: (a) the installation fee divided over 10 years, (b) the annual rental fee, (c) 700 local calls of three minutes duration, (d) 130 three-minute LD calls (up to 100 km) at the standard rate, and e) 70 three minute LD calls at the night-time rate.

Cost-sharing or revenue redistribution between urban and rural services -- often referred to as cross-subsidization -- is a means of maintaining the price of rural services within reasonable limits, while enabling the rural service to be provided commercially. This has good precedent in advanced countries but needs to be well understood at the national policy level.

Whether these financial flows, which are traditionally labeled as cross-subsidizations, are justified solely on social grounds or have justification on economic and commercial grounds is open to debate. In this section, we argue that favorable interconnection agreements which recompense operators fairly for the additional costs and risks of investment in rural networks can provide a very effective "kick start" for successful commercial operations. The impact of properly planned and operated rural networks on the revenue stream of urban networks needs to be recognized in a country's interconnection regime. The justification for revenue redistribution is that these financial benefits should be apportioned between urban and rural networks or operators according to their respective relative causal costs.

6.2 Tariff Fundamentals

Basic Service Pricing Structures

In an ideal world in which the principles of welfare economics are maintained, all telecommunications service prices, including those charged between carriers for interconnection of calls, should be based on forward-looking estimates of the long-run incremental costs of service provision, plus a reasonable profit margin. Although the calculation is a complex and often controversial exercise, the operator should attempt to allocate all capital and operating costs, including fair proportions of the corporate and administrative overhead expenses, to the various service categories offered.

The precise rationale and strategies vary widely from country to country, however a basic telephone service tariff usually includes the following:

Installation/connection fee	Covering part of the capital and/or special cost of line connection
Monthly line rental fee	Covering either the traffic-independent cost, or a flat rate for the actual expected monthly usage (e.g., including a certain number of "free" call units or all calls in the local calling area)
Call charges	Covering the traffic-dependent costs of call connection and long distance transmission (usually represents most of a user's long distance calling)

The most common approach to levying call charges is via a count of "call units," which may vary in length from 3 minutes (or untimed) for local calls to just a few seconds per unit for the longest distance charge bands. Because the pricing philosophy varies so much from country to country, the only way to compare charges is on the basis of a basket of call charges, such as the well-known Siemens basket.[33]

Some countries, especially in Latin America, have differential rental fees for business and residential customers, or differential connection charges for situations such as:

- Where a subscriber's location exceeds a certain distance from the nearest exchange or wire line route
- Where a subscriber wishes to pay a premium, in the form of a nonrefundable payment, a low or zero interest deposit, or a gradually refundable advance usage charge, to "jump the queue" and secure service faster than the average wait-listed customer
- Where a potential subscriber, group of subscribers, or community is willing to "co-finance" an installation by effectively paying a significant proportion of the capital cost upfront.

Most countries have nationally averaged call tariff charges, which is effectively a form of cross-subsidizing low-traffic / high cost routes and areas (e.g. rural) from high-traffic / low cost urban and inter-urban routes. This will be discussed more fully in this chapter. The underlying assumption of cross-subsidization is that users cannot afford to pay the full cost-based fee for service in the higher cost areas.

Many countries in both the industrialized and developing world also offer significant discounts (up to 70 percent of the standard rate) on their call unit charges for off-peak times. These reductions are often in two bands, e.g., early evenings 25 - 35 percent discount and a 50 - 70 percent discount at night. It is normal for rural and urban customers to have the same discount opportunities, as they encourage additional calling and incremental revenues from the nonbusiness, higher elasticity users.

Payphone users often pay a small premium above the normal call unit tariff, but they also have access to the same percentage discounts. Private payphone operators or agents operating publicly available phones on behalf of the telephone company are typically allowed to charge a small premium above the normal tariffs (e.g., in Nepal) or are given an additional discount of, say, 10 to 20 percent (e.g., India and Thailand) to provide for business profitability.

The Pricing Issue for Rural Telecommunications

Are rural telecommunications services loss-making and do they need to be cross-subsidized? Most of the world evidence, including the feasibility model and cases presented in Chapter 5, suggests that if only outgoing revenues are counted, rural telephone service is commercially viable solely within a narrow service penetration range, once the low-cost sub-

[33] ibid

urban (quasi-rural) boundaries have been left behind. Most governments are making a concerted effort to extend their networks into more remote rural areas, often at high cost. Those which have reformed their telecommunications sector are using the opportunity to put service obligations onto their restructured and newly privatized carriers. These obligations usually go beyond the feasible cost/revenue limits and are therefore financed through internal cross-subsidization. When all financial benefits are considered, however, these investments may not require as much subsidization as is believed.

The strategy for developing countries suggested in this report is to limit supply to the number of lines for which the achievable revenues cover the costs of operation plus profit. The quantity should only be increased in a controlled fashion, maintaining a balance between incremental costs and revenues. Once the initial investments have been made -- serving most of the high-revenue/high-benefit lines -- lower-revenue demand is served over time, as the economy and demand for service increase. If the technical systems are designed carefully, the required expansions will create significant economies of scale, such that average costs will progressively decline as average revenues decrease, facilitating self-sustaining growth.

In situations where per-line costs are well above the national average, the implications for customer prices are as follows:

- The connection fees should be affordable to the relatively high-benefit subscribers -- mostly businesses, institutions, and community leaders -- but not necessarily to the very small businesses and residential customers whose need or willingness to pay for service would amount to monthly revenues far below the incremental cost of service provision
- The call charges should be set to maximize both usage and revenues from the lines supplied, assuming those without their own private lines will have access to payphones or otherwise publicly available lines
- Tariffs should be lowered in line with any reduction in average costs made possible by declining incremental costs and rising revenue potential (e.g., due to economic growth).

This strategy is a combination of realistic cost/revenue projection and demand management based on user willingness to pay. It should, of course, be noted that the demand control element can be relaxed, with the tariff being adjusted to attract progressively more and more marginal revenue customers, as costs approach the national average. However, for low-income countries, the balanced approach is absolutely necessary at first.

6.3 Price and Revenue Generation Calculations

In rural networks, the dominant revenue component is from long distance call charges. Although the monthly rental fee might incorporate a prepaid usage charge, which is supposed to guarantee that the operator can recover an amount equal to the fixed (non-traffic-sensitive) costs, in rural areas this is typically well below the required level.

One way of compensating for the shortfall is for the operator to charge a large up-front installation / connection fee to reduce the capital amortization component. This is essentially a method of financing and has been used extensively in Latin America and elsewhere (see Chapter 7). However, here also, the amount which is judged to be reasonable may be far less than that which would restore the operator's cost structure to the national average. The only exception would be a situation in which the installation is fully financed through a cooperative or community joint venture arrangement.

The Charge Bands and Calling Patterns

Unless the rural tariff includes a large up-front charge, the operator must recover costs primarily from call charges. The potential revenues depend on the following:

- The users' originating call rate (in busy hour Erlangs or number of calls per day)
- The traffic pattern (e.g., percent of calls to district, regional, and national destinations)
- The structure of the long distance charge bands
- The price elasticity of demand (usually in the range -0.2 to -0.8, i.e., call minutes demanded may be reduced by 20 to 80 percent of proportionate price changes, and are typically higher in the short term than in the medium or long term).

A representative range of long distance calling patterns is provided in the following table. Included are two calling pattern extremes encountered in India, in the Districts of Thanjavur (Tamil Nadu) and Siliguri (West Bengal).[34] The pattern encountered in Zimbabwe is characteristic of smaller, nonfederal countries.

	Thanjavur	Siliguri	Zimbabwe
District center	70%	15%	25%
State capital or closest large city	20%	50%	25%
National capital and other cities	10%	35%	50%

Some regions exhibit an even higher proportion of calls to the capital city (e.g., in some parts of Thailand, well over 50 percent of the calls are to Bangkok). The call pattern differences from place to place depend on the economic and political structure of the region. For example, Siliguri's economy is dominated by Darjeeling tea exports and interstate transportation (with many calls made to Calcutta, cross-border, and overseas), whereas Thanjavur has a domestically oriented "rice-bowl" economy. Because of India's federal structure, Indian calling rates are generally far more localized and regional than in countries where all major commerce emanates from the capital city (as in many African countries).

[34] ICICI Ltd. *Report on Entry Conditions for New Entrants in Basic Services,* India, June 1994.

The tariff structure must take the calling pattern into account (with consideration of elasticity) if costs are to be recovered. The charge bands are usually based on varying length call units. The following examples from India, Malaysia and Bolivia represent typical standard (non-discounted) charges for various distances (in US$).[35] The correspondence is only approximate because of differing distance bands from country to country and all three countries have substantial off-peak discounts.

Distance bands	India	Malaysia	Bolivia
local, <20 km	0.04	0.05	0.02
20 - 50 km	0.09	0.05	0.13
50 - 100 km	0.21	0.16	0.13
100 - 200 km	0.32	0.42	0.30
200 - 500 km	0.54	0.42	0.35
500 - 800 km	0.65	0.78	0.40
800 - 1,200 km	0.91	N/A	N/A
1,200+ km	0.97	N/A	N/A

By super-imposing the destination pattern and calling rate on the tariff structure, it is possible to derive a figure for average revenue per minute and total revenue per year. As a general guide the busy hour calling rate to expect from subscribers in the business and institutional categories could range from 0.03 to 0.25 Erlangs (i.e. 3 to 25 percent loading). The rate for payphones ranges from 0.10 to 0.50 Erlangs (10 to 50 percent). The whole range translates into 2,000 to 35,000 paid minutes per year. The network average is typically between the 0.05 and 0.10 Erlangs range (3,500 to 7,000 minutes). Many rural networks may need to have at least 0.10 Erlangs (or 20 minutes per day) to be viable.

