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AN ANALYSIS OF THE COSTS AND REVENUES OF RURAL TELECOMMUNICATIONS SYSTEMS

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PREFACE

The past three decades have seen a revolution in telecommunications—from the first television transmissions via satellite in the early 1960s to the video- and computer-conferencing activities of the 1980s. Today, telecommunications serve as the "nervous system" of many societies; they are multi-purpose in use and pervasive in effect. Telecommunications provide significant social and economic benefits critical to improving and maintaining national economies and, by extension, the quality of life.

In the relatively short time that communication satellites have been with us, satellite technology has displayed amazing range and versatility. The technology has demonstrated its value to telephone and telex communications, radio and television broadcasting, business communications, and the delivery of public services to isolated communities.

It has also proved a sound financial and, according to many, productive development investment. Indeed, telecommunications' vital contribution to development was noted in The Missing Link, a report by the ITU's Independent Commission for Worldwide Telecommunications Development:

> Henceforth no development program of any country should be regarded as balanced, properly integrated or likely to be effective unless it includes a full and appropriate role for telecommunications and accords a corresponding priority to the improvement and expansion of telecommunication.

In the last decade, it has become evident that the developing world also considers telecommunications a worthwhile investment. Indonesia, India, Brazil, Mexico, China, and a coalition of 22 Arab nations have launched their own satellites. Through INTELSAT, 27 other developing nations have established internal satellite-based communications systems.

Satellite communications offer the potential to reach the isolated and rural areas which characterize much of the Third World and which have long remained outside the vital flow of information.

In 1980 the U.S. Agency for International Development initiated the AID Rural Satellite Program to explore the potential of telecommunications as a means of extending scarce expert resources and expanding educational opportunities to remote and rural areas. Building on simple, interactive, and inexpensive telephone-based technologies, the Program developed teleconferencing systems for use as a development tool. Three pilot projects—in Indonesia, the West Indies, and Peru—were implemented to test and demonstrate that audioteleconferencing could reliably and affordably support development activities in education, health, and agriculture.

In Indonesia and the West Indies, distance education programs were established with national universities. Linking 13 distant universities in Indonesia and six universities in the West Indies, audioconferencing systems are used to provide academic courses to university students, to upgrade faculty skills through in-service training programs, and to facilitate administrative and institutional communication. The effect is to make the expert resources of each institution available to all members of the network, thus multiplying each professional's outreach and effectiveness. Over 15 courses are taught each semester to thousands of university students in Indonesia. The University of the West Indies trained over 500 doctors and nurses in 1985 and doubled the annual number of teaching certificates awarded because of expanded training opportunities offered by the teleconferencing system.

In Peru, the Rural Satellite Program provided basic telephone service to seven rural communities and established an audioconferencing link for in-service training of health workers, agriculture extension agents, and teachers--connecting them for the first time with experts in the capital city of Lima. Over 300 audioconferences were requested by field personnel in 1985; over 92 percent of users indicated that the training improved their work.

The experiences of the Rural Satellite Program in Indonesia, the West Indies, and Peru have shown that:

- Telecommunications can be adapted to provide affordable communication services in rural areas and provide a cost-effective means of extending social services to these areas.

- Telephone-based technologies can be made to operate reliably in the developing world. The RSP pilot project networks operate at a 90 to 98 percent reliability rate.

- Teleconferencing, specifically audioconferencing, is an effective means of providing quality instruction and essential training to rural and isolated public service personnel.

Beyond these major research conclusions, the Rural Satellite Program projects have afforded valuable lessons in the planning and implementation of distance education programs, the design of appropriate technical systems, the programmatic and technical management required by these programs, the process of technology transfer, and the identification of the most suitable uses and audiences.

The following report, one of a monograph series, describes one aspect of the experience of the Rural Satellite Program.

INTRODUCTION

One of the mandates of AID's Rural Satellite Program has been to demonstrate that satellite-based rural telecommunications systems are affordable as part of a national communications development effort. Affordability does not refer to the issue of cost/benefits or even cost/effectiveness. Rather, it is a budgetary measurement of the magnitude of capital investment and operating expenditures required for rural telecommunications.

This report reviews the cost elements and revenues associated with rural satellite systems. It draws largely upon data generated by AID's Rural Satellite Program and is supplemented with information about new developments in satellite and earth station costs provided by various service providers. Finally, a study of a proposed telecommunications system in the Philippines provides a concrete example of the possible financial structure of a rural telecommunications system.

It is generally assumed that the cost of rural telecommunications is high compared with urban systems, while producing relatively low revenues due to low traffic potentials. The high cost associated with rural service relates to problems both of scale and terrain. Telecommunications transmission systems tend to exhibit substantial economies of scale--the larger the system, the lower the per channel cost. Because of their low population density, rural areas cannot utilize the most modern telecommunications technologies as efficiently as urban areas. This leads to higher unit costs.

Remote locations and difficult-to-reach terrain also raise costs. Because rural communities are often isolated by jungles and mountains, the construction and maintenance of microwave or openwire systems can be very costly. Microwave systems in particular require the use of "repeaters" which may be located in isolated locations, making maintenance and power supply very difficult.

The isolation of villages created operational problems for earlier technologies. Before the development of solid state technology, rural telephone systems required a fairly substantial power supply along with continuing maintenance. Obviously, the smaller the village, the greater the maintenance expense per telephone.

The introduction of solid state technology has greatly changed the technological possibilities and costs. Solid state equipment requires less power, is modular in design, and is generally reliable. As a result, it is less expensive to operate the system, and fewer trained technicians are required for maintenance in the field.

For rural communications, however, the major breakthrough has been the development of satellite technology. A satellite is basically a microwave repeater in orbit. Any point within the satellite's "footprint" (area of coverage) from which it can be "seen" can have access to it and connect to any other point accessing the satellite. In effect, distance and terrain become irrelevant. Rather than working through terrestrial networks with their branching requirements and problematic repeaters, a point can be added to the network simply by installing an earth station. Also, the satellite is extremely reliable (there have been few commercial in-orbit failures during any satellite's expected life), and earth station technology is increasingly reliable. All this makes satellites very promising for rural communications.

With the combination of new distribution and switching technologies designed specifically for rural use and the introduction of satellite transmission systems, it is possible to introduce modern telephone service to remote villages. Such services can run the gamut from telephony to teleconferencing, including data transmission, video reception, and telegraphy. Cost elements of a satellite-based rural telecommunications system are reviewed below.

COST ELEMENTS

Space Segment

The space segment's costs depend on choices made in the system design. A key factor in reviewing space segment costs is the amount of transmission power of the satellite. A satellite area can cover the surface of the globe which it "sees" or specific parts of that surface. The wider the area covered by the satellite and the more the sites which can be served, the less the power received at any one site. The levels of power, or the EIRP (effective isotropically radiated power), have a decisive effect on satellite usage and earth station characteristics. The larger the satellite footprint, the weaker the signal received on the ground. The weaker the signal, the larger the earth station required. And, of course, the stronger the satellite signal, the smaller the earth station required. However, the smaller the earth station, the fewer channels it can utilize.

By increasing the available power, it is possible to increase the efficiency of the transponder (the segment of a satellite which receives and transmits signals) utilization for particular types of earth stations. Because the INTELSAT system has very wide coverage of the earth, its satellites' EIRP is relatively low. Thus, INTELSAT's users must access this space segment with relatively large earth stations which can compensate for the low EIRP. However, while smaller earth stations can be used with the INTELSAT system, the number of satellite channels that can be utilized decreases as the earth station size decreases.

Increasing the EIRP by raising the satellite's power or by focusing the power allows smaller earth stations to access the satellite and utilize the transponder more efficiently, thus achieving overall economies. However, the tradeoffs between power and earth station size are not always clearly defined. They depend very much on the space segment's costs and the size of the envisioned ground segment.

Space segment costs are also affected by the intensity of transponder utilization, and utilization is affected by several factors. First, there is the loading based on the nature of the ground segment and modulation. Ostensibly, managers will try to load the transponder as efficiently as possible within the constraints of the satellite's power and the earth stations' characteristics. However, as satellite capacity is generally supplied in "lumps" (e.g., a portion of a transponder), there may be more capacity than there are channels to place in it. Because the space costs are fixed, utilization costs will be higher.

Second, changing modulation techniques can affect loading. For example, moving from Single Carrier Per Channel (SCPC) to Compandered Single Side-band (SSB) can increase the potential transponder loading from two to ten times. Similarly, decreasing the frequency size of voice channels or moving to digital SCPC can affect the transponder's capacity. These decisions must be made based on factors relating to tradeoffs between space segment and ground segment costs, as well as capacity requirements. It makes little sense to utilize compandered SSB if current capacity is not being fully utilized. However, it makes great sense if current capacity is almost saturated and switching to compandered modulation leads to major savings in future space segment costs.

Third, changing the way users access the satellite can improve overall loading efficiency. For example, using voice-activated circuits greatly increases the number of circuits which can be loaded on a transponder by decreasing the possibilities of intermodulation interference.

Fourth, Demand Assigned Multiple Access (DAMA) can increase the transponder efficiency by increasing the number of users who can utilize it. While most satellite systems use fixed assignments, that is, specific frequencies assigned to specific links between earth stations, it is possible to utilize a computerized system which assigns a frequency for a linkage upon demand. Thus, each node in the system only calls upon satellite capacity when necessary, freeing the overall transponder on a flexible basis. The tradeoff is that DAMA technology continues to be costly and greatly increases the cost of the ground network when utilized widely. Again, there must be a calculation of the tradeoff between the cost of the space segment and the cost of the ground segment.

"Fill" is a critical issue in assessing space segment costs. A small user or a small group of users may have difficulty filling an entire satellite during the early development of a system. Both the Andean nations in Latin America and many African nations have been reviewing the possibility of developing regional or multi-user systems. The advantage of such systems is that they can aggregate the relatively small demand of individual nations into sufficient volume to make a satellite system economically attractive.

Such systems have been offered by INTELSAT through its domestic leases for over ten years and are also offered by regional systems such as Palapa for the ASEAN members and Arabsat for the Arab states. The major differences between INTELSAT and the other systems are in terms of power and polarization. INTELSAT's domestic leases utilize spare satellite capacity. As this capacity was designed for international use, with the requirement for wide connectivity, the EIRP is relatively low. INTELSAT pioneered the use of circular polarization. The rest of the satellite industry, which developed some years later, utilizes the far more economical linear polarization. As a result, antenna feeds for use with INTELSAT are more costly.

Domestic and regional systems make capacity available on either a leased or purchased basis, as discussed below. These systems, such as Palapa, ARABSAT, and the proposed PANAMSAT system, are designed to provide service to very specific regions and, thus, focus power to those areas. As a result, they offer far higher power than INTELSAT (usually on the order of ten times greater) to users.

In comparing the cost of INTELSAT and domestic systems the reader should be cautioned that the numbers are not directly comparable because of the difference in ground segment costs, transponder loading, and basic assumptions which would be made in using each system.

INTELSAT's lease policies have become increasingly flexible. While in the past leases were restricted to whole or half transponders, there are now a variety of available leases including leased channels. There are also leases which provide non-preemptible services and, what are in effect, proprietary leases for unwarranted and unprotected transponders. The non-preemptible leases are more costly than the leases discussed below. The proprietary leases are the least expensive form of service offered.

