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This chapter provides an overview of telecommunications in Kenya and discusses the major policy issues facing this sector in the 1990s in the wider context of the challenges of development strategy as a whole. It also considers aspects of Kenya's telecommunications experience that may be of special interest to other countries pursuing or considering market-oriented strategies for a national economy similar to Kenya's. Finally, it reviews research conducted in Kenya over the last decade on the economic role of telecommunications and the benefits of investment in telecommunications infrastructure.

The challenges faced by the makers of telecommunications policy in Kenya are exceptionally demanding. To meet economic needs, it will be necessary to expand the network, enhance service quality and features, and upgrade operational efficiency and productivity. Kenya has a rapidly expanding economy, but it also has one of the world's highest population growth rates—by the year 2000 its population is expected to reach 38 million. Kenya will also need to invigorate agriculture and enhance the lives of those in its rural areas to stem the tide of migration into the towns. Five million new jobs will be needed in the urban areas if the country is to avoid massive unemployment and social unrest.

Kenya's government has responded to these challenges with a market-oriented economic policy that emphasizes openness to the world economy and export-led growth. This policy necessitates a more universal and reliable telecommunications network than would be needed had Kenya attempted a predominantly inwardlooking, centrally directed economic strategy similar to those attempted by some other African countries.

As in other countries that rely to a high degree on exports for both job creation and foreign exchange, economic policy in Kenya must ensure that the export sector is fully competitive in the global marketplace. As this chapter will show, the mere availability of a commodity for export (or of a tourist attraction to draw in visitors) is less and less a sufficient condition for economic success. Quality, productivity, effective marketing and distribution in global markets, superior customer service, and speedy and appropriate responses to changing market conditions are all essential. An efficient and reliable telecommunications infrastructure is essential to achieve these goals.

Moreover, successful export economies need the participation of global corporate leaders to set the pace for quality, technology, productivity, and innovation by implementing global "best practices." Their direct investment, though useful, is not as indispensable as their broader role as innovators, pace setters, and conduits for the transfer of technology and best practices. In Kenya, these global companies directly and indirectly support hundreds of smaller companies and tens of thousands of employees. The operating methods of such global companies require extensive use of both voice and data telecommunications, domestically as well as internationally. Experience shows that global companies will focus their management efforts and their investments where adequate telecommunications (as well as other preconditions for productive, effective operations) permit them to remain globally competitive.

The history of economic development from the 1970s to the 1990s, especially the spectacular success of export-led growth in certain newly industrialized countries in Asia such as South Korea and Thailand, and the equally spectacular failure of many national economies in Africa and Asia under nationalization and central planning, makes the Kenyan case of wide interest and significance for those concerned with development strategy. The economic role of the telecommunications sector in Kenya has been the subject of significant economic and business research. Based on that research and on a series of field interviews, we have drawn several conclusions:

- Expanding the scope and enhancing the quality of the telecommunications services offered to rural and urban businesses yields economic benefits far in excess of the costs incurred.
- Despite major expansion of the public network during the 1980s and early 1990s, there are still unserved or underserved user requirements of major economic significance.
- There are large direct and indirect benefits in foreign exchange earnings to be derived from improving telecommunications services; these benefits are particularly valuable to a country like Kenya with an economy strongly linked to international trade.
- The substantial net in-payments of hard currency accruing to Kenya from telecommunications carriers in other countries through the international settlements process could be used as collateral for the financing of major investments in telecommunications. This approach could help sustain the high rate of telecommunications sector investment that is clearly required—a rate that might otherwise be difficult to sustain because of the financial state of the Kenya Post and Telecommunications Corporation (KP&TC).

This chapter reviews the efforts that have been made in Kenya to understand and meet the telecommunications needs of economic development. It draws conclusions about the challenges that must be overcome if the telecommunications sector is to play its essential role in supporting and enabling continued economic growth—especially the continued growth of exports. It also offers some ideas regarding the future of the telecommunications sector in Kenya.