Example of Calling Pattern / Charge Band Interaction

As an illustration of the effect of the calling pattern on revenues, the following table presents an approximate calculation of annual revenues in the two previously mentioned telecommunications districts in India.[36] The networks include both urban and rural subscribers. It will be noted that the average revenues per minute for long distance calls in Siliguri are almost three times those in Thanjavur because of the vastly different calling patterns, combined with a tariff structure which is heavily skewed toward long distance. The Indian tariff structure is not particularly suited to operator self-sufficiency in areas such as Thanjavur (which is similar to much of India), where traffic is weighted toward short distance intradistrict or regional calling. Thus, in order for rural telephone service to operate profitably, the tariff structure should be

[35] Official tariff documents from various sources, 1994.

[36] Supporting documentation to ICICI report, June 1994.

rebalanced such that, for example, the 20 to 50 km band is priced higher and the price for calls above 500 km is reduced.

	Thanjavur	Siliguri
Existing subscribers	26,689	12,118
No. call minutes per line, per year	4,500	3,500
% calls local	90	85
Local calls average revenue/min.	$0.04	$0.04
Long distance average revenue/min.	$0.15	$0.40
Total annual revenue per line	$280	$330

If major rural expansion is to take place commercially, the operator would have to either increase the per-line usage (through careful subscriber line deployment) or rebalance the tariffs. Siliguri is better able to sustain substantial rural growth because of the expected calling pattern, even though the total calling rate per line may be lower because the district network is considerably smaller and local calling is therefore lower.

6.4 Summary

To be commercially viable, the total revenue figure must obviously match the operating cost plus profit. The above analysis indicates that different pricing structures can achieve the same end in different situations; hence, there is no single "correct" tariff structure. Ideally, operators may prefer to be able to set their tariffs on a regional basis, to match the characteristics of the marketplace -- in particular the costs, customer calling patterns, and elasticity of demand. However, most policymakers and regulators opt for enforcing a nationally averaged tariff structure that meets the commercial objectives of the national operator and achieves certain social goals, such as making service available at an affordable price everywhere in the country. In our view, consideration should be given to a measure of price deregulation.

One conclusion from analysis of the potential for private sector operators to enter the Indian telecommunications market at the regional level was that, under the existing tariff regime, most rural areas could not be served commercially by independent operators unless they are bundled together with the local urban (district center) demand, in order to provide some internal cross-subsidization. Also, it was recommended that operators should be allowed to secure adjacent territories/districts and to route traffic between them (rather than via the national carrier) in order to increase their long distance revenues and minimize the outflow of interconnection payments. India's eventual privatization strategy responded by licensing new operators on a state circle basis, rather than by inviting private operators to enter at the district level.

6.5 Revenue and Cost Sharing: Subsidization Issues

As previously noted, national price averaging can be detrimental to rural telecommunications viability. However, even a rigid application of cost-based pricing principles may still leave high-cost or otherwise problematic areas without adequate telecommunications service, unless additional support mechanisms are applied. Commercial viability is a challenge in these areas, but this need not lead to the conclusion that it is impossible. We now address the question of how "subsidization" can be understood, or perhaps even redefined so as to avoid the conclusion that attractive financial returns do not exist from rural telecommunication services.

Justification for Policy Intervention

Although economic welfare theory suggests that all subsidies are counterproductive because they distort consumer preferences, there are a number of factors which need to be considered. There is ample evidence that:

- Rural telecommunications service extension and provision are essential to socioeconomic integration and may justify some form of sector cross-subsidization to reach the most disadvantaged and high cost regions.
- Social optimality requires subsidization of services generating the externalities, and failure to do so results in a loss to society.
- Rural networks often attract at least as much incoming traffic as outgoing, which indicates the existence of substantial externalities, as well as higher financial benefits than they are usually given credit for.
- The incremental financial benefits generated from urban-to-rural calling should be considered to be (at least partially) available for transfer.
- Because of differential incremental operating costs between rural and urban networks, some means of reallocating the total revenues generated between rural and urban destinations, based on true costs, is called for.

From several perspectives, rural telecommunications can "pay their way." The following sections discuss the various options that exist to address the asymmetry in urban and rural service delivery costs. The most suitable mechanism will obviously depend on whether the country is served by a single operator or several operators, or whether special rural operator concessions are being considered.

Internal Cross-subsidization

When there is a single national operator, or when there are multiple monopoly operators with large urban and rural bases (i.e., as in most of the world), cross-subsidization has traditionally taken place between different service categories or from urban to rural subscribers. This practice has been recently used to good effect in the context of corporatizing or privatizing government owned telecommunications monopoly operations in Latin America.

Governments or newly created regulatory agencies have established service or investment obligations to accelerate rural development and guarantee service to villages above a certain threshold. Argentina, Chile, Mexico, Peru, and Venezuela are among the countries that have established quantified service obligations either in national programs or as part of the carrier's license agreement. In *Mexico*, for example, the National Rural Telephone Program requires the privatized monopoly operator to provide service to all communities with a population above 500 by the year 2000.

The Philippines' reform policy also enforces internal cross-subsidization by bundling local exchange service obligations onto international gateway and cellular service operators and by linking lower-return territories with more lucrative ones. The obligations will result in a certain amount of rural expansion, although the coverage targets are less specifically spelled out.

In all cases, the carriers are required to internally generate the necessary funds to meet service obligations. As already noted, cross-subsidization has been applied in many countries through "overcharging" for international long distance and value added services, and providing local access below cost.[37] Although this approach has been effective in providing affordable access, it has come under increasing criticism in the context of moving toward cost-based pricing and fully liberalized markets.

Regarding the transfer of revenues from urban to rural operation, Australia, Canada, the United Kingdom, and the United States are among those that have used route averaging, i.e., uniform distance charges. Local access charges have also frequently been structured along lines of "value of service," meaning small exchanges charge low access fees while large exchanges charge high access fees. The prices do not necessarily bear any relation to the underlying actual costs of service provision and amount to a cross-subsidization of rural by urban exchanges. Several low-income and middle-income countries are currently using this mechanism. India and Malaysia are two examples.

6.6 Transfers among Operators

The licensing of multiple carriers, whether on a regionally exclusive or competitive basis, has introduced additional options for cross-subsidizing rural operations. The mechanism can be through settlement and repayment pooling schemes, skewed interconnection charges which favor

[37] How substantial this cross-subsidization is depends in part on the allocation of costs to service categories. Cost allocation mechanisms and practices have long been an issue of debate and the focus of numerous studies.

the rural operator, or a rural telecommunications fund financed from revenues of the national/ urban carrier(s).

Settlement and Repayment Pooling Schemes

Because a high proportion of calls originating in rural areas are long distance, contributions to cover nonrecurring capital costs need to be complemented by mechanisms that address the relatively high per-subscriber costs of providing long distance services. Their recovery is either negotiated between the parties or included in a tariffed interconnection charge.

Industrial countries such as Canada and the United States have established complex toll settlement schemes in which the national or urban operator bears a larger burden of costs while the small or rural operator obtains payment relief. These schemes allow the rural operators to apportion a higher percentage of their traffic-sensitive[38] and non-traffic-sensitive (NTS)[39] costs to the long distance services requiring interconnection with the national or urban carriers. Under such schemes, the access prices charged by rural operators for interconnection of national and urban traffic are substantially above those charged by urban operators and serve to funnel funds to rural operators.

The United States, for example, had established a separations and settlement procedure which provided local exchange carriers with a contribution to their local access revenue shortfall, as well as toll settlement payments for providing network facilities to the long distance carriers. Historically, 26 percent of the non-traffic-sensitive (NTS) costs of local exchange operations were, on average, allocated to providing interstate long distance service, while rural operators could apportion up to 85 percent of their NTS costs to interstate.

However, the effectiveness of this scheme was reduced when competition was introduced. Where long distance rates are not based on true cost, the larger operators become subject to cream-skimming practices by the new competitive entrants, who may not be required to interconnect with rural operators. Thus, NTS-based scheme was replaced by an access charge based on traffic volume through per-minute charges (access minutes). The new plan brought those operators that had previously enjoyed 85 percent recovery of NTS costs from interstate charges down to a uniform "price capped" 25 percent NTS recovery level.

The National Exchange Carrier Association (NECA) was created to average access costs into a single set of nationwide access prices. These include fixed cost and traffic-sensitive costs. The long distance carrier is charged on a per-minute basis for using local exchange facilities to originate and terminate long distance calls. The local exchange companies record access minutes of each inter-exchange carrier and render to each the appropriate Carrier Access Bill.

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[38] Traffic-sensitive costs include switching, inter-office circuit equipment and inter-office transmission facilities.

[39] Non-traffic sensitive costs or subscriber plant investment include the line from the central office to the customer's premises, the related circuit equipment and. where regulated, customer premises equipment.

The subsidy reduction that results when long distance cost allocations are capped leaves rural operators with a revenue shortfall. One compensatory instrument that has been successfully applied is the creation of a special fund -- the "Universal Service Fund" -- financed out of the revenues of the national or inter-exchange carriers, and administered as part of the toll settlement and revenue-pooling scheme. The fund is an explicit subsidy per access line to transfer revenues to high-cost (above 115 percent of national average) areas from low-cost areas. This allows the rural operator to maintain affordable rates to subscribers.

Skewed Interconnection Charges as a Means of Cost and Revenue Sharing

The approach outlined above establishes a regime of nationally averaged equal access or contribution charges and special repayment or redistribution mechanisms. An approach based on cost causality will stress the need for asymmetric interconnection charges to address the different costs and risks of interconnection for rural and urban operators.

The incremental costs of providing interconnection between rural and urban exchanges differ significantly. For the urban operator, interconnection of rural traffic is only a small incremental top of a relatively large base volume. Incremental costs will therefore be relatively small. However for the rural operator, the majority of calls may be to/from urban centers. Thus, a large portion of the rural operator's costs are associated with interconnection to the urban or national operator. As a result, incremental costs are significantly higher.

The rural operator also has higher risks. Interconnection costs and related charges are based on expected costs and traffic volumes and the rural network is constructed accordingly. If these expectations do not materialize, the rural operator is likely to suffer massive losses, while the urban operator is not likely to incur additional costs, due to the small impact of the shortfall on urban operations.