The annual transponder lease for member countries is $680,000 for a 36 MHZ global or hemi beam, and $1,360,000 for a full 72 MHZ transponder.[1] These transponders may be interrupted by higher priority INTELSAT customers in the case of a satellite failure.

Alternately, INTELSAT has introduced a service for rural communications, called Vista. This service is leased on a per voice channel basis and is available for $3,180 per voice channel per year. Leasing on a channel basis is the lowest existing level of service.

The annual costs of domestic or regional systems vary according to the specific system. PERUMTEL, the operator of the Palapa system, has generally followed a policy of pricing transponder leases at just under INTELSAT's price to entice the other ASEAN nations to use the system. In 1982 the Philippines paid an annual charge of approximately $800,000 per 36 MHZ transponder.

Apart from the existing systems, a new system proposed by PANAMSAT may sell full transponders to Latin American nations for approximately $6,000,000 per transponder with an annual operations charge of $100,000 per transponder. The annual cost of such transponders, assuming a 12 percent interest rate, would be approximately $1,200,000. These transponders will have a ten-year life and cannot be interrupted by other customers.

Satellite-Related Earth Station Costs

The choice of ground segment is tied to several variables, including use of the space segment, number of circuits to be carried by each earth station, power requirements, and operating environment. There is no simple formula to make this choice easy, although experience in the United States, Canada, Indonesia, and India offers possible approaches.

In discussing earth station size, one should first examine some key cost variables. First is antenna size. The larger the antenna, the greater the capital cost. The reason should be obvious--a larger antenna costs more to manufacture and to install. At about seven or eight meters motorized mounts are required to move the antenna. In general, if the antenna is larger than five meters, construction equipment is needed to actually erect the antenna. Smaller antennas can be erected using local labor at a much lower cost, particularly in remote areas.

A second cost component is the power requirement. While power-generating equipment per se is not costly, power supply is problematic in rural areas, thus favoring the minimization of power requirements. Earth stations by themselves generally use little power. The small, rural earth station used by AID in Indonesia requires only 430 watts, less power than that needed by an ordinary steam iron. Larger rural stations for use with INTELSAT require substantially more power due largely to their need for air conditioning and their greater uplink (transmission from earth stations to satellite) power requirements. Overall, power requirements will increase as the number of channels installed in each earth station increases.

Power requirements escalate when air conditioning and lighting are required. Air conditioning is required when the electronic equipment produces more heat than can easily be dispersed with convection or blower systems as happens, for example, when non-solid state amplifiers are used. Air conditioning and lighting are both required if the earth station requires permanent staffing and the environment is warm and/or humid. Security requirements may call for the installation of perimeter lighting. Air conditioning and lighting can more than triple power costs.

Power requirements under 500 watts can be met with photovoltaic or wind generators, but larger power requirements become more problematic. As power requirements increase, greater quantities of fuel and larger, more costly, and complex generators are required.

Third, the station's reliability affects costs. Reliability is generally increased through redundant equipment. This means that certain pieces of equipment are provided in pairs so that in case of a failure, the station can switch to the spare unit. This procedure obviously raises system costs. Thus, an earth station with full redundancy, which will have virtually no "down time," will be considerably more expensive than an earth station with little redundancy but somewhat more down time. The question of how much down time can be tolerated is a matter of judgment relating to national telephone standards and cost assessments. For example, the Alaskan rural telephone system has a substantial amount of redundancy built in to ensure that reliability remains close to the prevailing "toll standards" in the rest of the United States. These stations are also subsidized by the overall U.S. telephone industry.

The earth station supplied by AID to the Indonesian Government for the Indonesia Satellite Project has no redundancy and, as a result, may be "off the air" for several hours each month. It was designed to be as inexpensive as possible and still provide reasonably reliable rural service.

Fourth, staffing requirements affect operating costs. Staffing is related to the station's operating requirements, decisions about reliability, and national policies. With the advent of solid state devices, many rural stations can be left unattended, with occasional visits by technicians to ensure reliable operations. Obviously, the greater the station's redundancy, the less the need for attended operation. However, even with little redundancy, the creation of regional maintenance centers, combined with adequate transportation, can keep stations operating at a relatively acceptable level. Aside from the costs of actually paying the staff, regional centers generally require housing in remote villages.

Earth station cost estimates are based on historical assumptions and practices--and these may be altered with changes in satellite and ground technology. Telephone thin-route earth stations used with domestic satellites generally have been 4.6-5.0 meters in diameter, with two SCPC channels, each requiring 0.4-watt transmitters. These stations will be expandable to four channels without the addition of a larger transmitter. They require 450 watts of power and are assumed to operate without air conditioning and with minimal lighting. Minimum shelter is needed for the equipment. This type of station has been quoted at $90,000 by Scientific Atlanta. Assuming the purchase of spare parts, test equipment, and other installation equipment, the total cost, exclusive of installation, is estimated to be at $125,000.

INTELSAT has two basic stations for use with domestic systems, its Standard D1 for Vista service and the Standard Z for domestic leases. The Standard D1 has an antenna diameter of approximately five meters. These stations are specified for operation using SCPC/FM, with voice activation. Using a global beam transponder with the high gain setting, they will require a high power amplifier (HPA) which can deliver approximately 100 watts for four voice channels. If only one or two voice channels are considered, roughly 20-watt solid state power amplifiers should be satisfactory.

INTELSAT estimates that the cost for a Standard D1 earth station equipped to handle up to four voice circuits will eventually be $150,000, including installation, testing, documentation, and essential spare parts. Although it is not yet available at this price and D1 earth stations have been reported to cost more than $200,000, INTELSAT initiated a program in 1986 of group procurement of D1 stations in an attempt to reduce the price of the stations.

Standard Z stations have typically been from six to eight meters in diameter, although INTELSAT has indicated that they can be the same size as the Standard D1 stations, but with a somewhat different antenna feed, reflecting the stricter axial ratio requirements for domestic leases. Estimated costs for the Standard Z would be above $200,000 for two to four SCPC channels, uninstalled. The costs for telephone thin-route earth stations are summarized in Table 1 at the end of this report.

Adding Video Reception

After the basic earth station is installed, a video receiver can be added to allow video distribution. The video receiver, with the necessary power splitter, will cost less than $3,000, depending on the model. Using anything larger than a two-meter earth station operating off of a domestic satellite will provide very high video quality.

Video reception will cost the same with INTELSAT, but the quality of video reception will be marginal operating off of an antenna smaller than seven or eight meters. This difference is caused by the lower power from the satellite. If the domestic video lease uses less than the full 29 dbw of a 72 MHZ Hemispheric Beam transponder, a substantially larger antenna will be required for video than for telephony.

"Television Receive Only" Earth Stations

Many developing countries are interested in expanding their rural broadcasting networks. Because the cost of "Television Receive Only" (TVRO) stations has decreased, such networks have become increasingly attractive.

The cost of TVROs varies directly with the level of power from the satellite. TVROs working with domestic satellites can be substantially smaller, and hence less expensive, than stations working with INTELSAT. Generally, a domestic satellite transmitting one video signal on a 36 MHZ transponder can transmit into a two-meter earth station for home reception, and into a three-meter station for broadcast quality reception.

INTELSAT, utilizing the power of a full 72 MHZ transponder (approximately 29 dbw), can provide a video signal at threshold (i.e., the minimum signal strength for receiving a signal) into a 5.5-meter antenna, and a broadcast quality signal into an eight meter antenna. Utilizing the power of a 36 MHZ transponder, INTELSAT must broadcast into at least a ten-meter earth station to be at threshold. The costs of TVROs are summarized in Table 1.

Costs of Using INTELSAT Compared to a Domestic Satellite System

Tables 2 and 3 compare space segment and earth station costs for systems based on INTELSAT and PANAMSAT. The latter approximates a domestic system. Two prices are set for INTELSAT, its non-cancellable, protected lease rate, and the cost of a 36 MHZ transponder annualized over seven years. PANAMSAT's price is provided, annualized over ten years (reflecting the satellite's longer life), along with an annual charge of $100,000 for satellite control. All earth station prices are annualized over a 15-year period. In each case, earth station sizes and transponder capacity are based on the available transponder power from each carrier.

Domestic satellite systems are less expensive than a system based on an INTELSAT domestic lease, but they are not universally available. Where they cannot be leased or transponders are not sold, INTELSAT offers the least expensive means of establishing an initial space segment.

Switching and Distribution Costs of the Terrestrial Segment

This section reviews some of the cost considerations for the terrestrial distribution system of a satellite-based telecommunications system. Given the very large number of variables which can affect these costs, specific equipment costs are not provided. However, illustrative costs for a rural telecommunications system, including distribution and switching costs, are provided in a later section of this report.

Public Call Offices

The most basic type of rural telephone center is the Public Call Office (PCO). This generally will be one or more calling booths, placed in a central location where they are available to the public. Although some countries allow people to receive calls at the PCOs, it is obviously difficult to make the necessary arrangements between the caller and the receiver, particularly given the difficulties of placing calls in rural areas. PCOs are primarily a device for initiating calls in situations where there is very little or no local telephone distribution.

PCOs vary in price according to the size of the calling center and the sophistication of the operation. In areas where there is no power, some type of generator or battery system must be installed and maintained. An operator may have to be employed, if only to control the queue and arrange payments.

Generally, assuming that there is an existing building, the PCO itself will cost only a few hundred dollars. Operating costs will vary according to whether there is any power and the type of staffing required.

Switched Systems

Telephone switches allow calls to be distributed from the earth station to offices and homes. There probably are many communities in rural areas which can financially support distributed telephone services. There are distinct advantages to introducing switching. It allows calls to be originated more easily, easier termination of calls coming from outside of the village, intra-village calling, and, in general, it introduces far more intensive use of the system, thus offering the possibility of greater revenue generation. This assumes that sufficient trunking is available in the satellite system to allow such growth to occur.

Switching technology is in a rapid state of technological change. A good example is the appearance of digital Stored-Program Control (SPC) within five years of the introduction of analog SPC offices. Manufacturers can be expected to introduce new systems at an increasing rate, primarily because the newer electronic components and devices reduce hardware manufacturing costs. Large Scale Integration and Very Large Scale Integration costs are coming down rapidly, bringing the cost of small electronic switching devices much closer to the cost of their electro-mechanical counterparts. Furthermore, the newer devices are size and fuel efficient, dramatically reducing operating costs for both buildings and energy.

Modern automatic switches using SPC techniques allow flexibility in features, maintenance, and service that was impossible ten years ago. Furthermore, the advent of distributed processing allows systems to be designed with a minimum of common hardware, making them more economical for small users.

As a result, digital SPC is becoming more popular in developing nations, largely supplanting the older electro-mechanical technology. Organizations like the World Bank and national regulatory agencies have been increasingly encouraging developing nations to utilize SPC and other digital devices as a means of upgrading their systems. The World Bank estimates that an SPC switch installed will cost approximately $800 to $1,000 per line.