4.1 Telecommunications in Kenya: Historical Evolution

4.1.1 Development of the Public Telecommunications Network

Kenya's earliest telecommunications connections to the outside world were the submarine cables linking Zanzibar, Mombasa, and Dar es Salaam laid by the Eastern & South African Telegraph Company in 1888. Internally, the construction of a telegraph network began with a 200-mile coastal line linking the port city of Mombasa with Lamu. Extension into the interior of the country began in 1896 in conjunction with the building of the railway system, forming a dual backbone for Kenya's communications infrastructure. The extension of the telegraph line even overtook railway construction, reaching Nairobi in 1898 and Kampala and Entebbe in Uganda in 1900. Telephone service soon followed. In 1908, the public telephone network began service in Nairobi, the capital, and in Mombasa. In Nairobi that year, eighteen telephone subscribers were connected.

The subsequent history of Kenya's network was one of gradual but sustained expansion. By 1980, there were 73,932 direct exchange lines (DELs) in use in the public telephone network; just over 84 percent were connected to automatic switching equipment and 75 percent had direct long distance dialing (STD or subscriber trunk dialing) capability. There were 1,228 telex lines in use and 50 leased data transmission circuits in use. The network of 1980 represented a solid foundation for future expansion even though it had significant shortcomings: 33 percent of long distance call attempts failed due to congestion, and at any given time 15 percent of exchange lines were not in working order (KP&TC Annual Reports; Tyler and Jonscher 1982).

In the 1980s, growth of Kenya's network occurred on a larger scale. The Kenya Post and Telecommunications Corporation undertook three telecommunications development programs: the First Program ran from 1979 to 1983; the Second Program began in 1984 and was completed in 1988; and World Bank funding for the Third Program was negotiated in 1985–86, with disbursements beginning in 1987 and completion achieved in 1992.

The First Program called for the addition of 58,800 exchange lines of capacity, a 60 percent increase over the system capacity available at the end of 1979. It also called for the provision of public telephones in 200 previously unserved locations, urban and rural. External funding was provided by the World Bank and bilateral development assistance programs, notably those of Japan and the Netherlands. Although the ambitious targets were by no means fully met, substantial growth was achieved (e.g., the number of working DELs rose from 69,996 at the end of 1979 to 95,000 at the end of 1983).

The Second Program stressed the expansion of service in Kenya's rural areas,

with the emphasis on "District Focus"—installation of new digital switches in nine locations to ensure that all forty-one "District Headquarters" locations in Kenya had automatic telephone service. This goal was achieved in 1988.

The Third Program largely continued the approach established by the first two but included two significant innovations: extensive replacement of small manual exchanges in rural areas with digital switching equipment and the introduction of optical fiber transmission for the links (known as "junctions") connecting nearby exchanges.

As Table 4.1 shows, the three programs succeeded in achieving rapid growth of the network, especially since 1983. The network doubled from just under 96,000 working exchange lines at the end of 1983 to nearly 214,000 in 1993, a compound annual growth rate of almost 8 percent.

The available data do not indicate improvement in service quality. In 1980, congestion of the long distance network was a major problem: 33 percent of all call attempts failed due to congestion (Tyler and Jonscher 1982). Based on interviews with KP&TC management, the overall call completion rate for long distance calls in 1991 was only 48.1 percent, suggesting (though not definitely confirming) that the degree of congestion remained similar to that of 1980. Congestion of the long distance network and other service quality problems continued to be a major concern for many users (see Section 4.4).

Another problem area that became evident during the Third Program concerned the financial management and financial condition of Kenya's public telecommunications organization and its management's relations with international (and certain bilateral) lending and development assistance agencies. The issues involved are discussed in Section 4.5.

4.1.2 Institutional Structure

The historical evolution of the institutional structure of Kenya's telecommunications has been shaped by political developments in East Africa as a whole. During the 1920s and 1930s, the British colonial administrations in Kenya and Uganda, and the British-administered League of Nations administration of Tanganyika, became more and more closely linked. By 1933, the postal and telegraph services of the three countries had been fully amalgamated with a single postmaster general responsible for all three postal and telecommunications services. In varying forms, the joint operation of posts and telecommunications for the three countries continued until 1977, through independence and other major political changes, such as the union of Tanganyika and Zanzibar to form Tanzania.