Some asymmetric payment mechanism is therefore required to redress the burden of both cost and risk on the rural operator. The rural operator could recoup higher access costs through one or a combination of several mechanisms. The four options are as follows:

- For rural-to-urban traffic, the rural operator pays the national/urban operator the incremental cost of carrying and terminating the traffic, plus a reasonable profit margin (the total typical payment would amount to only a fraction of the urban operator's normal subscriber tariff).
- For urban-to-rural traffic, the rural operator charges a larger amount, to reflect the incremental cost of carrying the traffic (which is higher than the urban carrier's reciprocal cost in the first place) plus a higher margin to reflect the higher risk of rural investments.
- The urban operator contributes directiy to the rural operator's capital or recurring costs.
- The urban operator foregoes virtually all revenues from rural traffic (up to a certain limit) in light of the small impact rural traffic has on urban operations, allowing both terminating and originating call revenues to flow to the rural operator and eliminating much of the complex settlement and revenue-sharing arrangements.

The first two options should be applied together, since they reflect an approximation to the welfare theory prescription. Both urban and rural operators should be charging one another cost-based prices. The optional addition of the "risk premium" could be calculated by using a higher rate of return when determining the rural operator's costs compared to the urban operator's acceptable rate of return. The premium reflects the higher risk and the resulting higher costs of capital, yet leaves the risk entirely with the rural operator.

The effect of this approach, based on what we believe would be conservative assumptions (retaining more than adequate profit for the urban network operator), would provide revenues for the rural operator at least 30 percent higher than if the bothway revenues were shared evenly between the rural and urban operators. A typical calculation, assuming equal traffic in the two directions, is shown below:

2 x $1.00 calls	Rural share	Urban Share	Total
Urban to rural	$0.60	$0.40	$1.00
Rural to urban	$0.70	$0.30	$1.00
Revenue due	$1.30	$0.70	$2.00

The third option is a regime that reflects some risk-sharing -- an interconnection agreement which includes direct contributions to the capital and/or running costs of the rural operator. The contribution may be traffic dependent or traffic independent, but would be in place of options one and two. The fourth option treats both terminating and originating call revenues as belonging to the rural network operator. In this case the urban operator foregoes charging any of the incremental costs of originating calls which terminate in the rural network, except possibly an administrative "collection fee." Because the actual cost per minute is only a fraction of the urban operator's normal subscriber tariff, the foregone revenue would be relatively insignificant but could as much as double the rural operator's revenue base and thus transform the commercial viability scenario.

Although simple in principle, the fourth option would require periodic estimates or measurements of the traffic, in order to evaluate its actual incremental cost and to reassess the arrangement from time to time.

Canada has a similar scheme that applies to low traffic volume/low-revenue rural operators that interconnect with large operators. Bell Canada compensates the small operators on a commission basis which effectively provides compensation for bothways traffic when the volume is small, but changes to a more equal share, on a sliding scale, as the traffic volume or average revenue per minute rises.

6.7 Summary

Skewed interconnection and revenue sharing regimes work well in a monopoly environment or where the size ratio between the urban and rural networks is high, because they inherently recognize the differing incremental costs between urban and rural networks. Also, there is very little relative cost to the urban network operator for foregoing rural-destined traffic revenue. However, the urban operator could be subject to "cream skimming" in a liberalized environment, once the rural network becomes a significant portion of the national infrastructure.

Cost-sharing/revenue-sharing based on skewed interconnection agreements is an effective means of encouraging the start-up and early growth of rural network operators. Once these operators achieve significant size, however, the arrangement may be more difficult to continue, although it is economically justified if based on true long-term incremental costs.

Rural Telecommunications Development Funds

For rural environments where the costs and revenues remain unbalanced even after the application of revenue-sharing agreements, direct cross-subsidization may be required. Peru is one example where the license condition for the privatized carrier requires a contribution (1 percent of gross revenues in Peru's case) to a rural telecommunications development fund (FITEL). The fund will be available to finance capital expenditures on rural network deployment, under various repayment conditions, to localities not covered by the national operator's service obligation. Providing service in these localities is not limited to the national carrier but also includes private operators who can apply to access the fund.

Paraguay has also been considering such a fund and similar ideas are in use elsewhere in Latin America, although most amount to direct government support rather than cross-subsidization funds to which main carriers contribute. The United States' Universal Service Fund, administered by NECA and described previously, is perhaps the prime example of a cross-subsidization fund in an industrialized country.

Covering the capital costs of infrastructure deployment is only one aspect of the rural operator's challenge to establish and maintain economically viable operations. For really high-cost situations, a combination of capital contribution and revenue-sharing, as described previously, is probably justified.

7. FINANCING OPTIONS

7.1 General

It is now well publicized and widely accepted that the future growth of world telecommunications networks -- more than $100 billion per year to be invested over the next decade - will require a massive infusion of private financing. Estimates are that more than 50 percent of this financing will need to come from private sources and 40 percent from internal revenue generation, with less than 10% from official development assistance.[40] Also, government and multilateral assistance will increasingly take the form of quasi-official venture capital, syndicated funds, and mixed equity/debt financing such as is available from the International Finance Corporation (IFC), the Commonwealth Development Corporation (CDC), and similar quasi-commercial instruments, rather than traditional aid or aid/trade packages.[41]

Overall, reform and restructuring have accelerated telecommunications investment, and financing options have improved significantly. The previous chapter dealt at length with the various forms of cost-sharing and revenue-sharing arrangements that are available through the pricing, licensing, and interconnection mechanisms within a country's regulatory environment. These arrangements are, in fact, forms of financing, since they either enforce cost and revenue averaging between highly profitable and lower return services, or increase the self-financing potential of rural operators through the provision of additional cash flows to them. The mechanisms covered were as follows:

- Internal cross-subsidization through the establishment of rural service targets under the license agreements of privatized carriers
- Inter-carrier settlement and repayment pooling schemes which provide support to operators in an environment with nationally averaged rates but above-average costs
- Skewed interconnection charges or contributions which recognize different incremental costs between interconnected operators by distributing the bothway revenues asymmetrically, in favor of the smaller rural operators
- Rural development funds, generated through levying a charge on national and urban based carriers, and made available to finance the capital costs of rural operators.

All of the above are potentially significant contributors to accelerated rural investment. This chapter focuses on the various types of opportunities for direct investment and funding which have been identified in the study, and assesses their relevance and potential for the rural telecommunications market. The acceleration of rural telecommunications investment is dependent on the market entry options as well as the investment and fiscal environments.

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[40] World Bank projection.

[41] In the "Helsinki Package" agreement, the OECD countries effectively agreed to discontinue aid and trade financing mixes on projects which are commercially feasible, in all but the poorest countries.

7.2 Market Entry Options

There are a number of avenues for private sector involvement in rural telecommunications beyond privatization of a country's national operator. These options are discussed in the following paragraphs.

Revenue-Sharing Concessions

These concessions include arrangements such as Build Transfer Operate (BTO), Build Operate Transfer (BOT) and similar schemes, already noted in chapter 2. Under a BTO, the equipment supplier or other investor, often in an investment consortium, finances and builds a complete turn-key system (e.g., a regional network segment), transfers ownership, but manages and operates the network on behalf of the operator in exchange for a proportion of the revenues. Under a BOT, the investors finance, build, and operate a project and transfer ownership to the telecommunications operator at the end of a contract term.

Although these schemes were pioneered in Asia for example, in Indonesia, Thailand, and Vietnam, several BOT schemes have recently been concluded in Brazil and Colombia and are being proposed in Guatemala, Paraguay, and Venezuela. There are few examples of BTOs and BOT specifically focused on rural areas. In almost all cases, the arrangements were created to accelerate urban investment, although rural and quasi-rural components have been piggy-backed in some cases (e.g., in Indonesia). However, one BOT project in Colombia, involving Alcatel, provides a major regional infrastructure for 350 rural communities.

Joint Ventures or Strategic Partnerships

Many countries allow up to 49 percent foreign participation in joint ventures, with the national partners being either major industrial groups or the national telecommunications carrier. Telenz of New Zealand is understood to be providing rural service under a joint venture arrangement in Vietnam. Many joint ventures exist in the Commonwealth of Independent States (CIS) and Central Europe. Virtually all of India's new entrants will probably involve joint ventures; the focus will be on statewide networks with rural service obligations. Strategic partnerships and joint ventures also figure highly in the Philippines' sector strategy, where international gateway and cellular operators have to contract to provide fixed service.

Rural Cooperatives

The subscribers or share owners of a rural cooperative decide on the balance of up-front subscription, rental and call tariff arrangements. Prime examples are in Bolivia, Canada (Ontario and Quebec), Finland, and the United States. A number of other Latin American countries also have cooperatives or other forms of community cost-sharing, some of them in rural areas.

The advantages of cooperatives are as follows:

- The mobilization of financial resources, including the up-front capital and labor, comes from the local community and therefore reflects the economic importance attached to the securing of telecommunications service by the community
- The service is geared to the perceived needs of the community
- The service is self-regulating on tariffs, with the only national issue being the interconnection arrangements with the national/long distance carrier(s). In some countries, such as Canada, the interconnection arrangement provides a favorable settlement specifically designed to guarantee the viability of the rural cooperatives.

The disadvantages/weaknesses include.[42]

- The typical profit-neutral characteristic of cooperatives limits their capability to generate new investment capital on top of the major contributions which subscribers have had to make to establish first-time service
- Potential conflict between the interests of owner and customer, especially with regard to marginal network extension, may limit a cooperative's willingness to reach out to lower revenue subscribers even on a community access basis
- The inherent consensus management of cooperatives typically limits risk-taking, entrepreneurship and technological development.

Cooperatives have tended to be most prevalent in urban communities and townships. Traditionally, in those countries where cooperatives have played a major role, the government has funded and supplied service to rural areas through cross-subsidization from the long distance and international services. The revenue-sharing arrangements between the cooperatives and the national carrier have often perpetuated this situation by distributing an insufficient share of the long distance and international revenues to the regional operators and cooperatives, thus discouraging their expansion and nonurban investment. One example of this situation is in Bolivia.