However, there is still a great deal of electro-mechanical and manual switching gear available in the developing world which, with refurbishing, may provide years of reasonable and economical service. Reasons for delaying the introduction of SPC exchanges relate to the problem of developing adequate overall maintenance routines and the traffic patterns in rural areas in general. SPC offices are less tolerant of poor outside plant, poor maintenance, and traffic overloads than are electro-mechanical systems. The effect of this intolerance to poor outside plant is to increase the number of outside plant fault reports and accelerate the replacement of old plant. Intolerance to poor maintenance is a function of the high degree of control centralization in the system and the increased possibility of total system outage resulting from accidental or deliberate technician action. Intolerance to traffic overloads probably has little significance in organizations where the grade of service is an engineering decision, but clearly is a factor where financial decisions must be weighed against budgetary factors. Traffic congestion is the normal mode of central office operation in many developing countries. Because the overload characteristics of SPC offices restrict the service to an increasingly large number of lines as traffic levels rise, the average subscriber can actually receive a worse grade of service under traffic overload than the subscriber in an electro-mechanical system. Therefore, it may be best to start service using the refurbished electro-mechanical switches. Restoring these switches will be much less expensive than purchasing expenses. As the system matures, with the replacement of faulty outside plant and an increase in the number of subscribers, it will be desirable to move into an SPC switch.

For the smallest communities, operator-controlled switches may be a reasonable means of providing service economically. Given the very low cost of labor in most rural areas, it is likely that the use of a manual switch with an operator will still compare favorably with an automatic switch. Further, given the trunk shortages which often characterize rural areas, an operator may provide a reasonable approach to assigning trunks and rationalizing congestion until an overall engineering approach can be established for permanently relieving trunk congestion.

Distribution Plant

Outside plant, or the cable which connects the subscriber to the central office, is often the most problematic part of a telephone system. First, there is the problem of distance and terrain for installing the cable. The farther the subscriber from the central office, particularly if there is difficult terrain, the more expensive the system. This is obviously a problem in rural areas where there may be considerable distances between subscribers.

Second, outside plant is susceptible to weather, animal and insect damage, vandalism, and accidents. These problems are particularly troublesome in tropical areas where there appears to be a running war between telephone companies and various insects which find cable insulation ideal habitats.

Automatic exchanges are logically situated in concentrated or high density subscriber areas where the majority of subscribers can be connected to the central exchange by means of a cable system. As long as the distance from the central exchange to the subscriber is only a few kilometers, the cable plant is the most economical way to connect the subscribers. However, as the distance to subscribers increases, passive and active electrical devices are required to maintain acceptable telephone performance, and consequently the cost per subscriber increases dramatically. The World Bank estimates that the average cost for outside plant, assuming the subscribers are concentrated around the switch, is approximately $300 to $400 per subscriber line.

A means of bypassing the cable problem, while greatly expanding the number of customers who can be served out of a single central office, is subscriber radio. Subscriber radio equipment design is generally based on a random multiple-access principle consisting of a point-to-multipoint radio distribution. A base station radiates the connection from the exchange in a concentric pattern covering a radius of 40 to 60 km depending on selected frequencies, topography, and economics. Remote subscriber units radio back the connection using small directional antennas and low-power transmitters. The system is designed to provide fully transparent interfaces between the rural subscriber and the central exchange, including the numbering plan.

The transmission quality and method of operation of the rural telephone set using subscriber radio normally are the same as for those sets connected to an all-cable plant. The cost per subscriber is independent of the distance between exchange and subscriber, but directly dependent on the number of subscribers served by a common remote subscriber unit.

Rural subscriber radio techniques are increasingly being utilized to reduce the cost of providing service to isolated subscribers. The subscriber radio technique provides a means of using the central exchange with its earth station trunk lines to service small communities of subscribers at a lower cost per subscriber than through conventional methods. Also, establishing a cluster concept (i.e., service to small communities) allows upgrading of remote locations as the system evolves both in increased subscriber demand and in requirements for additional locations. All maintenance and administrative functions for the radio can be handled from the central office; there is no requirement to staff the remote sites. Subscriber radio can also be installed more quickly than cable plant. Thus, subscriber radio can be used to provide interim service while cable routes are being constructed and can then be moved to other locations.

Video

As already noted, adding video reception on the earth station will cost approximately $3,000 regardless of whether an INTELSAT or domestic satellite is used. If INTELSAT is used, however, careful attention must be given to antenna size. A five-meter antenna for use with Vista and the six meter antennas used in domestic service cannot provide a video signal of sufficient quality for retransmission, if a signal is produced at all. If retransmission of the video signal is desired, attention might be given to a low power television transmitter. An approximate cost for such a system, exclusive of any program origination facilities, is $70,000.

End Equipment and Special Applications

A relatively new telecommunications service which offers promise for rural applications is teleconferencing. This service is relatively inexpensive to add to other telecommunications activities and offers a very useful service in rural areas where transportation to meetings is difficult or costly.

The basic components of a teleconferencing system are a series of microphones, an amplifier, speakers, and a device for interconnecting with the telephone network. In addition, a bridge in some central location for connecting the conference sites is required unless the satellite system is used as a bridge. The bridge will allow all of the participants in a teleconference to call a common location and then have their signals combined into what appears to be a common circuit. The major problems with this type of system are the cost and the technical quality. Each user pays the standard long distance charge. Users may have trouble dialing the number if they are semi-literate, and the quality of the connections, even in the best of systems, will be inconsistent.

If a dedicated teleconferencing system is designed, then the least expensive route is to use the satellite to bridge the circuits. However, this will require that satellite circuits be set aside for teleconferencing, removing the circuits from full economic use for commercial telephony. A dedicated system should have fewer technical problems than a dial-up system but its cost effectiveness will vary directly with use. Because transmission costs are fixed, there will be a need to generate as much traffic as possible to bring down the unit costs. Dedicated systems will generally require some form of network controller for signalling remote sites, connecting specific pieces of equipment, and controlling output levels.

The actual equipment used for teleconferencing will vary with the types of information required and the money available. It may be desirable to add some form of interactive graphics, particularly when teaching is involved. These graphics may be slow-scan video or "electronic blackboards"--both devices which allow the transmission, often interactive, of writing and other graphics.

If documents must be transmitted, telecopier machines or microcomputers may be included in the network. In most cases it will not be possible to speak and use any of the graphic technologies simultaneously on a single circuit. Thus, the addition of graphics, whether an electronic blackboard or a telecopier, may require the addition of more transmission circuits.

Finally, in looking at teleconferencing systems it is necessary to include the construction of a building or conferencing room. In Peru the teleconferencing rooms varied from very basic rooms located in the market to somewhat more elegant conferencing rooms at the telephone company. A teleconferencing room can consist of basic acoustic treatment and tables and chairs. However, if the room is used for ceremonial or more "official" uses, more will have to be expended for decor.

Table 4 shows the costs of the teleconferencing system provided in the AID Indonesia Satellite Project. These costs do not include the initial costs of engineering or installation. In addition, funds must be budgeted for spare parts, shipping, and the like. An analysis of University of the West Indies Distance Teaching Experiment (UWIDITE) expenses resulted in the following, which are valid for similar projects:

Item	Loading Factor
Spare Parts	10.0%
Shipping to Port	4.3%
Insurance	0.5%
Installation Materials	6.0%
Miscellaneous	7.0%
TOTAL	27.8%

REVENUES

Revenues are difficult to discuss because they depend on qualitative and, generally, political judgments of pricing policy. The prices for telecommunications services are almost always set by the government in developing nations. The prices are usually set to favor urban users and, more importantly, often deviate from real costs for political reasons. Thus, rates may not increase along with inflation. If the currency is devaluing as it inflates, more local currency is needed to pay the same foreign debt while the local currency account is not increasing at the same rate as the devaluation. As telecommunications investment requires a relatively high foreign exchange component, such policies can have serious financial consequences for the telecommunications company.

Rate levels are also a function of the political decisions. Attempting to set rates to fully recover costs and earn a commercial rate of return is generally an admirable goal, but one which can make rural services unaffordable. Rates nationwide can be set to recover costs, but only if the relatively more affluent urban areas subsidize the far less affluent rural areas. Doing this, however, requires a national policy to foster this type of distribution.

There are three basic sources of revenues: subscriber fees (usually fixed), local service fees, and long distance fees. The first is a payment by a subscriber to establish service--in effect, a purchase of stock in the telephone company to pay for the telephone's capital costs. The relation between the fee and actual incremental capital requirements varies from country to country. This is an important source of investment capital, particularly for establishing local telephone networks. It can, however, depress the demand for telephone service in capital-scarce rural communities.

Local telephone fees are the payments made on a monthly basis for the maintenance of residential or business telephone service. Because of metering costs, this fee is rarely based on usage and is usually set at some flat rate.

Long distance fees are obviously usage sensitive, both to distance and to time of day. These are the fees which may be most crucial for rural usage, given the importance PCOs will play for those who cannot afford telephones in their homes or businesses.[2]

There are a series of secondary revenues which may be generated to make rural service more viable. First, private line services for businesses may be useful sources of revenues. In many remote areas mining operations, plantations, or large government installations require reliable communications. These enterprises often utilize high frequency radio systems for barely adequate service. The telecommunications supplier can make these enterprises major sources of revenues by supplying them dedicated systems using earth stations and connecting technologies like subscriber radio.

Second, attempts can be made to significantly increase government use of the system. The government is often the largest economic presence in rural areas. Its use of the telephone system is often limited, even though there are applications of the system which would lower other government costs. If one examines the costs of running many rural programs in terms of travel, administration, and training costs, there are significant areas for cost reduction simply by using the telephone system. Obtaining some of these "saved costs" as revenues would make the rural system far more economically attractive to the telephone carrier.

Third, there are some innovative areas where revenues could be generated. For example, pay television services might be introduced. Rural areas generally have inadequate television services. AID research in the Philippines found great willingness by rural residents to pay for the introduction of television. Television revenues could significantly ease the financial costs of a rural communications system. Policy problems are raised with pay television if the urban areas receive their television signals without charge. However, if other types of services are provided, the pay television system may not be seen as onerous.

COSTS AND REVENUES OF A SATELLITE-BASED RURAL TELECOMMUNICATIONS SYSTEM IN THE PHILIPPINES

This section presents the results of a cost study of a rural telephone system proposed for the Philippines as part of the Rural Satellite Program (RSP). Although the cost figures are several years old and the system was not implemented, this study provides an idea of what a rural system would cost and the range of revenues which might be available to support it.

The RSP began negotiations with the Government of the Philippines for a satellite demonstration project during 1981. The proposed project was to be installed in the province of Palawan, a very poor and isolated series of islands in the southwest part of the Philippines. The project was to combine the grant of satellite earth stations and related hardware with equipment and operations support from the Philippine Government.

At the request of the Philippine Government, RSP staff members collaborated with the staff of the Philippines Long Distance Telephone Company (PLDT, the long distance carrier), PILTELCO (the franchised telephone carrier in Palawan), and the Domestic Satellite Company (DOMSAT, the operator of domestic satellite facilities) in preparing a study of the economic feasibility of the Palawan project. Although the project's grant component obviously makes aspects of the project's finances different from rural telephone investments which must be wholly financed, the overall financial analysis provides a useful summary of what a rural telephone system may cost and the types of revenues it may produce.

The basic project (Option One) proposed earth stations in the communities of Roxas, Narra, and Brooks Point. A more elaborate proposal (Option Two) was then generated to extend telephone service through subscriber radio to other outlying communities. Finally, to maximize the system revenues, subscriber television and other specialized services were proposed, with the revenues being used to help pay the overhead costs of the satellite system. The costs and revenues of these options are discussed below.

Option One: Telephone Service Restricted to Urban Areas

Telephone Demand

The demand estimates for the basic system were drawn from a PLDT/PILTELCO study of Palawan.[3] Interviews were conducted with potential subscribers in Palawan. PILTELCO then projected the demand in each of the communities through 1987 using an annual growth rate of ten percent. This growth rate was based on experience in Puerto Princesa, the provincial capital, which averaged ten percent growth per year between 1974 and 1978 when the exchange capacity was reached. These estimates were somewhat conservative when compared with other demand studies developed at the same time.[4] However, the PILTELCO estimates were used. Table 5 provides the projected demand for residential and commercial telephone service from 1985, the projected start of system operations, through the year 2000.

Using PILTELCO's estimates as a base, demand growth was projected at ten percent per year through 1990 and six percent thereafter. The lower growth rate reflects the general experience that demand growth slows after the first years of system operation.

Note that the number of subscribers actually receiving service does not grow at a steady rate. In fact, there is no growth in subscribers in Brooks Point between 1992 and 1994. Because it is financially impossible to build a system large enough to handle all possible demand, the Palawan system was designed to meet service needs in an economical manner and does not carry a large amount of plant held in reserve for future use. Expansion was slated to occur at those points where there would be sufficient customers to justify expansion to the next economical level of plant investment. Hence, the number of subscribers at each location would be frozen at the exchange's design capacity until a sufficient demand level was reached to justify the incremental investment.

Treatment of Inflation

There are essentially two ways of addressing the financial feasibility of the proposed system: using "real" costs (that is, costs pegged at a specific year and held constant over the study period) or using nominal costs (that is, costs which are inflated to reflect the costs which will be prevailing throughout the project given assumptions about inflation).

Using real costs offers the advantage of indicating the economic returns to society without the distortions introduced by inflation. Using nominal costs gives a more realistic indication of the actual financial costs which will be incurred in any particular year and indicates the types of policy decisions on rate adjustments which will have to be addressed. Because this study is primarily interested in the financial aspects of rural systems, we have used nominal costs.

A six percent annual inflation rate was assumed for the purposes of cost and revenue projection. In retrospect, this was far too low, but the estimation technique still holds. With this inflationary assumption, rate increases were proposed for every two years (i.e., the first, third, fifth, seventh, ninth, eleventh, thirteenth, and fifteenth years). An extraordinary rate increase of 30 percent was also factored in for the fifth year, to allow the telephone company to "catch up" with regulatory lag in previous rate increases. These regular rate increases were designed to prevent financial distortions resulting from delays in rate adjustments during inflationary periods.[5] Note that the relative cost of locally financed capital diminishes as a result of inflation as capital financing remains constant over the study period. This is a common phenomenon in public utility financing. However, capital costs financed in foreign exchange will increase, possibly not in proportion to inflation if there are devaluations of the national currency against the currency of the debt.

Revenues

Drawing upon the projected demand in Table 5, projected system revenues were based on the 1981 prevailing rates of $5.25[6] per month for residential customers, $8.75

per month for commercial customers, $7.00 for installation fees, and the existing PLDT toll structure.

For the purpose of estimating toll revenue, half of all toll calls are assumed to be to or from Manila and half to or from Puerto Princesa. Thus, the following base toll schedule was used:

To/From Puerto Princesa	Average Rate/Minute
Brooks Point	$0.34
Narra	0.14
Roxas	0.22

The rate from all municipalities to Manila was $0.78/minute. Based on a PLDT study of toll traffic patterns in all of PILTELCO's exchanges, it was assumed that each telephone would generate an average of 45.5 toll minutes per telephone per month. The results of these computations are shown in Table 6.

Capital Costs

Capital costs are shown in Tables 7 and 8. The system is designed to meet the projected demand through the year 2000 by providing a basic, but expandable, plant. The Brooks Point plant was designed to accommodate 300 initial subscribers, with 150 additional lines to be added in 1995. Narra was initially provided with a 300-line central office, but with only 250 lines of outside plant, reflecting the initial levels of demand. Fifty additional lines of outside plant were to be added in 1992, and 150 new lines were to be added in 1998. Roxas was initially to be provided with 150 subscriber lines, then increased by another 150 lines in 1995.

The study assumes the use of the small earth stations provided under an AID grant (note that this does not affect capital recovery costs) and refurbished analog switches provided by PILTELCO. Other capital costs (e.g., microwave capacity to haul traffic from the Manila earth station into the Manila central office) were assumed to be minor because they would be provided within the substantially higher traffic requirements of the PLDT system.[7]

Operating Costs

Annual operating expenses using the 1982 base are listed in Table 9. These estimates were based on discussions with the existing Philippine carriers. The earth station staffing is based on the staffing requirements for the type of earth stations recommended. It was assumed that the telephone system would be in service 24 hours per day, seven days per week, in conformance with Philippine toll practices. All costs are increased by six percent per year, as previously explained. The earth station's spare parts were budgeted at an annual cost of five percent of the facilities' capital cost. This is a standard ratio. This item is deleted from the first two years of operation because spare parts would be covered by the AID grant during the research and demonstration period.

Earth station power was estimated at half the cost of exchange power. The 1981 power cost for the Puerto Princesa exchange was $162.50 per month. It was assumed that all of the municipalities in the project would have commercial power by 1985.

The cost of the DOMSAT earth station facilities in Manila and Puerto Princesa and the space link are shown in Table 10. Satellite costs were excluded from operating expenses during 1985 and 1986. Because DOMSAT will be operating under design capacity at least through 1987, the addition of the proposed system to DOMSAT's system would impose no incremental costs on the space segment or on the earth stations. AID would provide the necessary channel equipment for the Puerto Princesa and Manila earth stations. As such, no charges are levied against the project until DOMSAT's existing facilities are fully utilized and incremental capacity is required. DOMSAT has projected that its system will be fully utilized in 1987.

The treatment of DOMSAT's charges to the project is somewhat different from that of other costs discussed in this study. DOMSAT's costs are largely tied to its capital costs and the cost of the leased space segment from PERUMTEL, the Indonesian operator of the Palapa satellite system. As such, Domsat's costs are not as directly tied to inflation as are those of the other operating entities in this project. Thus, two rate changes are included in the study to reflect probable changes in DOMSAT's charges.

Each of these projected increases, assumed at 30 percent, is expected to result from increased lease charges from PERUMTEL to reflect higher space craft costs whenever a new space craft is placed into service. Thus, an increase was assumed for 1983 with the launch of the Palapa B and a further increase in 1993 with the launch of the Palapa C.

Financial costs are shown in Table 11. All of the earth station facilities are assumed to be provided by AID, while exchange facilities were provided by the Philippine Government, utilizing government borrowing, to PILTELCO under a lease arrangement. Because PILTELCO will be providing the local service and PLDT the long distance service, all costs and revenues are divided between the two companies.

Because the earth station is proposed as an AID grant, no depreciation is charged. However, to provide for the equipment's replacement after its design life of 15 years, a sinking fund account has been included. The interest rate for accumulating this account was set at 17 percent per year.

The calculation of the capital recovery charge (principal repayment plus interest) for exchange equipment was based on the assumption that government financing would be available at ten percent per year. Note that the capital recovery charges increase in 1996, 1997, and 1998 to take account of the need for incremental investment. Also note that all increments to earth station capacity are financed largely through debt capital and, hence, appear in the capital recovery charges.

The Subscriber Investment Program (SIP) revenues are deducted from the local exchange investment costs prior to the calculation of the capital recovery charge. This subtraction is made because PILTELCO and PLDT treat SIP as equity capital. Thus, SIP should be separated from, and charged differently from debt capital. The annual SIP charges are shown in Table 12. The SIP is, conservatively, not increased over the study period.

Finally, pre-operating expenses, estimated at $20,000, are repaid over ten years. Table 13 summarizes the project costs divided between toll and local service.

Cash Flow

Table 14 presents a summary of the cash flow which can be expected. Although there is an initial deficit, the overall system will produce a positive cash flow by 1993.

Option Two: Expanded Telephone Service through Subscriber Radio

In this option the basic telephone service described above is expanded into other communities using subscriber radio (SR). While this option is somewhat costly, its significance is in the use of a new radio technology which allows the quick extension of telephone service to remote areas and which requires relatively low power and maintenance.

Telephone Demand

Demand projections for areas outside of the Roxas, Brooks Point, and Narra communities are quite low. After some discussion with the Philippine carriers, estimates were made which showed a demand for 24 lines in the communities of Aborlan, Pulot, and Rio Turba. Six lines were projected for Batarasa, and two additional areas of demand were hypothesized, one with 12 lines, and one with six, in the vicinity of Narra. Thus, total SR demand was projected at 96 lines, with provision made for an additional 24-line unit in Brooks Point, a high growth area, in 1998.

Because the provision of SR increases the exchange equipment's capacity requirements, somewhat larger exchange capacity was provided for Brooks Point and Narra than in Option One. This larger capacity will respond to somewhat different demand growth from Option One, because the capacity constraints will be reached at different times and at higher demand levels. The overall demand growth, as in Option One, is assumed to be six percent per year, except for the SR facilities which are filled immediately and are not expanded during the study period (Table 15).

Revenues

The revenue projections are built on those developed in Option One and presented previously in Table 6. Incremental revenues are estimated for the SR-based demand, the higher number of overall subscribers because of the higher exchange capacity, and the Public Call Offices (PCOs) which would be installed at each SR location. PCO revenues were based on a PLDT-derived calling factor of .054939 toll minutes per person per month in the communities surrounding the PCOs. These projections are shown in Table 16.

Capital Costs

The costs for providing service to the communities discussed above, as well as the costs for the incremental exchange and earth station capacity, are shown in Tables 17 and 18. Note that provision is made for an expansion of the Brooks Point SR system in 1998 by 24 lines. It is assumed that the initial SR facilities will be provided as an AID grant, while the exchange facilities and incremental SR plant will be financed by the Philippine Government.

The SR cost per line in Narra was projected as $5,875 (including central office capacity) and $7,026 per line in Brooks Point. The latter is more costly because of the required addition of a relay station to reach the subscribers.

Note that the cost per line for these systems diminishes as the full capacity of the SR system is reached at 96 lines. If one uses Narra as a more typical case because it uses no relays, the addition of two increments of 24 lines would increase capital costs by $169,800 (including central office capacity), to a per line cost of $4,513. Although this is higher than the country average of $669 per line (central office and outside plant), it is in line with other studies which show the average cost per line in remote areas of the Philippines as approximately $3,750 per line.

Operating Costs

Because SR has low maintenance requirements, the only incremental operating expenses included will be for spare parts. The addition of SR should impose only minor incremental costs on the exchange operations. However, the change in overall exchange capacity will affect the timing of requirements for incremental space segment capacity and, hence, the space segment costs. These costs are shown in Table 19.