Cooperatives are probably best suited to relatively developed, high-demand, and homogeneous areas with a predisposition toward community ventures. Dealing with the kind of public access issues germane to rural telecommunications could be a challenge, though not impossible. It is interesting to note that Finland's network of cooperatives has traditionally maintained viability and influence through association. These cooperatives have recently been able to establish a second national network which has ventured into competition with Telecom Finland for rural business.

In Argentina, rural cooperatives that were established to provide or secure telephone service have successfully competed with the national carriers.

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[42] FINNIDA. "A Study of Alternative Solutions for the Provision of Telecommunications Services in Developing Countries". *The Regulatory and Organizational Structures in Finland.* November 1992.

Rural Joint Venture and Cost-Sharing Arrangements

These arrangements are often associations between the telephone operator and community-based organizations (e.g., local telephone agency, business group, farmers' association, municipality). The structure of the local entity often resembles that of a cooperative.

In a number of countries, various community or business groups have been prepared to supply most or all of the capital to finance the installation of telephone service. For examples a wide range of business, agricultural and local government groups in Brazil have joined to finance service; coffee growers and municipal groups have partially financed systems in Colombia, and coffee plantation owners in Kenya have financed service extensions. Similarly, farm associations in Paraguay and tea plantation owners in India have been willing to pay connection charges well in excess of the official tariff.

Typically, these associations are able to finance the first line or a group of lines to a community (e.g., by a TDMA radio station); the telecommunications company may then be able to justify the incremental cost of a payphone and subsequent lines to serve lower net benefit/ lower-revenue subscribers in the local community.

Competitive Entry by Independent Operator

The introduction or threat of competition encourages innovative approaches to old problems. Competition at the rural level is reported to have been a significant factor in the lowering of per-line costs and prices in Argentina.[43] The government of India has tendered for second operators to compete with the Department of Communications (DoT) on a state-by-state basis. New entrants are expected to maintain a balance between urban and rural operations under their terms of license. The new Philippines regime involves duopolistic competition between newly licensed operators and PLDT throughout the country, on a territory-by-territory basis.

The governments of Mexico, Sri Lanka, and elsewhere are allowing new entry by private operators for innovative (non-wireline) technical solutions, e.g., fixed cellular and VSAT. Some of these approaches may represent an extension of a corporate value added services network. The regulator needs to review these opportunities and create a suitable environment for their emergence.

Competitive Entry by Existing Private Telecommunications Network Operators

These competitors may include power, rail, bank or resource companies. Power companies have been active in the development of competitive network options in the United States and Britain, while the major rail companies were instrumental in development of the second national long distance network in Canada. In China, competitive entry is coming also

[43] Source. Pyramid Research.

from other agencies of government combining to form alternative carrier options.[44] In most situations, the companies or agencies involved start out with data and private line voice communications; however, as scale economies available from digital integration and ATM technology begin to take shape, they see the potential for public network services.

At present, this option has shown potential but little else in the developing world. In theory, organizations with existing networks which have been cost-justified for their own corporate needs, could afford to extend services to rural communities within their areas of operation. The offering of VSAT solutions for public voice applications in Brazil, the CIS, and Mexico is illustrative of this approach. In another example, a possible new entrant in Sri Lanka intends to justify such investment at least partially on the basis of a major corporate need. The extension of networks initially designed for corporate data applications to serve voice customers and to offer enriched data and voice services is now becoming a reality. Some of these services could be made available economically in rural areas which have business and industry customers nearby.

Cable Television Operators

Since community antenna television (CATV) operators entered the competitive telephone service arena in Britain, and then in the United States, there has been a great deal of interest in their ability, with a combination of fiber backbone and "switched star" network topology, to achieve cross-economies which are beneficial to both cable television and telephony subscribers, as well as to provide a wide range of multimedia services. Some operators in this class (notably US West) are promoting mixed technology solutions such as the following:

- CATV backbone
- Cable-based subscriber access for high-use customers and those within the core service area
- Fixed cellular technology for lower-use and perimeter customers.

This type of solution was originally proposed by US West for India and now is being actively promoted by new entrants in Eastern Europe and elsewhere. The application is for district centers and new industrial zones with substantial surrounding rural areas.

Service Agency Opportunities

In addition to the provision of wide area network solutions, which include public exchanges and long distance interconnection, there are a variety of small entrepreneurial options which can be encouraged at the local community level, such as payphone kiosks, phone shops, and tele-access centers offering a mixture of telecommunications and information services.

[44] China United Telecommunications Co. (Unicom), formally launched in July 1995 as a second national commercial operator, is a joint venture between the Ministry of Electronics Industries, the Ministry of Railways, the Ministry of Electric Power, and China International Trust and Investment Corporation (CITIC).

These were discussed in Chapter 5 as options for enhancing network revenue generation. If they are encouraged by policymakers and prove to be profitable, they will become significant contributors to the financing of telecommunications services.

7.3 Degrees of Interest and the Commercial Environment

The following is a list of the factors that have influenced or are likely to influence the level of interest of private sector investors and financiers in the rural telecommunications market:

Commercial opportunity and regulatory environment	• market size, revenue potential and growth rate • service/market limitations or exclusions • pricing and marketing freedom • service obligations • rights or limitations on service bundling • terms of interconnection with national and international carriers • expected revenues and rate of return
Market protection	• term of license and conditions • time limit on monopoly status • rights of competitors
Finance	• total equity requirement • amount and terms of commercial loans • availability of special loans (low interest, long term)
Investment and fiscal environment	• limits to foreign ownership • corporate tax structure and available concessions • share issuance regulations • dividend treatment • repatriation of profits • political stability of investment and fiscal policy
Technology	• technical standards • rights or limits on deployment of new technology • type approval requirements and procedures • radio spectrum availability and allocation procedures
Productivity and labor relations	• availability of skilled and trained manpower • level of freedom on employment and remuneration • commercial orientation and response to incentive
Joint venture partnerships	• relative strengths of partner(s) • company control and management

All of the above need to be covered in the feasibility and business case preparation studies, which are required by reputable investors.

7.4 Rural Funding Potential and Requirements

Under a liberalized regime in which private operators, cooperatives, community or business groups, and agency entrepreneurs can be licensed to provide services to rural areas, and the pricing/revenue-sharing environment is favorable, demand for finance will increase and a range of funding mechanisms can be employed.

If the revenue/cost pre-conditions for commercial operation, as cited in Chapter 5, are present and the regulatory regime is designed to enhance commercial viability through, inter alia, favorable interconnection agreements, then the possibilities for commercial funding will be increased. *However, since many marginal situations will continue to exist, a blend of private and public sources of finance will be required.*

Commercial and Blended Funds

Rural operators should, of course, be able to tap into funds available from commercial banks and from development agencies such as the IFC and their special regional funds (e.g. Central European Telecommunications Investments (CETI) in Central and Eastern Europe), and other special equity and/or loan funds available on commercial terms.

In addition, a single funding agency could be designed to collect both commercial and concessionary/aid funds and provide a range of equity and loan options tailored to the needs of both commercial and concessionary operators. Fully profitable operations would borrow at commercial rates, while those that are more marginal for reasons of cost would have access to lower interest and longer term money.

To ensure that certain infrastructure targets are met, governments may still provide complementary direct government assistance, using one or a combination of three instruments: tax concessions, low interest loans, and government grants. These instruments are also part of the continuum of cost and price subsidy mechanisms.

Tax Concessions

Tax concessions can serve as an incentive to investment. For developing countries with high tax rates and a need to import most of their telecommunications equipment, release from import taxes is especially important. Additional tax concessions, such as are provided in Brazil, may be in the form of reduced corporate rates, tax credit/refund schemes and accelerated depreciation allowances. The Philippines has a varied incentive program: reduced import taxes and reduced duty on capital investment, income tax holidays, and carry-over of net loss deductions for rural telecommunications.

The financial impact of tax concessions on rural operators may be balanced by special taxes on the national/urban carrier's revenues or may be absorbed by the Treasury. However, these measures are much less desirable, in our view, than the direct administration of a rural development fund.

Low Interest Loans

Governments (and bilateral and multilateral agencies) should still provide special low interest loans to encourage the most difficult rural service extensions. The provision of loan guarantees, where possible, in commercial limited-recourse project financing packages could also be very useful. Traditionally, many soft loans and bilateral aid/trade packages have led to serious "misallocations" of scarce foreign exchange, because they were spent on poorly planned, overpriced, and high-cost investments, in which all commercial realities, including proper asset registration and the need to provide appropriate marketing, operational, and maintenance support, were completely neglected.

Since sector reform has taken root -- with corporatization at least -- a greater semblance of allocative efficiency and commercial responsibility is being observed. However, the use of official development assistance and government subsidies, without consideration of commercial viability and cost-sharing or revenue-sharing, is no longer advised.

The "Rural Electrification Program" (REA), which has been in operation in the United States since 1949, is one example of a successful low interest loan program that has sought to extend service to unserved rural areas. Although it has paid out more than it has received from payments from telecommunications operations, the REA has been successful in terms of ensuring service extension to previously unserved areas and universal service at affordable rates. REA borrowing, initially at 2 percent interest and later at 5 percent, has been extended to many hundreds of small operating companies and cooperatives over the years. By effectively reducing the financing costs, the REA program has successfully contributed to bringing the cost structures of the recipient companies close to those of the larger US carriers, despite their having significantly higher per-line capital costs. It has been argued, however, that more companies than really needed the support were able to secure funds.[45] Hence the terms for discontinuation of such funding need to be spelled out.

Grant-based Rural Development Funding

Inevitably, governments will still choose to directly fund some aspects of the provision of telecommunications services to disadvantaged areas or categories of users. For example, Brazil,

[45] Armstrong & Fuhr. "Cost Considerations for Rural Telephone Service." *Telecommunications Policy*. January/February 1993.