Financial charges are shown in Table 20. As the initial SR facilities were to be part of the AID grant, they are replaced through funds generated in a sinking fund account. As in Option One, the sinking fund is assumed to reach maturity in 15 years, using a 17 percent interest rate. All exchange equipment and incremental earth station, SR, and exchange equipment is funded out of a combination of debt capital, shown in the capital recovery lines, and equity, shown in SIP. The cumulative SIP available for investment is shown in Table 21.

Note that further investment will be needed in 1995 for additional plant in Roxas, in 1996 for Narra, and in 1998 for Brooks Point. These investments are reflected in the capital recovery accounts for those years.

Cash Flow

A summary cash flow for Option Two is shown in Table 22. Although there are initial deficits, note that breakeven and surpluses are achieved sooner than with Option One. This is discussed further below.

Other Revenue Enhancements

While PLDT generally estimates other sources of revenue as approximately ten percent of income, the requirements for telecommunications services, combined with the specialized teleconferencing service which will be part of the system, will lead to a considerably higher percentage of income coming from non-telephone sources. Three possible sources of other revenues have been identified--private line telecommunications, government teleconferencing, and television transmission.

Private line telecommunications is the easiest of the three to quantify. Both Narra and Brooks Point have mines and other commercial enterprises within the proposed service area which could utilize private line service. The earth stations in Narra and

Brooks Point have each been provided with one extra circuit to handle future toll growth. These circuits can be used for private line service for the period of this study. DOMSAT's tariff for private line service to Palawan is $21,030 per year. In addition, PLDT's and PILTELCO's local loop lease charge of $2.00 per km per month must be added. Assuming that the loop on each side would be approximately 20 km long, the local loop annual leased cost would be $958 per circuit. An administrative surcharge of 15 percent is then added to the total by PLDT. Thus, two leased circuits would produce $50,572, with $7,554 going to PLDT and the remaining $43,018 going to cover system costs.

Aside from telephone services, the proposed satellite system will also be able to provide teleconferencing services. These services are part of the package AID had proposed for government use. Assuming that government agencies would pay a fee for the teleconferencing services, AID proposed that the charges be on an annual rather than usage basis. By separating usage from cost, at least during the initial period, government agencies could be encouraged to frequently utilize the teleconferencing system. An annual tariff would also be easier to administer and would generally be more reliably obtained through annual budgets than would a usage-sensitive tariff. Because the teleconferencing service would be placed within the proposed system and would not require incremental plant, it would impose only minor costs on the overall system.

The provision of television transmission service will require more detailed analysis, given the policy and technical problems presented. Because it is uncertain how the service would be provided, it is difficult to develop precise cost projections. However, a reasonable estimate of the capital cost would be approximately $20,000 per earth station for both the incremental earth station equipment and a small transmitter. The annual operating charges would be negligible because they would be included within the overall earth station operation.

Based on discussions with both the provincial and national governments, the revenues from television and government teleconferencing services combined are conservatively estimated to be $125,000 per year, after expenses and finance charges. Thus, $168,018 per year in contributions to system revenues from non-telephone sources is anticipated. A conservative increase of six percent per year, to account for inflation and growth, is added to the summary in Table 22.

The revenue effects of the non-telephone revenues on the overall system are summarized in Table 23. In both options the addition of non-telephone revenues substantially improves the overall cash flows and shortens the period of deficit operations.

CONCLUSIONS

Although the Philippine project presented here is not fully representative of the situation in many developing countries, particularly because of the initial grant components of the system, it does indicate that a rural telecommunications system, over time and with some ingenuity, can pay its direct costs. Clearly, it can do so only with the strong support and assistance of the government, particularly in terms of making low-cost financing available.

Ideally, total national telephone revenues should be utilized as a means of providing financing and support for rural development at the same time that the overall finances of the telephone operation are not jeopardized by too rapid expansion in the rural sector. A gradual expansion policy will generate increased revenues so that in the long term, the overall financial position of the telecommunications system should be assisted, or at least not impeded, by the introduction of rural telecommunications.

FOOTNOTES

1. The user of a satellite transponder can use various combinations of the available band width and power. The most important example of this is with the lease of a 72 MHZ transponder from INTELSAT for video. There is no video equipment made for using a 72 MHZ transponder. However, by leasing the entire transponder, the client can use 36 MHZ of band width, but the entire 29 dbw of satellite power. If the client were to lease only 36 MHZ of the transponder, he would have to accept considerably less power, with effects on ground station costs.

2. In conducting a financial review of the costs and revenues of its extensive satellite-based rural telephone system, RCA Alaska Communications discussed the possibility of introducing a small number of telephones exclusively for access to the toll system. These telephones would be divided between PCOs and a series of businesses with major long distance telephone requirements. The study found that this type of system greatly enhanced the revenues from rural areas while fostering a relatively modest increase in investment and operating costs over a basic PCO. See Daniel Allan, et al., "Telecommunications Alternatives for Rural Alaska: Commercial Feasibility and Social Benefits," Final Report, June 1981, SRI Project 1672.

3. Philippines Long Distance Telephone Company, "USAID/AED/MOTC Palawan Rural Satellite Project: Provision of Toll Services," July 1981.

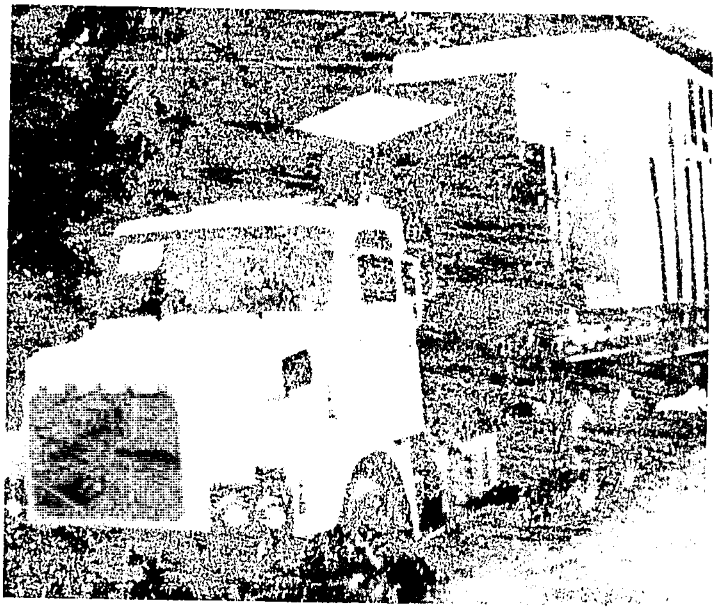
4. At the time this feasibility study was being undertaken, the ITU had commissioned A.D. Little and Teleconsult to prepare an overall telecommunications plan for the Philippines. The staff of the A.D. Little/Teleconsult study provided their draft demand computations for comparison.

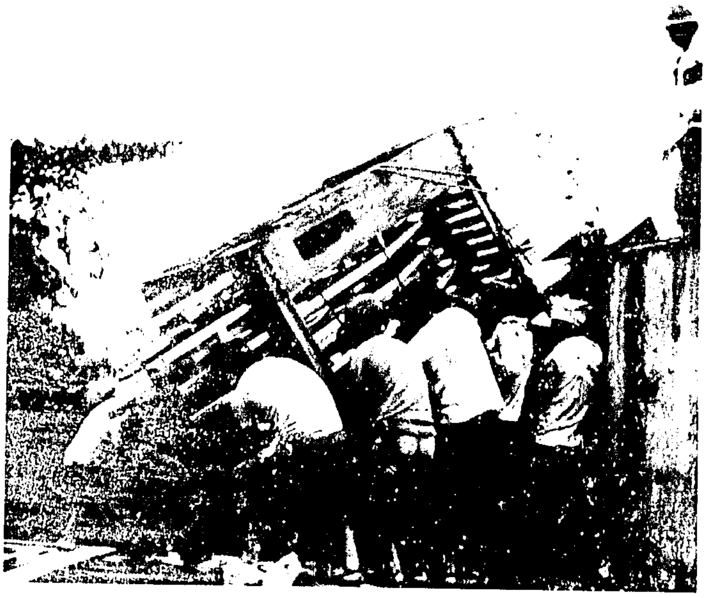
5. One of the characteristics of utilities which are subject to rate regulation is that the process of regulation inevitably causes rate changes to lag behind changes in costs. This may be compensated for by raising rates somewhat above costs at the time of each rate change, thus allowing average rates over an extended period to approximate costs, even given the lag in rate adjustments.

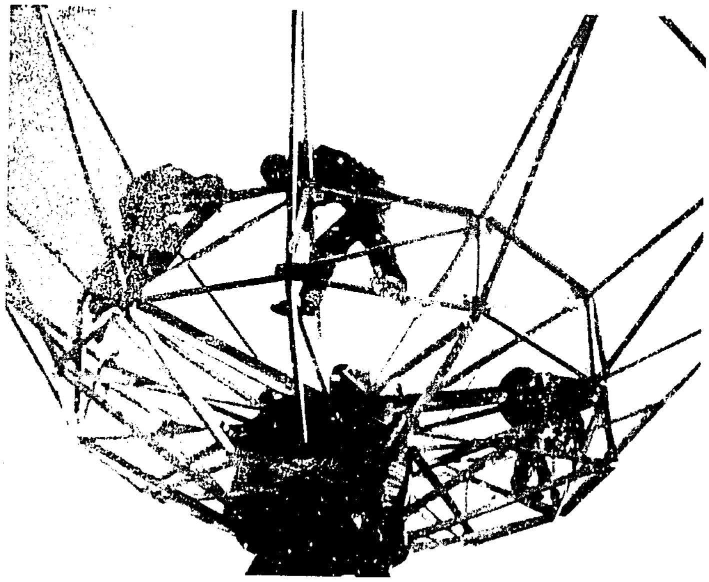
6. All Philippine costs are converted to U.S. dollars at the October 1982 exchange rate of 8.0 pesos to $1.00 U.S.

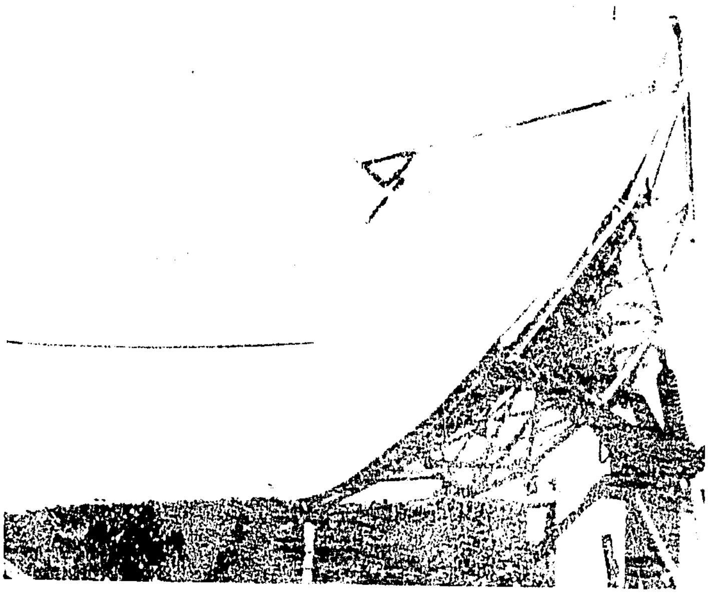
7. This assumption obviously would not hold if a country were considering a large-scale rural telephone expansion. In such a case, provision would have to be made in urban exchanges to terminate the new traffic.

Images from the AID Rural Satellite Program

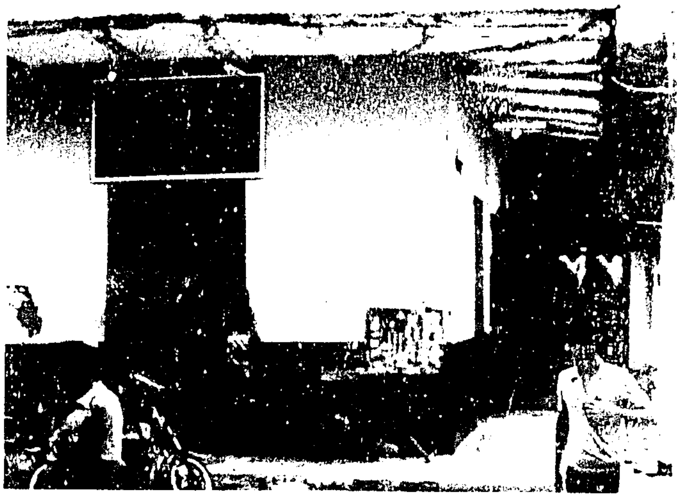




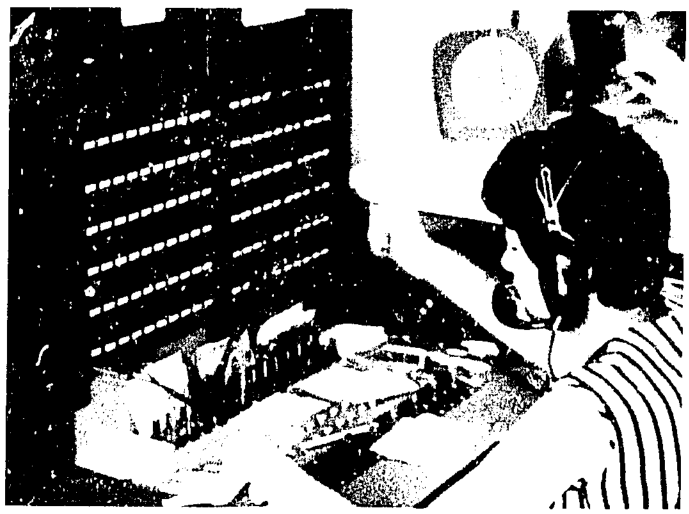




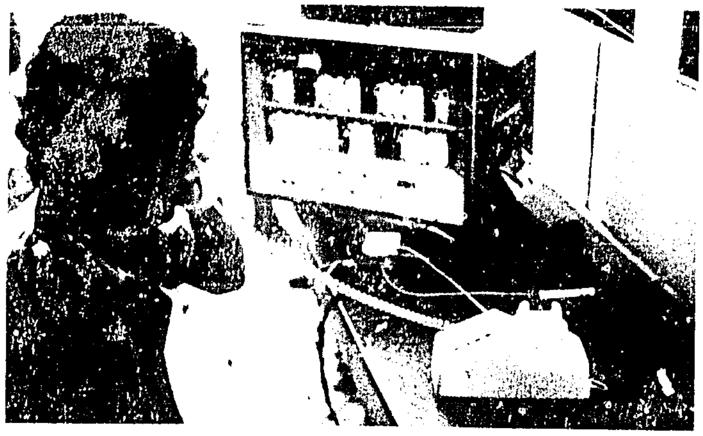
Satellites can provide telecommunications services to remote and rural areas. The smaller the earth stations, the lower the costs. The Peru Rural Satellite Project is the first to successfully use small six-meter stations with the international satellite system for internal communication.



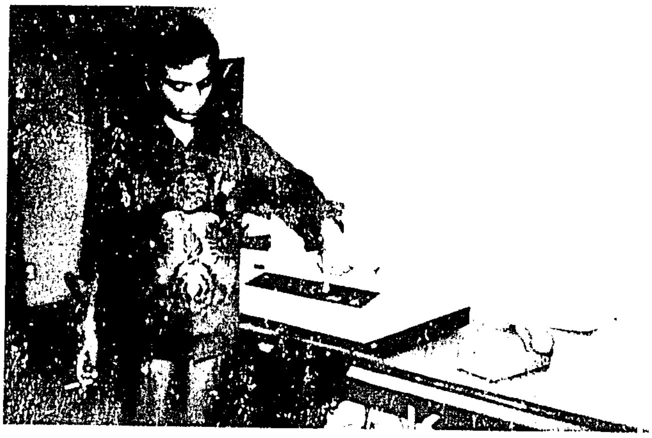
Basic telephone service is essential to rural development. For the first time, the rural Peruvians in the remote San Martin region are connected with the nation's commercial and political centers—and with each other. Within months, the new telephone system was used to capacity and has since been expanded twice to accommodate heavy usage. Over 110,000 phone calls were made in 1985, generating over $100,000 in revenues.



Push-to-talk microphone

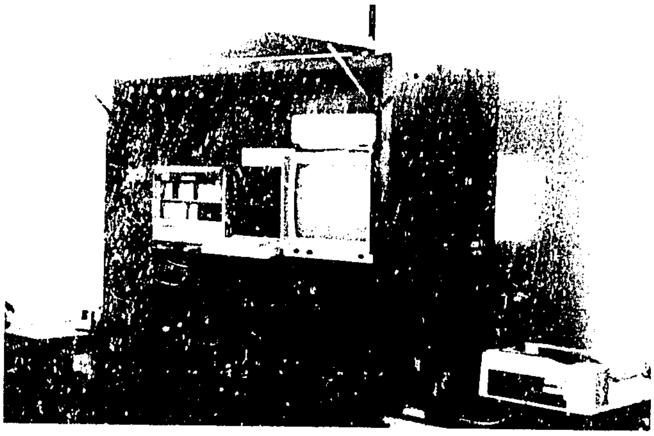


Telephone terminal and private telephone



Facsimile machine

Telewriter/graphics display



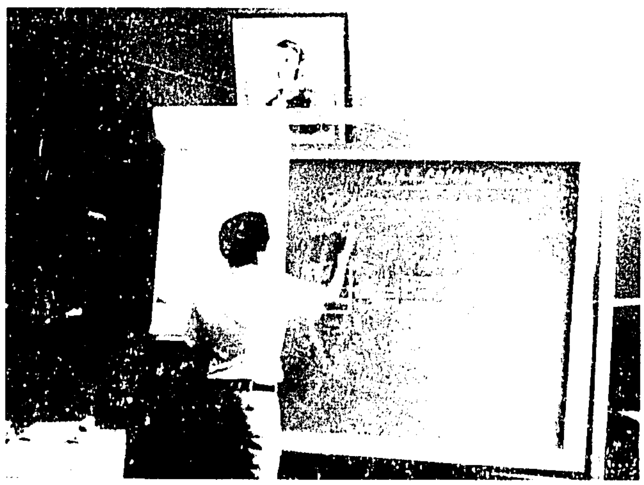
Typical classroom layout

Special equipment attached to telephone lines can transform ordinary telephones into audioconferencing systems linking many groups over vast distances. Using a simple telephone circuit, groups of people can talk, view pictures transmitted by telewriters, and receive text via facsimile. The Rural Satellite Program installed 25 "electronic classrooms" for three different projects.

In-service training of primary school teachers

Administration of rural institutions

University teaching to thousands of students



Technical training for tele-communications personnel

Interactive audioconferencing networks can reliably and affordably support many different development activities. Audioconferencing provides a means of extending scarce expert resources and educational opportunities to remote and rural areas. The Rural Satellite Program explored its applications for health, education, and agriculture. The Pilot Projects in Indonesia, the West Indies, and Peru used audioconferencing for university teaching, in-service training of health care workers, teachers, and agricultural extension agents, medical consultations, research exchange, and rural administration. Over 92 percent of the participants indicated it helped them do their jobs better.

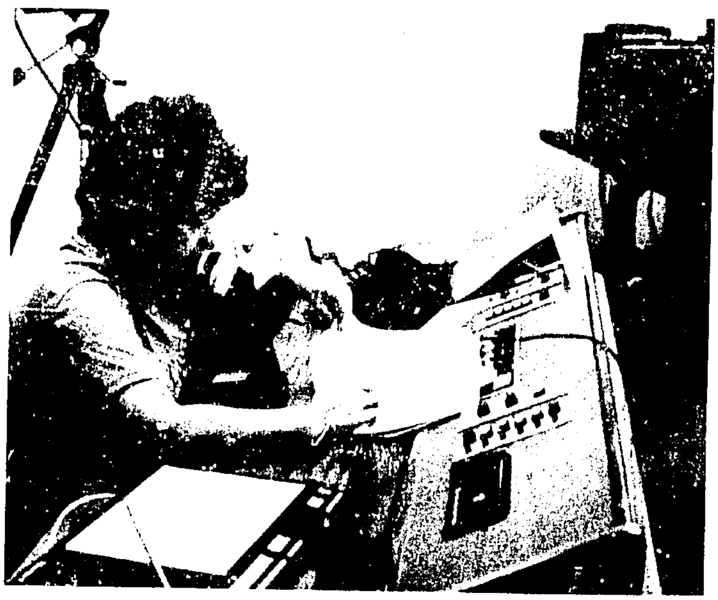
Animal husbandry training for extension agents

Coordination of Child Health Campaign

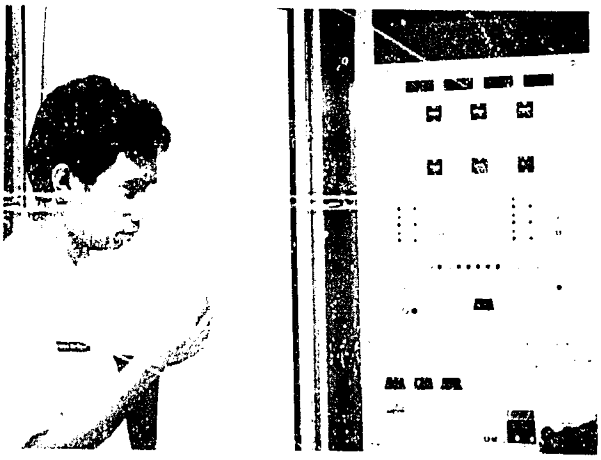

DEPARTEMEN PENDIDIKAN DAN KEBUDAYA
UNIVERSITAS HASANUDDIN
KANTOR PUSAT
PROYEK PENDIDIKAN JARAK JAUH
MELALUI SATELIT
USAID-BKS PTN INTIM

Effective audioconferencing programs need careful coordination and management of programming, technical, and administrative components. General requirements for successful communications support projects include:

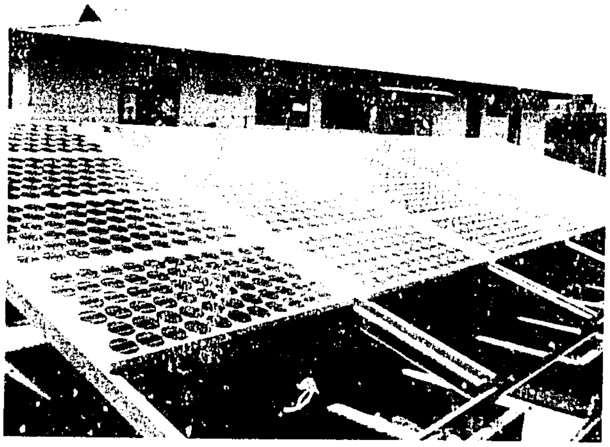
- a central coordinating office supported by staff at all sites
- accurate identification of user needs and appropriate program development
- thorough training of management and technical staff, as well as program presenter and general users
- development and distribution of educational support materials
- adequate budget for central office and local site operations




Earth station, photovoltaics, and audioconferencing room


Station requires only quarterly maintenance visits

Satellite technology can be adapted to withstand the rugged conditions prevailing in rural areas. In the remote Indonesian village of Wawatobi, the Rural Satellite Program designed and installed a small solar-powered earth station and photovoltaic array. The station provides multi-channel telephone service with low maintenance and power requirements. It operates on less electricity than a home steam iron.