Canada, Chile, Mexico, and the Philippines, have at some time established special direct grants to extend service. Nevertheless, it is recommended that all efforts at creating commercially viable scenarios by other means be explored first.

Canada established a Northern Communication Program in the 1970s to extend high cost telephone service to remote northern regions in conjunction with the deployment of satellites. The government funds had to be matched by the carrier operating in the region at that time, namely, Bell Canada and Canadian National Telecommunications. Similarly, Mexico provides federal and state contributions, through its national regulator, SCT, to support the extension of the telecommunications network beyond the service obligation of the national carrier. Many of the service extensions are at very high cost -- well in excess of $10,000 per line.

Although direct subsidies are effective in supporting service extension, governments in developing countries increasingly lack sufficient funds to pursue their economic and social development objectives. Rural telecommunications services have to compete with many other sectors to receive funding. Experience has shown that government funds can and should be only complementary to funds and subsidies that are generated within the telecommunications sector itself. In some cases, a correct application of revenue distribution or asynchronous interconnection charges might be a better approach, while in others the appropriate use of blended funds and fiscal incentives could be sufficient. Additionally, these approaches would instill a greater sense of commercial awareness and discipline into the planning and operational processes.

While not eliminating the need for direct grants altogether for the most remote and difficult situations, it is possible that the total amount of direct grant-based funding required could be reduced significantly. As proposed in Chapter 4, it is vital that governments integrate their priorities for social and economic infrastructure development in the poorest regions with those of their telecommunications sector policymakers (and vice versa), in order to ensure that rural telecommunications both contribute to the regional development goals and receive the best chance of maximizing revenues and operating in a commercially viable manner.

Rural Program Policy and Financial Country Information

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues and Commercial Experience
Bangladesh	State-owned Bangladesh Telegraph & Telephone Board (BTTB). Rural and cellular sectors privatized in 1989. Two major private rural operating concessions granted to Bangladesh Rural Telecom Authority (BRTA) and Integrated Services Ltd. (ISL). Licenses cover 390 of the country's 460 rural administrative units for 25 years.	Rural modernization program emphasizes private sector role. Service is currently provided to businesses, institutions, government agencies and franchised PCOs.	Local entrepreneurs are to invest in and operate the rural networks. Financing is a combination of supplier credit, initial subscriber deposits, and investor contribution. Low per-line costs ($1,000); $500 subscriber deposit and high revenues ($1,000 per line per year) allow the network to be virtually self-financing.	Standard connection charge of $3.90, but $500 advanced deposit charged by BRTA. Low monthly charges of $3.90. Low local calls of $0.04. Domestic fee structure: for calls between BRTA and BTTB "sender keeps all international outgoing: BTTB/BRTA split the charge 50/50; incoming: BTTB splits with BRTA 70/30 after settlement of third party charges.
India	Monopoly state-owned operator (DOT). Private sector competition in value added services and 1994 National Telecom Policy (NPT): allowed private sector duopoly on a circle (state-by-state) basis for local and intrastate services. New entrants must be majority Indian owned. National interstate long distance will remain a DOT monopoly for 5 years. VSNL, a quasi-private sector company, has a monopoly on international services.	NPT has following targets: telecom within reach of all; universal service covering all villages through PCOs by 1997; and quality of service comparable to urban areas. NPT promotes new technology, particularly wireless pilot projects for rural areas. Several projects with foreign involvement (e.g., Motorola) are almost underway. NPT orders private investments to achieve balance in coverage between rural and urban areas and provide rural access through PCOs.	Internal financing. Private investments, including foreign investment through international capital markets. Commercial PCO operators finance their own terminals and receive 80% of outgoing call revenues, 50% in rural areas.	Installation fee $27. Monthly charge varies according to exchange area size, from $3-$13. Local call rate $0.03, but flat local tariff including first 120-150 calling units. LD rates up to $0.97/min. 30% off-peak discount. Fee structure is generous to rural subscribers. Connection charge same as for urban subscribers. Monthly charges in exchanges below 1,000 lines are heavily cross-subsidized . Average revenue/yr between $160-$350/line, though 30-40% of rural subscribers do not exceed free calling limit ($60 per annum). PCO revenues much higher.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues and Commercial Experience
Indonesia	Three major carriers: government-owned PT Telkom (domestic service); government-owned INDOSAT (international traffic) partially privatized; SATELINDO (70% private, 30% Telekom). Private mobile and value-added service providers on competitive basis. Private sector participates in basic service provision in cooperation with Telekom through different revenue sharing and joint venture schemes.	Rural development part of 5-Year Development Plan (1994-1998) to have digital facilities in all districts. Rural deployment strategy is based on both density and accessibility criteria. Includes private lines as well as PCOs and public kiosks ("Wartels"). Focus on connecting all administrative centers and increasing the number of telephones. 20% of private sector lines have to be in rural areas. SATELINDO will provide national GSM network by 1998, which will include rural areas. Mobile cellular covers rural areas. Under the *Build, Own, and Operate (BOO)* scheme a number of investors have been given concessions to set up small-scale public call office operations in remote and underserviced areas. These PCOs provide CPE rather than infrastructure.	Of 5 million additional lines, 2 million are to be financed through private capital. Telkom reinvestment of revenues. Privatization of government operation. Private venture capital. Soft loan (government to government agreement). Various revenue-sharing schemes: *Build, transfer, share profit (PBH).* The investor provides capital, labor, and other resources for network construction in exchange for 100% of the revenues from connection fees and 60%-70% of the pulse-based revenues over a predetermined time period, but does not manage or operate the network. *Build, Operate, Transfer (BOT).* Private investors build and operate a project and transfer ownership to Telkom at the end of the contract term. This scheme is used with new mobile telephone operators which have established cellular networks. *Build, Transfer, and Operate (BTO).* Under a scheme called KSO, consortia with at least one private Indonesian company and a foreign telco build complete systems and transfer ownership immediately, yet operate the system in exchange for 70% of the revenues generated from monthly service fees and tariffed traffic, plus 100% of the revenues from installation fees.	Tariffs are set by government. High installation charge of $147.80. Low monthly charge of $3.70. Local charges are $0.05. Under revenue-sharing arrangements, private investors receive 70% of the revenue for a 5 to 11.5 year period. Community service obligation of private consortia, determination of roll-out priorities, and tariffing arrangements for fixed wireless are not yet determined.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues and Commercial Experience
Malaysia	Partially privatized (25%) monopoly Telekom Malaysia (TM) provides telecom services. Competition for mobile services: TM and two private companies for AMPS, one for digital.	Rural telecom development is integral part of accelerating national development. Rural telecommunications is part of TM's mandate. Rural telecom technology includes fiber to the street, wireless local loop, and wireless PCOs. Celcom serves customers in some rural areas, primarily businesses.	Internal Resources, no special external funding. Rural budget under 6th Malaysia plan: $846 million.	Low connection fee: $20 residence and business. Monthly charge from $48-$96, depending on the size of exchange. Local call rate $0.05, with the first 100 units included in the monthly charge. LD rates up to $0.78/min. at 550 km. 50% off-peak discount. The average cost of providing rural telephone line is $3,500 ($1,200 urban). Deployment of wireless loop technology has reduced some rural costs to $1,500/line. Average revenue from rural customers is $170/annum (much higher from PCOs), compared to $580 national average.
Vietnam	Government monopoly VNPT. Basic telecom service provided by 53 independent public sector provincial P&Ts, which are considered part of VNPT. Restructuring is planned to allow competition. Build, Transfer, and Operate (BTO) schemes are being established. e.g., Telstra has a 10-year Business Cooperation Contract with DGPT for international service, which is effectively a credit line, with repayments from revenue-sharing.	Rural telecom is part of the national social and economic development plan. Addressed in a comprehensive telecom modernization program. Objective is 1 tel/100 pop. and to have service in all villages by 2000. Government is reluctant to privatize rural service but exploring joint ventures. Telenz of TCNC (NZ) is providing service in some rural areas.	30% of total telecom investment for rural development. Planned to invest between $1.29 billion and $1.55 billion in telecom infrastructure during 1993-95 period. ODA; e.g., aid agencies, ADB. Supplier credits and joint ventures (e.g., the Telstra contract for international service). BTO schemes call for local production jvs, with foreign partners for start-up capital	Connection fees vary from $100 in small localities to $600 in Ho Chi Minh City. Low monthly charge ranges from $2.35 to $6.80. Flat rate: no charge for local calls. Unbalanced tariff structure. International rates are high. Plan exists to establish special tariffs for rural telecommunications.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues and Commercial Experience
Pakistan	State-owned monopoly Pakistan PTC is being privatized as PTCL with a 25-year renewable license and a guaranteed monopoly for voice services for 7 years. PTC privatization is part of the national policy of deregulation and privatization. Already privatized are cellular (2 AMPS, 1 GSM), paging (1 operative, 4 issued), card payphones (3 operative), data networks (12 licenses issued). In the process of being privatized are satellite, voice mail, trunked mobile radio, and VARs, such as audiotex	Rural telecom is part of an overall rural development plan (8th Five-Year Plan). Goals are 150,000 new lines by 1998 to reach villages with over 1,000 pop. and achieve a telephone density of 0.2 lines/100 pop. Rural network will include PCOs and card phone terminals. Present rural penetration: 0.08 per 100 population. A rural telecom strategy is expected soon, based on synergies between public and private cooperation. The top 15 customers of cellular operators operate as PCOs in rural areas.	Internal resources Bi-lateral soft credit Supplier's credit Buyer's credit. Estimated cost of rural program is $260 million, which includes a $137 million foreign exchange component.	Connection fee $100, residence and business. Low monthly charge $2. Local call rate $0.07: Current per-line revenue $15 for rural manual exchanges, $100 for rural auto exchanges, and $300 for urban exchanges. Forecast revenues per annum: PCOs $0.11 per capita; government lines $1,270; business $650; residential $160. Average revenue per PCO is $36-$1,020 per month. Expected IRR for rural network development is 15%. Cellular "PCOs" in rural areas achieve annual revenues of $2,200-$2,600.
Thailand	State agencies TOT (local, national telephone) and CAT (telegraph, data, overseas, cellular). Private collaboration through investment and revenue-sharing: shift from concession approach, where private sector is financier and operator to facilities leasing *Build, Operate, Transfer (BOT).* Limited competition: license to private firm for VSAT service. Privatized: cellular, paging, VAS including telebanking, online services.	Recognition of rural telecommunications in 7th National Economic and Social Development Plan: expand telephone service to cover all villages with 2 lines in each sub-village. Policy of privatization of rural telecommunications failed. There were no offers for BOT, because of the lower perceived return on investment. In TOT's rural program, telephone is placed in landowner's house with agreement to allow local villages to use. TOT pays 10% commission to landowner. Two other PCOs per village, in government offices or public places.	State contributions Soft loans Grants Tax privileges Promotional privileges Duty free import Concession schemes BOT schemes. Under BOT scheme, concessionaires lease their facilities to TOT for the duration of the concession, after which ownership and control of facilities will transfer to TOT. The aim is to increase TOT's degree of operations control during concession lifetime.	High connection fee of $145 (residence & business). $3.90 monthly charges, $0.04 local calls. National average annual revenue per line for TOT is $456. Annual revenues per subscriber in rural areas are $305. First TOT program cost $8000/line. Revenues were $200/line per month (4-year payback). 2nd program is costing up to $16,000/line and revenues are at $80/line per month (16-year payback).