Photovoltaic panels

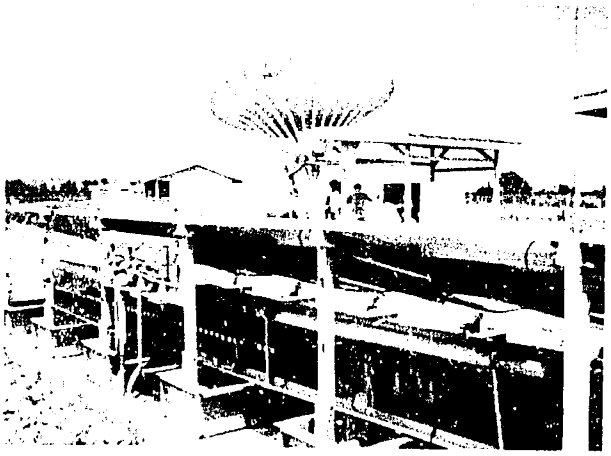

Panels and storage batteries

Table 1

Comparison of Earth Station Costs for INTELSAT and Domestic Systems

System	Antenna Size	Cost
Telephone Earth Stations		
Domestic System	4.6 - 5.0 m	$90,000
INTELSAT Standard Z	6.0 m	200,000
Vista	5.0 m	110,000
Television Receive Only		
Domestic System	2.0 m	$1,000
	3.0 m	3,000
INTELSAT	5.5 m[a]	13,000
	8.0 m[b]	33,000
	10.0 m[c]	103,000

a. A 5.5-meter antenna operating with the power of a 72 MHZ INTELSAT transponder produces a video signal just at threshold and is thus inferior to a three-meter antenna operating with a domestic system.

b. An eight-meter antenna using the full power of a 72 MHZ transponder will produce a signal quality comparable to a three-meter antenna on a domestic transponder.

c. A ten-meter antenna is required to produce a signal at threshold when the power of an INTELSAT 72 MHZ transponder is split to provide two video signals.

Table 2

Comparison of PANAMSAT and INTELSAT Costs for SCPC Services

Transponder Size	Annualized Costs	SCPC Channels Per Transponder	Annualized Cost Per SCPC Channel	Annualized E.S. Cost	Network and Space Segment	
					20 E.S.'s	50 E.S.'s
PANAMSAT						
36 MHz	$1,105,000	593	$1,863	$15,075	$376,000	$940,050
INTELSAT (Spot Beams)						
Sale--36MHz	933,000	305	3,060	31,858	759,560	1,899,000
Lease--36MHz	1,427,000	305	4,679	31,858	824,320	2,060,800

Table 3

Latin American Domestic Video Leases:
Financial Comparison Between PANAMSAT and INTELSAT
(values in U.S. dollars)

Space Segment Annualized Cost	Earth Station Antenna Size (meters)	Carrier/ Noise Ratio	Signal/ Noise Ratio	Annualized		TOTAL ANNUAL COST Space Segment		
				Cost of Receive Station	Cost of Transmit Station	100 E.S.	200 E.S.	500 E.S.
PANAMSAT--36 MHz								
$1,105,016	3	12.6dB	50.0dB	$916	$51,942	$1,202,758	$1,248,558	$1,340,158
INTELSAT VB Spot Beam--36 MHz								
sale: $933,000	5	10.96dB	48.4dB	3,675	65,183	1,496,000	1,863,000	2,966,000
lease: $1,427,000						1,990,000	2,358,000	3,460,000

Table 4

Costs of End Equipment for a Teleconferencing System

Item	Cost
Audio-Conferencing System (2 speakers, 8 microphones, amplifier)	$4,530
Network Controller	6,757
Facsimile	2,995
Graphics Writer (electronic blackboard)	8,160
Backup Electricity Supply and Voltage Controllers	3,544
Installation Materials	600
Supplies	1,000
TOTAL	27,586
Test Equipment (project wide)	8,858
Graphics Production Studio	31,400

Table 5

Projected Telephone Subscribers: Option One

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Brooks Point																
Residential:	63	69	76	84	92	101	107	114	114	114	135	143	152	161	171	171
Business:	102	113	124	136	150	165	175	185	186	186	221	234	248	263	278	279
Total:	165	182	200	220	242	266	282	299	300	300	356	377	400	424	449	450
Narra																
Residential:	45	50	55	61	67	73	79	84	89	94	96	96	96	118	125	133
Business:	98	108	119	131	144	159	167	177	187	199	204	204	204	252	267	282
Total:	143	158	174	192	211	232	246	261	276	293	300	300	300	370	392	415
Roxas																
Residential:	20	23	25	28	30	30	30	30	30	30	41	43	46	49	52	55
Business:	75	82	90	99	109	120	120	120	120	120	164	174	184	195	207	219
Total:	95	105	115	127	139	150	150	150	150	150	205	217	230	244	259	274
TOTAL	404	445	489	539	592	648	678	710	726	743	861	894	930	1,038	1,100	1,139

Source: PILTELCO, July 1981.

Table 6

Total Revenues:
Option One
(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Local[a]	45	46	57	63	99	108	127	133	153	156	204	211	247	276	292	303
Toll																
Intraprovince:	30	33	41	45	71	78	93	98	117	124	148	157	187	198	236	250
Interprovince:	97	107	132	145	227	250	298	315	376	398	474	503	599	635	757	802
Total Toll[b]	127	140	173	190	298	328	391	413	493	522	622	660	786	833	993	1,052
TOTAL REVENUES	172	186	230	253	397	436	518	546	646	678	826	871	1,033	1,109	1,285	1,355

a. Includes non-recurring installation charge and monthly charge.

b. Based on 45.5 minutes per telephone per month, with ½ of toll calling being intra-Palawan and ½ to Manila.

Table 7

Earth Station Capital Costs

A.	8-Channel Earth Station (Narra or Brooks Point)	
	1. Earth Station Equipment	$148,000
	2. Prime Power Back-up Unit	2,000
	3. Test Equipment and Tools	8,000
	4. Exchange Interface	8,000
		166,000
	5. Loaded @ 1.65*	$273,900
B.	4-Channel Earth Station (Roxas)	
	1. Earth Station Equipment	$110,000
	2. Prime Power Back-up Unit	2,000
	3. Test Equipment and Tools	8,000
	4. Exchange Interface	4,000
		124,000
	5. Loaded @ 1.65	$204,600
C.	8-Channel Modern Unit (Puerto Princesa)	
	1. SCPC/DAMA Equipment	$88,000
	2. Exchange Interface	8,000
		96,000
	3. Loaded @ 1.65	$158,400
D.	4-Channel Modem Unit (Manila)	
	1. SCPC/DAMA Equipment	$50,000
	2. Exchange Interface	4,000
		54,000
	3. Loaded @ 1.65	$89,100
E.	Total Initial System	
	1. Narra	$273,900
	2. Brooks Point	273,900
	3. Roxas	204,600
	4. Puerto Princesa	158,400
	5. Manila	89,100
		$999,900
F.	Earth Station expansion in Brooks Point, Roxas, Manila, and Puerto Princesa - 1995	$94,051
G.	Earth Station expansion in Narra, Manila, Puerto Princesa	$51,150

* To account for spare parts, shipping, insurance, and installation, a factor computed at 65 percent of the equipment cost, FOB is "loaded" onto total cost.

Table 8

Initial Investment for Local Exchanges

Component	**Brooks Point (300 Subscriber)**	**Narra (250 Subscriber)**	**Roxas (150 Subscriber)**
Central Office	$103,500	$103,500*	$51,750
Outside Plant	97,031	80,859	51,750
Telephone Sets	13,594	11,328	7,750
Generators	7,188	7,188	7,188
Buildings	14,375	14,375	14,375
Land	2,875	2,875	2,875
Tools	2,875	2,875	2,875
Vehicles	8,625	8,625	8,625
Furniture	2,875	2,875	2,875
TOTAL	$252,938	$234,500	$150,063

* A 300-line central office is installed with an initial 250-line outside plant.

Incremental Investment:

1992 - Narra (50 lines) - 19,063

1995 - Brooks Point and Roxas (150 lines each) - 211,875

1998 - Narra (150 lines) - 105,938

Table 9

Annual Operating Expenses:
Option One

1	Satellite Engineer	$4,150
6	Earth Station Technicians ($3,338 each)	20,028
15	Guards ($884 each)	13,260
3	Exchange Managers ($3,286 each)	9,858
9	Plant Staff ($1,801 each)	16,209
14	Operators ($1,980 each)	27,720
	Repair (60 pesos/line)[a]	- - -
	5% of Total Earth Station Investment[b]	12,660
	Earth Station Spares (5% of investment each)[b]	32,194
	Travel	2,500
	Insurance	1,088
	Taxes (5% of gross revenues)	- - -
	Earth Station Power	2,925
	Others	17,119

---

a. Based on number of lines in service.

b. Spare parts for the first two years are excluded because they are part of the AID grant.

Table 10

DOMSAT Satellite Charges:

Option One

(000's dollars)

1985[a]	1986	1987[b]	1988	1989	1990	1991	1992	1993[c]	1994	1995[d]	1996	1997	1998[e]	1999	2000
--	--	179	179	179	179	179	179	232	232	241	241	241	250	250	250

a. Space segment charges are excluded until new capacity is required by DOMSAT in 1987.

b. Initial costs are based on the following:

A.	20 half-circuits (@ $1,300/year) originating in project earth stations	$26,000
B. 1.	8 half-circuits originating/terminating in Puerto Princesa, 4 in Manila (@ $12,280)	+ $147,360
2.	Less $3,000 per half-circuit to compensate for AID providing the required channel equipment	- $36,000
		$137,360

All of these costs have been inflated by 30% in expectation of an increase in the space lease charge from PERUMTEL, the Indonesian operator on the satellite, after the launch of the Palapa B.

c. An additional 30% increase anticipated because of increased space lease charges after the launch of the Palapa C in 1993.

d. An additional 4 half-circuits for increased toll capacity in Brooks Point and Roxas.

e. An additional 4 half-circuits for increased toll capacity in Narra.