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues and Commercial Experience
Philippines	98% of basic telephone services provided by numerous private carriers. Remaining 2% by government and provinces. PLDT has 90% market share and has had an effective long distance monopoly. Despite private involvement, low quality of service. New policy objectives: balance development between metro, provincial and rural areas; promote effective competition; encourage foreign investment; break monopoly in long distance by encouraging non-PLDT operators. Exec. Orders 59 and 109 prescribe compulsory interconnection and the policy for local exchange carrier (LEC) service. In exchange for licenses, all service operators in Manila, or International Gateway Facility (IGF) operators or cellular (CMTS) operators are required to provide new exchange lines in provincial and rural areas, to help meet the country's network growth needs. Service providers include: Digitel, ICC Telecom, Paptelco, PT&T, RCPI, Globe Telecom, Eastern Telecom, ETPI, Islacom and M/S Philcom. *CMTS Operators* include PLDT Extelcom, Smartcom, Philtel.	Government places high priority on rural telecom. Objectives are provision of local telephone exchange in each municipality; extension of PCOs to unserved barangays; and nationwide cellular mobile telephone. Municipalities should have at least one PCO. Private sector will be main executor of the expansion plan. Currently, just 20% of municipalities have local exchange service; 22% of Barangays have PCOs. In response to deregulation, PLDT has significantly increased investment in network development under the "zero backlog" policy. IGF and CMTS operators are required to install local exchange lines, 10% in rural areas, as part of their license. Several firms specialize in rural service provision. Provinces and municipalities can set up PCOs or grant franchises to private operators.	Government resources contribute $8.3 million; $12.5 million to come from foreign aid and commercial loans, e.g., for the Municipal Telephone Project Office (MTPO) initiative. A combination of measures are applied to assist private sector to obtain: • Access to long-term financing, soft loans from foreign companies, development banks, and ODA (including Canadian mixed credit, CIDA funds) • Tax incentives during start-up period (including reduced import tax and duty on capital investment, income tax holiday of 4 years and carryover deduction of net loss). Cross-subsidy of local exchange service by more profitable operations within each company is allowed until such time as universal access is achieved and prices can be moved to reflect cost. Funding for PLDT's "Zero Backlog" program is to come from issuing 10-year bonds on European market. PLDT is also seeking a consortia revenue-sharing scheme under a 7-10 year Build-Operate-Transfer scheme. The consortium will invest in capital equipment, while PLDT will operate the system and resume ownership at end of contract. Private sector uses investments by foreign telcos to pursue network expansion.	NTC sets uniform rates for each type of call. Low connection charge $11.50 residence and $14 business. Monthly charge $9 and $19. Local call rate $0.08. Long distance rate up to $0.39/min at 1,170 km. 30% off-peak discount. MTPO program PCO revenues are very low because of poor siting, time availability and poor O&M.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, revenues and commercial experience
Laos	State-owned monopoly EPTL provides all basic services.	75% of population in rural area are not served. A 3-year rural program aims to provide basic service to all 17 provinces. 6-10 years are required to achieve complete coverage of all rural areas.	Grants, loans (German government has provided $12 million in support).	Connection charge $100 residence & $175 business. Low monthly charge of $5 and $11. Low local call rate of $0.03.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues & Commercial Experience
Argentina	Privatized monopolies - TELECOM and TASA - for 7 years (extendable to 10 years), but rural telecom is deregulated and competitive. Rural concessions compete with the two main operators.	Minimum Service Plan obliges TELECOM and TASA to extend service to all communities above 300 population. 135 Rural Cooperative Societies, exist to supply telecoms to communities. Rural concessions can compete with the main operators.	TELECOM and TASA meet their obligations through internal cross-subsidization. The rural cooperatives have funded their facilities through financial and other resource pooling.	High installation fee ($750 residence and $1250 business). Monthly charge $8 and $16. Average local call rate ($.04). Price reduction objectives under the privatization agreement. Extensive wireless service in suburban and surrounding rural areas.
Bolivia	Privatized ENTEL has the monopoly for basic services. Seventeen major cooperatives will become regional service companies and will receive shares in ENTEL.	ENTEL currently serves all areas not covered by the municipal operating companies, primarily rural areas. Also, DITER provides long distance telecom to 600 locations. COTAS, one of the large municipal opcos, serves at least 30 rural communities. All of the regional service companies will be obligated to incorporate rural areas under the privatized regime.	ENTEL has financed rural service from profitable international and national services. Spends 40% of its construction budget on rural. Accepts external loan finance e.g., CAF (Andean Development Fund), CIDA line of contribution, commercial terms.	High connection charge ($1500 residence and business). Recommended to reduce to $300 residence and $600 bus. Low monthly charge $3 residence and $10 business, should increase to $10 residence and $34 business. Low call rate $0.016; should increase to $0.03. Long distance rates are reasonable. CIDA case is an example of making rural service profitable, by focusing on intermediate-sized locations and high revenue PCO, business, and institutional lines.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues & Commercial Experience
Chile	Full liberalized telecommunications market. Major players in local services are CTC, CTM, and CMET. ENTEL and CTC are the primary long distance providers.	Rural service provided mostly by CTC. ENTEL serves the extreme south. Operators must provide service on demand in their licensed area.	Internal resources. External credit. Government subsidy program assists operators to meet rural exchange and PCO service targets. Community contribution also used to meet new connection costs.	Tariffs have been re-balanced in view of the long distance competition. No specific information.
Brazil	TELEBRAS - the holding company - is 52% government - owned and the balance owned by Brazilian investors. EMBRATEL is the long distance and international carrier. 90% of the local service is provided by 27 TELEBRAS-owned state companies. 9% of the business is provided by 4 independent state companies.	Service in rural areas is provided by the 31 state companies. The National Rural Telecom Program emphasizes the role of telecoms in social and economic development, especially the agriculture sector, and to counter urban migration. The policy objective is to provide a telephone within 5 km of all inhabitants.	TELEBRAS provides only commercially justified service; therefore, looks for cost-sharing with cooperatives and other joint venture agents for high-cost localities. Funding of the NRTP is 50% by publicly owned banks, 30% by private banks and suppliers, and 20% by users. A rural fund exists at the state level. Tax credit/refund scheme can be used to finance rural projects. Individual line service is provided on demand to entities - e.g., rural businesses, unions, cooperatives and associations, which assume the costs. "Collective lines" to towns and villages, on demand by the municipality, state, government, or community, with costs assumed by the requesting agency.	High connection fee ($1500 residence/$1800 business.) Low monthly charge of ($1 & $4.60) and low call rate ($0.02). Community Teleservice Centers (CTSC's) are well advanced in Brazil as a service provision and revenue enhancement tool. Strategy for CTSC development to service 10,000 population per center. CTSCs have 4 modules: 1. public services (telecom, mail, energy, municipality, public health, information, etc.) 2. teleoffice (fax, PC, copy machine) for businesses 3. support applications for small shops and factories to improve performance 4. educational applications (e.g., computer training) CTSCs have user demands of several hundred visits per week.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues & Commercial Experience
Ecuador	State-owned monopoly operator, EMETEL, to be privatized as two regional entities, EMETEL N. and EMETEL S.	Rural telecoms is part of EMETEL's mandate.		Connection fee $170 residence and $280 business. Monthly rate very low ($0.2 and $1) and very low local call rate $0.01.
Honduras	State monopoly.	Rural priorities guided by the country's development programs. Country has a telecoms Rural Master Plan. High priority given to PCOs, which represent 7% of total investment.	Central funds and ODA.	Rural tariffs are the same as for urban service. Low connection fee ($57 residence/$115 business). Relatively low monthly ($4 and $7) Low local call rate ($0.02).
Colombia	Currently government-owned monopoly. Total of 25 local municipal operating companies. Five largest companies provide over 70% of country's local lines. TELECOM is the long distance and international carrier, and also serves 13% of the country's local lines, plus rural areas. TELECOM will be privatized soon, with a 10-year license and able to acquire up to 45% in regional joint venture companies.	Rural service is provided by all companies. The National Rural Telephone Program (PNTR) calls for one rural community telephone plus maximum of five other lines per locality. The objective is to cover the whole country and particularly serve all agricultural industries. Current coverage is approximately 65% of localities with population above 500.	Combination of credit, soft loans, special funds, cooperatives and user finance. At least one major rural project is BOT-financed. Joint venture and cost-sharing programs with private sector (local telephone businesses and suppliers), farmers, associations and interested individuals, municipal authorities, and other departments. For example, joint ventures with coffee growers, in which the growers financed the terrestrial transmission systems while TELECOM provided switch connections, outside plant, and engineering.	Connection fee $260 for residential and $320 for business. Monthly rate of $6 and $8.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues & Commercial Experience
Mexico	Privatized monopoly, TELMEX, provides local service. Further liberalization planned to allow local service competition. 8 licenses planned for long distance services. One competitor will be IUSACELL, which provides radio-based telephone service to rural areas, but plans to expand to provide countrywide service.	Under the National Rural Telephone Program, TELMEX must provide service to all communities above 500 population by year 2000, plus an automatic exchange in all communities above 2,500 population where demand exists. The NTPR requires TELMEX to install PCOs first, then to increase the number of phones to agencies, then improve service to level of TELMEX norm.	Below 500 population, federal and state contributions support the extension of the telecom network. Through joint ventures with local governments, the national regulator, SCT, purchases systems, while TELMEX operates them under a state agreement.	Connection fee $480 for residence and $840 for business. Monthly rate of $8 & $18. Relatively high local call rate ($0.13).
Peru	Privatized monopoly for all basic telecom services.	ENTEL is required to extend service to all communities above 500 population (1,486 localities), but this may be reduced to communities above 1,500 population. A rural telecom fund, FITEL, will be used to finance service to localities not covered by the operator's obligation.	FITEL receives 1% of gross revenue from ENTEL, plus donor contributions. FITEL will be used to finance service provision to communities not covered under ENTEL's obligation.	Connection fee $320 (residence and business). Low monthly rate ($ 1.40 and $4.30). Low local call rate ($0.02).
Paraguay	State-owned ANTELCO provides all basic telecom services. Privatization approved by Congress but yet to be implemented.	ANTELCO currently provides inadequte level of rural service. Private operators may be invited to serve rural areas.	Consideration is being given to creation of a rural telecom development fund. This study found the fund to be feasible commercially for S. Paraguay.	Connection fee $500 Monthly rate $3 and $6. Low local call rate ($.01). Annual revenues per line: PCOs $2,000 Business/Institution $1,000.

Country	Regulatory Setup	Rural Program	Funding	Tariffs, Revenues & Commercial Experience
Venezuela	Privatized monopoly for local, long distance and international service. CANTV is the service provider.	CANTV required to provide service to all communities over 5,000 population by end 1994, and meet annual targets for smaller communities. CANTV must install PCOs in at least 20 new communities per year and has regional targets to meet.		Very low connection fee ($40 residential and business.) Monthly rate $1.60 res./$12 bus.) Low local call rate ($.02).
		Three other companies are licensed to provide payphone networks in areas not covered by CANTV, i.e., communities below 5,000 population.	Commercial.	
		The regulator, CONATEL, is soliciting bids for general rural service provision.	Connection fees for rural concessions will be split 50/50 between the operator and CANTV.	
		Cellular operators will be permitted to service rural areas.		Tariffs for the fixed rural cellular customers must be cost-related.

LIST OF COMPANIES PROVIDING DATA

Alcatel

Allan Telecom

Canadian Marconi

Daniels Electronics

Digital Microwave Corporation

Glenayre Electronics

Globalstar

Harris Farinon

Hughes Network Systems

Iridium

Lenbrooke Industries

Motorola

Noller Communications

Northern Power Systems

NovAtal

Odyssey

Qualcomm

SATTEL Technologies

SR Telecom

Tellabs

Teledesic

TELOS Engineering

TIW Systems

TMI Communications

Transworld Communications

TRT Philips

COUNTRY STATISTICAL DATABASE FOR FEASIBILITY MODEL

FEASIBILITY MODEL DATA BASE	Population (millions)	% pop'n rural	GDP per cap (US$)	% GDP Agric.	% Income attrib. to rural pop'n (based on Income distr. data)	Rural per cap Income (US$)	Urban per cap Income (US$)	Urban/rural Income ratio	Land area (km2)	Rural pop'n density (Inhab/km2 assuming 90% land area)	Current tel. lines (DELs)	Overall penetration (lines/100)	Current rural tel. penetration (lines/100)	Rural Subscriber density (lines/km2)
Uganda	17.0	87	170	57	68.4	134	413	3.09	197	83	28,200	0.17	0.02	0.02
Nepal	19.9	88	170	52	72.1	139	395	2.84	141	138	80,700	0.41	0.003	0.004
Bangladesh	114.4	82	220	34	63.8	171	442	2.58	144	724	268,400	0.23	0.06	0.43
India	883.6	74	310	32	52.4	220	567	2.58	3,288	221	8,037,400	0.91	0.13	0.29
Kenya	25.7	75	310	27	33.8	140	821	5.88	580	37	207,400	0.81	0.09 *	0.03
Pakistan	119.3	67	400	27	46.0	275	655	2.38	796	112	1,604,800	1.35	0.14	0.16
Sri Lanka	17.4	78	475	26	58.4	356	898	2.53	66	228	157,800	0.91	0.76	1.74
Zimbabwe	10.4	70	570	22	29.0	236	1,349	5.71	391	21	127,100	1.22	0.09 *	0.02
Indonesia	184.3	68	670	19	45.1	444	1,149	2.59	1,905	73	1,805,900	0.98	0.10 *	0.07
Bolivia	7.5	48	680	18	21.1	299	1,032	3.45	1,099	4	186,000	2.48	0.22 *	0.01
Philippines	64.3	56	770	22	28.1	386	1,258	3.26	300	133	847,500	1.32	0.05 *	0.06
Peru	22.4	29	950	17	9.0	295	1,218	4.13	1,285	6	613,700	2.74	0.31 *	0.02
Ecuador	11.0	42	1,070	13	17.5 *	446	1,522	3.41	284	18	531,300	4.83	0.35 *	0.06
Colombia	33.4	29	1,330	16	7.0	321	1,742	5.43	1,139	9	2,821,700	8.45	0.52 *	0.05
Paraguay	4.5	51	1,380	24	30.0 *	812	1,971	2.43	407	6	128,100	2.85	0.17	0.01
Thailand	58.0	77	1,840	12	50.7	1,212	3,944	3.26	513	97	2,184,900	3.77	1.72	1.66
Brazil	153.9	23	2,770	11	7.0 *	843	3,346	3.97	8,512	5	10,670,100	6.93	1.00 *	0.05
Botswana	1.4	73	2,790	5	34.4	1,315	6,779	5.16	582	2	36,500	2.61	0.24	0.00
Malaysia	18.6	55	2,790	20	22.7	1,152	4,793	4.16	330	34	2,410,700	12.96	3.41	1.17
Mexico	85.0	26	3,470	8	8.3 *	1,108	4,300	3.88	1,958	13	6,753,700	7.95	0.07 *	0.01
Argentina	33.1	13	6,050	6	5.0 *	2,327	6,606	2.84	2,767	2	3,682,100	11.12	4.00 *	0.07
Korea	43.7	26	6,790	8	13.5 *	3,526	7,937	2.25	99	128	16,686,100	38.18	18.8	23.97
Greece	10.3	36	7,290	8	20.0 *	4,050	9,113	2.25	132	31	4,496,500	43.66	30.0 *	9.36
Portugal	9.8	65	7,450	25 *	45.0 *	5,158	11,707	2.27	92	77	3,162,500	32.27	25.0 *	19.23
Spain	39.1	21	13,970	8 *	14.6 *	9,712	15,102	1.55	505	18	13,792,200	35.27	30.0 *	5.42
Australia	17.5	15	17,260	3	8.3 *	9,551	18,620	1.95	7,713	1 *	8,257,000	47.18	40.0 *	0.45
U. Kingdom	57.8	11	17,970	3	5.5 *	8,985	19,081	2.12	245	29	26,084,000	45.13	40.0 *	11.53
Canada	27.4	22	20,710	3	13.6 *	12,803	22,940	1.79	9,976	2 *	16,246,600	59.29	50.0 *	1.01
Finland	5.0	40	21,970	5	30.5 *	16,752	25,449	1.52	338	7	2,742,000	54.84	50.0 *	3.29
United States	255.4	24	23,240	2	14.5 *	14,041	26,145	1.86	9,373	8 *	144,056,700	56.40	50.0 *	4.09
Sweden	8.7	16	27,010	2	10.6 *	17,894	28,746	1.61	450	3	5,919,000	68.03	64.0 *	2.20

Note * denotes estimate or contains revision of methodology

SUMMARY OF ECONOMIC AND SOCIAL BENEFITS OF RURAL TELECOMMUNICATIONS

Key Findings from the Research

Findings from research and pilot projects in rural and developing regions show that telecommunications can contribute to social and economic development. There has been progress in developing models that can predict the quantitative financial benefits of investment in rural telecommunications, typically based on the theoretical underpinnings of the role of information in economic activities. Substantial evidence also exists as to the benefits that result from specific applications of telecommunications in various sectors such as distance education, medical consultation, administrative support, and transport substitution. Some studies also conclude that benefits are proportionately greater in areas of low teledensity, but it is not clear whether this is because each added increment of telecommunications is a greater percentage of the installed base than in high teledensity areas.

Many authors also note that telecommunications should not be seen as a panacea. A more positive statement of this conclusion is that telecommunications is necessary but not sufficient for development. Other forms of infrastructure including transportation, water, and electrification are also important, as are other factors such as labor costs, skills, and reliability; tax or other concessions or incentives; and proximity to major markets.

Thus, there is no simple formula that can safely predict quantifiable benefits of investing in telecommunications in a specific rural area, because many factors may influence the extent of the impact of better access to information. They include:

- Existing and planned economic initiatives
- Well-organized public services and/or private sector activities
- Existence of other essential infrastructure
- Participation of users in planning location and features of telecommunications facilities to eliminate cultural, linguistic, or gender-based barriers
- Administrative systems for development activities emphasizing supervision and feedback
- Employee training where telecommunications facilities are installed to support sector activities
- Accessibility of telecommunications facilities for personal use.