Table 11

Division of Finance Charges: Option One

(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PLDT																
Sinking Fund for Earth Station Equipment (15 years at 17%):	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Capital Recovery (10% over 20 years):	--	--	--	--	--	--	--	--	--	--	12	12	12	18	18	18
Pre-operating Expenses (over 10 years):	1	1	1	1	1	1	1	1	1	1	--	--	--	--	--	--
TOTAL	20	20	20	20	20	20	20	20	20	20	31	31	31	37	37	37
PILTELCO																
Capital Recovery* (10% over 20 years):	65	65	65	65	65	56	56	56	56	56	73	73	73	79	79	79
SIP Dividends (at 12%):	15	17	19	20	22	25	26	27	28	28	33	34	35	39	42	43
Pre-operating Expenses (over 10 years):	1	1	1	1	1	1	1	1	1	1	--	--	--	--	--	--
TOTAL	81	83	85	86	88	82	83	84	85	85	106	107	108	118	121	122

* Because the Subscriber Investment Program is a form of equity capital, its revenues are deducted from the total debt capital requirement for equipment in 1985, 1990, 1995, and 1998. The 5-year intervals are used for overall simplicity with the 1998 infusion of SIP capital occurring with the planned plant expansion in Narra.

Table 12

Subscriber Investment Program Revenues: Option One

(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992
Brooks Point	$50,438	$4,875	$5,438	$6,000	$6,750	$7,313	$5,000	$5,313
Narra	45,188	4,688	5,063	5,625	6,000	6,750	4,375	4,688
Rosas	31,875	3,188	3,375	3,938	4,125	4,688	--	--
TOTAL	127,501	12,751	13,876	15,563	16,875	18,751	9,375	10,001
CUMULATIVE TOTAL	127,501	140,252	154,128	169,691	186,566	205,317	214,692	224,693

	1993	1994	1995	1996	1997	1998	1999	2000
Brooks Point	$313	--	$17,500	$6,563	$7,188	$7,500	$7,813	$313
Narra	4,688	5,313	21,875	--	--	21,875	6,875	7,188
Rosas	--	--	17,188	3,750	4,063	4,375	4,688	2,188
TOTAL	5,001	5,313	56,563	10,313	11,251	33,750	19,376	9,689
CUMULATIVE TOTAL	229,694	235,007	291,570	301,883	313,134	346,884	366,260	375,949

Table 13

Division of Costs between Exchange and Toll Carriers:

Option One

(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PLDT																
Operations	41	44	88	94	104	111	120	127	130	146	158	167	181	191	209	222
DOMSAT	--	--	179	179	179	179	179	179	232	232	241	241	241	250	250	250
Finance	20	20	20	20	20	20	20	20	20	20	31	31	31	37	37	37
Total	61	64	287	293	303	310	319	326	382	398	430	439	453	478	496	509
PILTELCO																
Operations	95	101	108	115	124	132	141	142	159	169	183	194	207	222	237	252
Finance	82	83	85	87	89	82	83	84	84	85	106	107	108	118	120	122
Total	177	184	193	202	213	214	224	226	243	254	289	301	315	340	357	374
TOTAL COST	238	248	480	495	516	524	543	552	625	652	719	740	768	818	853	883

Table 14

Cash Flow Summary:
Option One
(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PLDT																
Costs																
Operating	41	44	88	94	104	111	120	127	130	146	158	167	181	191	209	222
DOMSAT	--	--	179	179	179	179	179	179	232	232	241	241	241	250	250	250
Finance	20	20	20	20	20	20	20	20	20	20	31	31	31	37	37	37
Total	61	64	287	293	303	310	319	326	382	398	430	439	453	478	496	509
Revenues	80	88	109	120	187	206	245	260	310	328	391	415	494	524	624	662
Income (Deficit)	19	24	(178)	(173)	(116)	(104)	(74)	(66)	(72)	(70)	(39)	(24)	41	46	128	153
PILTELCO																
Costs																
Operating	95	101	108	115	124	132	141	142	159	169	183	194	207	222	237	252
Finance	82	83	85	87	89	82	83	84	84	85	106	107	108	118	120	122
Total	177	184	193	202	213	214	224	226	243	254	289	301	315	340	357	374
Revenues	92	98	121	134	209	230	272	286	336	350	409	456	539	585	661	693
Income (Deficit)	(85)	(86)	(72)	(68)	(4)	16	48	60	93	96	120	155	224	245	304	319
TOTAL INCOME (DEFICIT)	(66)	(62)	(250)	(241)	(120)	(88)	(26)	(6)	21	26	81	131	265	291	432	472

Table 15

Telephone Demand Projections:

Option Two

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Brooks Point	220	236	254	274	296	320	336	353	371	390	400	400	478	502	527	554
Narra	185	200	216	234	253	274	288	300	300	300	300	371	391	412	434	457
Roxas	95	105	115	127	139	150	150	150	150	150	205	217	230	244	259	274

Table 16

Total Revenue:

Option Two

(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Local	55	56	68	74	115	124	145	150	173	177	214	234	292	308	364	384
Toll																
Basic[a]	127	140	173	190	298	328	390	414	493	522	622	660	786	833	993	1,052
SR[b]	30	30	34	34	42	42	55	55	61	61	69	69	77	97	109	109
SR/PCO[c]	12	12	13	13	18	18	21	21	23	23	26	26	29	29	33	33
Total	169	182	220	237	358	388	466	490	577	606	717	755	892	959	1,135	1,194
TOTAL REVENUES	224	238	288	311	473	512	611	640	750	783	931	989	1,184	1,267	1,499	1,578

a. Basic toll revenues from subscribers in Brooks Point, Roxas, and Narra only.

b. Toll revenues from subscribers using subscriber radio.

c. Toll revenues from public call offices using subscriber radio.

Table 17

Capital Costs of Subscriber Radio Facilities: Option Two

I. Initial Costs	
A. Narra	
1. Base unit in Narra	$70,000
2. 24-line unit in Aborlan	80,748
3. 12-line unit	50,625
4. 6-line unit	34,688
Total	$236,061
B. Brooks Point	
1. Base unit in Brooks Point	$70,000
2. 24-line unit to Rio Turba (including radio relay)	140,851
3. 6-line unit to Batarasa	34,688
4. 24-line unit to Pulot	80,748
5. Additional 100 lines of capacity at Brooks Point (@ $345)	33,375
Total	$359,662
Total A and B	$595,723
II. Incremental Cost in 1998 Brooks Point - 24-line unit	$80,748

Table 18

Capital Costs of Exchange and Earth Station Equipment: Option Two (000's dollars)

I. Exchange Equipment	
Initial	
Brooks Point (400 lines)	$324
Narra (300 lines)	253
Roxas (150 lines)	150
Incremental	
1995 - Roxas (150 lines)	$106
1996 - Narra (150 lines)	106
1998 - Brooks Point (200 lines)	141
II. Earth Station Equipment	
Initial	$1,062
1995 (Roxas)	$20
1996 (Narra)	20
1998 (Brooks Point)	73

Table 19

DCMSAT Costs:

Option Two

(000's dollars)

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
--	--	179	179	179	179	179	179	232	232	237	241	241	254	254	254

Table 20

Division of Financial Costs Between PLDT and PILTELCO: Option Two

(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PLDT																
Sinking Fund for Earth Station Equipment (15 years at 17%):	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Capital Recovery (10% over 20 years):	--	--	--	--	--	--	--	--	--	--	2	5	5	13	13	13
Pre-operating Expenses:	1	1	1	1	1	1	1	1	1	1	--	--	--	--	--	--
TOTAL	20	20	20	20	20	20	20	20	20	20	21	24	32	32	32	32
PILTELCO																
Capital Recovery:*	72	72	72	72	72	63	63	63	63	63	70	79	79	99	99	99
Sinking Fund for SR:	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
SIP Dividends:	19	20	22	24	26	28	29	30	31	32	34	37	41	43	46	48
Pre-operating Expenses:	1	1	1	1	1	1	1	1	1	1	--	--	--	--	--	--
TOTAL	107	108	110	112	114	107	108	109	110	111	119	131	135	157	160	162

* Because the Subscriber Investment Program is a form of equity capital, its revenues are deducted from the total debt capital requirement for equipment in 1985, 1990, 1995, and 1998. The 5-year intervals are used for overall simplicity with the 1998 infusion of SIP capital occurring with the planned plant expansion in Narra.

Table 21

Subscriber Investment Program Revenues:

Option Two

(000's dollars)

1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
158	169	183	199	215	233	242	251	257	263	283	309	344	362	381	402

Table 22

Summary Cash Flow:

Option Two

(000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PLDT																
Costs																
Operating	41	44	88	94	104	111	120	127	130	146	158	167	181	191	209	222
DOMSAT	--	--	179	179	179	179	179	179	232	232	241	241	241	254	254	[illegible]
Finance	20	20	20	20	20	20	20	20	20	20	24	24	24	32	32	[illegible]
Total	61	64	287	293	303	310	319	326	382	398	423	432	446	477	495	508
Revenues	106	114	138	149	229	248	293	307	363	382	451	475	561	603	713	751
Income (Deficit)	45	50	(149)	(144)	(74)	(62)	(26)	(19)	(19)	(16)	28	43	115	126	218	243
PILTELCO																
Costs																
Operating																
Basic	95	101	108	115	124	132	141	142	159	169	183	194	207	222	237	252
SR	17	18	19	20	21	22	24	25	27	35	30	32	34	36	38	40
Total	112	119	127	135	145	154	165	167	186	204	213	226	241	258	275	292
Finance	107	108	110	112	114	107	108	109	110	111	119	131	135	157	160	162
Total Costs	219	227	237	247	259	261	273	276	296	315	332	357	376	415	435	454
Revenues	118	124	150	162	250	270	317	332	387	402	455	514	623	664	785	827
Income (Deficit)	(101)	(103)	(87)	(85)	(9)	9	44	56	91	87	123	157	247	249	350	373
TOTAL INCOME (DEFICIT)	(56)	(53)	(236)	(229)	(83)	(53)	18	37	72	71	151	200	362	375	568	616

Table 23

Income Effects of Other Sources of Revenues on Options One and Two (000's dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Option One																
Income (Deficit)	(66)	(62)	(250)	(241)	(120)	(88)	(26)	(6)	21	26	81	131	265	291	432	472
Other Income	168	178	189	200	212	225	238	253	268	284	300	319	338	358	380	403
Income Effect (Deficit)	102	116	(61)	(41)	92	137	212	247	289	410	381	450	603	649	812	875
Option Two																
Income (Deficit)	(56)	(53)	(236)	(229)	(83)	(53)	18	37	72	71	151	200	362	375	568	616
Other Income	164	178	189	200	212	225	238	253	268	284	301	319	338	358	380	403
Income Effect (Deficit)	108	125	(47)	(29)	129	172	256	290	340	355	452	519	700	733	948	1,019

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Jorge Cisneros
Isabel Candia
Mildred Casanave
Margot Ruis
Victor Torres
Alippio Quincho
Ruth Cardenas
Gladys Infante
Angela Campos
Lili Aguila
Carmen Reategui
Cesar Arias