The Changing Socio-Economic and Technological Contexts

Throughout the developing world, rural as well as urban industries are being drawn into the global economy. To stay internationally competitive, farmers must resort to increased specialization and react to shifts in consumer demand. Historically, rural development took place where there was geographic advantage in the form of arable land or natural resources. Increasingly, new economic development depends on human resources and economic diversification. Thus, basic education of children and adults as well as specific training, is important, yet rural regions worldwide continue to face a shortage of teachers and educational facilities. Typically, rural residents also have much more limited access to health care than their urban counterparts, resulting in lower life expectancy and higher infant mortality rates in rural areas.

The technological context is defined by several major trends in telecommunications, including:

- *Capacity*: Satellites and optical fiber have enormous capacity to carry information, ranging from thousands of telephone calls to financial and scientific data, to motion video for distance education, to highly detailed images for remote medical diagnosis.
- *Digitization*: Any type of information, including voice and video, can be sent as a stream of bits.
- *Convergence*: The convergence of telecommunications, data processing, and imaging technologies is ushering in the era of multimedia, in which voice, data, and images may be combined according to the needs of users.
- *Ubiquity*: Advances in wireless technology ranging from satellites to cellular radio make it possible to provide reliable communications virtually anywhere.

Among the recent technological innovations that can make rural service more reliable and cheaper to provide are:

- *Wireless technologies* such as cellular radio and rural radio subscriber systems
- *VSATs* (very small aperture satellite terminals)
- *Digital compression* e.g. using low earth orbit (LEO) satellites
- *Voice messaging* e.g. a means of providing "virtual telephone service" to people still without individual telephone service.

The Role of Telecommunications in Development: An Overview

If information is critical to development, then telecommunications, as a means of sharing information, is not simply a connection between people, but a link in the chain of the development process itself. The role of telecommunications in transmitting information can be particularly significant in rural areas where alternative means of obtaining and conveying information such as personal contact, transport, and postal services are likely to be less accessible.

In the 1970s, several studies noted a high correlation between economic growth and telecommunications investment. However, these studies did not answer the chicken-and-egg question: Did telecommunications investment contribute to economic growth, and/or did economic growth result in increased telecommunications investment?

The first major study to address the causality issue underlying the correlation between telecommunications investment and economic growth found not only that telecommunications investment did increase as economies grew, but also that telecommunications made a small but significant contribution to economic development. The implication was that early investment in telecommunications could contribute to economic growth.

Using the same methodology, it was estimated that the benefits of the U.S. Rural Electrification Administration (REA) telephone loan program were six to seven times higher than costs to the government in interest subsidies. A further analysis showed that not only did increases in output or GNP level lead to increases in investment in telecommunications, but that the converse is also true: increases in telecommunications investment stimulate overall economic growth. Findings from a 1993 study suggest that investment in telecommunications infrastructure is causally related to the national total factor productivity and that contributions to aggregate and sector productivity growth rates from telecommunications advancements are both quantifiable and substantial.

Benefits of telecommunications may be grouped under several categories, including the following:

- Market information for buying and selling
- Transport efficiency and regional development
- Isolation and emergency security
- Coordination of international activity, including business, tourism, and international organizations.

To summarize, instantaneous communication can help improve:

- *Efficiency,* or the ratio of output to cost
- *Effectiveness,* or the quality of products and services
- *Equity,* or the distribution of benefits throughout the society.

Regional Analyses and Case Studies

Several studies from western Europe and North America support threshold theories that telecommunications is a complement in the development process, i.e., certain levels of basic infrastructure as well as organizational activity are generally required for the indirect benefits of telecommunications to be realized. In other words, telecommunications is a necessary but not a sufficient condition for rural economic development.

Telecommunications may also serve as a *catalyst* at certain stages of the rural development process, becoming particularly important when other innovations are introduced such as improved farming practices, lines of credit, incentives for decentralization, and diversification of the rural economic base.

Several studies indicate that the economic benefits of telecommunications are related to distance and density, so that benefits are proportionately greater where telephone density is low and alternatives means to communicate are expensive and/or time consuming. Field research from developing countries cites examples of rural residents keeping in touch with family members who have gone to the city or overseas to seek work, families contacting relatives scattered in many rural communities, and field staff such as nurses and teachers in rural posts keeping in touch with colleagues and family members. It appears that telecommunications is one of several factors that may tend to reduce staff turnover, along with other benefits as pay bonuses, travel, and continuing education.

Telecommunications Users

Several studies indicate that the most frequent users of rural telecommunications are better educated than average rural residents, and may have higher incomes or be engaged in progressive agriculture or other employment where access to information is important. Some studies show that better-educated users call farther afield; others indicate that the most common characteristic of telecommunications users is that they are "information seekers" regardless of education or income source.

One study found that residential telephones appear to contribute more to economic development than business telephones. One possible explanation may be that in many developing countries, residential phones are often used for business activities and are available 24 hours per day; whereas business phones are available only during work hours.

Rural Projects in Industrialized Countries

Industrialized countries in Europe and North America have supported rural telecommunications pilot projects and trials. Major European Union projects include STAR (Special Telecommunications Action for the Regions) and ORA (Opportunities for Rural Areas), which are intended to create a solid basis of knowledge and expertise for subsequent implementation of suitable telematic systems in specific rural areas.

Another European-initiated application is telecottages, which originated in Scandinavian countries. These are typically small buildings or rooms in rural communities equipped with a few personal computers, printers, modems and a fax machine. Although there has not been a systematic evaluation of costs and benefits, one consistent finding is that an important element is the resource person who provides training and other guidance. It appears that other factors are needed for the project such as local entrepreneurs, business experience, and contacts with potential contractors who could provide rural information services such as data entry and telemarketing.

Canada has supported rural telecommunications projects for distance education, telemedicine, and teleworking, many of them using Canadian domestic satellites to link isolated and remote areas. In the United States, the Rural Utilities Service (formerly Rural Electrification Administration) has established a Distance Learning and Medical Grant Program. The U.S. Department of Education supports distance education through its Star Schools Program. The National Telecommunications and Information Administration (NTIA) has awarded infrastructure grants for the planning and construction of telecommunications networks for educational, health, library, and other social services. Some U.S. states are combining high quality infrastructure with attractive rural settings to attract "footloose" entrepreneurs such as consultants, architects, and software developers who appreciate the quality of rural life.

Telecommunications and Rural Sectors

Agriculture. In the United States, access to computerized databases has helped farmers to obtain higher prices for their crops and to enter foreign markets. Examples of profitable use of market information in developing regions range from Brazilian coffee growers who contact the Chicago futures exchange to farmers in the Nile Delta who take orders from merchants in Alexandria by telephone, to Sri Lankan farmers who can obtain market information from Colombo.

Education. Radio is still used extensively for distance education in many developing countries, while televised courses are more often found in industrial countries. However, the major change in this area has been in the growth of interactive applications, ranging from audio tutorials and student interaction to computer conferencing and in some limited applications, fully interactive video. Corporate trainers have predicted that distance learning can cut training costs in half, while one study estimated that the US education sector saved $76.1 billion through the use of telecommunications from 1963 to 1991.

Four basic models have been developed to use telecommunications in education:

- *Curriculum-sharing*: links schools so that courses available at one school can be taught to students at another location, typically using microwave or optical fiber
- *Outside expert*: delivers courses not available in rural schools, typically via satellite, using phone lines for voice or computer interaction with students
- *Virtual classroom*: delivers content to students in the workplace or at home; technologies range from satellite video to interactive audio and computer conferencing
- *Educational broker*: makes available seminars and courses from a variety of sources, usually via satellite.

Health Care. Telecommunications is used for several different functions in support of health care delivery:

- *Consultation*: to give advice to rural health workers, or directly to isolated patients
- *Data ollection and record keeping*
- *Training*: of health care workers
- *Education*: of target populations including expectant mothers, mothers of young children, groups susceptible to contagious diseases and the like.

Emergency communications are often cited as critically important; such social benefits may precede economic benefits in less developed areas. For both education and health care, incentives are often critical for sector adoption.

Employment and Entrepreneurship. Rural businesses in the US are increasingly using telecommunications networks for competitive advantage. Information-intensive businesses such as "back offices", telemarketing, customer support and reservation systems have relocated to rural areas with high quality and affordable telecommunications. However, other highly ranked relocation factors include access to airports and highways, labor costs and skills, and proximity to major markets. While developing countries do not have the range of rural economic activities found in industrial countries, there is evidence that reliable telecommunications can help attract data entry businesses and support tourism.

Travel, Transportation and Energy. Telecommunications offers important benefits in overcoming the distance disadvantage that hampers business activities and service providers in rural and remote areas. Research that focuses on travel/transport substitution measures benefits in terms of time saved, sometimes converted to monetary amounts; another approach is to estimate the value of energy saved if the number of trips could be reduced. The time value is most dramatic when money is directly involved, for example, in timing transfers of funds between banks.

Women and Rural Telecommunications. In many parts of the developing world, women do much of the agricultural work. In such cases, the benefits of telecommunications in getting information about prices and markets, and getting expert advice from extension agents should apply to women. while studies on direct benefits to women are few, it appears that women do benefit either as participants (teachers, health care workers, farmers, etc.) or indirectly through information that benefits them as mothers, entrepreneurs, employees, community residents, etc.

Implications for Planning

In regard to planning, this review concludes that telecommunications planning cannot be done in isolation if the intent is to derive maximum benefits for rural development. Planning must be integrated across sectors, that with it must involve other agencies in such sectors as education, health and social services, agriculture, and economic development. To summarize, for coordinated communications planning to occur:

- Telecommunications administrations must be informed about national priorities and development plans.
- National planners must be made aware of the importance of telecommunications infrastructure to national development.
- Resources for extension and improvement of facilities must be allocated to the telecommunications sector, and resources for training and utilization of facilities must be included in the sector budgets.
- Potential users must be made aware of the services available and how they could benefit them.

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