In the 1960s and early 1970s, it was widely believed that the advantages of a large-scale common infrastructure and economic union would be reconciled with national sovereignty through an East African Community (EAC) broadly analogous to the European Community. By the late 1970s, however, the desire to maintain the East African Posts and Telecommunications Corporation (EAP&TC) as a going concern was in direct contradiction with the political realities of the three participating countries, which had divergent political orientations and development

	1978	1980	1983	1985	1987/88	Jan. 31, 1991	1992/
DELs in use	65,344	73,932	95,749	118,361	151,964	184,583	207,328
Percentage of DELs in use served by automatic switching	86.2%	84.5%	86.7%	88.5%	91.4%	92%	92%
Public telephones	1,490°	-	734 ^b	2,189*	3,630	5,631 ^b	5,631 ^b
Telex lines in use	1,017	1,228	1,750	2,188	2,536	2,357	2,031
Data modems ^c		504	169	216	307	l	Ι
Source: All data are from KP&TC Annual	Reports, except as of	therwise indicated.					
Includes rented coin phones (coin boxes) (on private premises a	is well as KP&TC p	ay phones.				
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Table 4.1. Expansion of the Public Telecommunications Network in Kenya

^bDoes *not* include rented coin phones on private premises. ^cModems provided by KP&TC and used on leased lines for data transmission.

^dSee Tyler and Jonscher 1982, Appendix B.

'KP&TC changed from calendar year accounting and reporting to a financial year ending in June.

^f1992 data reported by the ITU.

strategies. In 1977, the EAC collasped and a separate Kenya Post & Telecommunications Corporations was established.

Today, little remains of the former collaboration within the framework of the EAP&TC. Tanzania and Uganda have their own independent access to the Intelsat global satellite system, although they still make some use of Kenya's earth stations. The long distance dialing arrangements (in which calls from Kenya to Tanzania and Uganda are routed directly rather than through the international gateway) and certain collaborative training arrangements are the only major parts of the old three-country collaborative facilities that remain.

The Kenya Post and Telecommunications Corporation has proved to be very durable; indeed, its first managing director, Kipng'Eno Arap Ng'eny, was still running the corporation in 1991. It is a wholly government-owned enterprise (referred to in Kenya as a "parastatal") but is intended to be run on a commercial basis. Its board is appointed by the government, and the minister of Transport and Communications exercises broad policy-making powers. In practice, however, management appears to enjoy substantial autonomy.

Kenya's international telecommunications services have a somewhat distinct history. In the colonial era, these, like similar services in other British colonies, were operated by the Cable & Wireless Company. In 1964, control of these services passed to the newly formed East African External Telecommunications Company Limited (EXTELCOMS), jointly owned by the government of Kenya and Cable & Wireless. This company continued as a joint venture until 1974 when KP&TC purchased the 40 percent share owned by Cable & Wireless and renamed the entity KENEXTEL. In 1982, KENEXTEL was merged with KP&TC, which is now responsible for both national and international telecommunications.

Notwithstanding the collapse of the EAC, other forms of international cooperation have thrived. Kenya is an active member of the International Telecommunication Union (ITU). In 1981, Kenya promptly completed its national component of the ITU's Panaftel program, which involved the interconnection of African countries' national networks by means of new or extended microwave transmission routes. Kenya's Panaftel links were financed collaboratively by the World Bank (a loan covered the foreign exchange cost) and KP&TC, which covered the local currency cost. In 1994, KP&TC became a member of the Regional African Satellite Communications System Corporation (RASCOM), which has the goal of launching a dedicated African satellite system. Also, KP&TC is active in regional training programs, and Kenyan telecommunications specialists have played a major role in the international exchange of ideas over telecommunications planning and policy (Okundi, Ogwayo, and Kibombo 1977; Okundi and Evans 1975).

In 1968, Kenya became a member of the Intelsat global satellite communications consortium, with EXTELCOMS (and subsequently KENEXTEL and ultimately KP&TC) responsible for operating earth stations to access Intelsat's satellites. Kenya's first major earth station came into operation at Longonot northwest of Nairobi in 1970. There are now two such stations at Longonot, each accessing Intelsat satellites in the Atlantic Ocean and Indian Ocean, with a third earth station in Nairobi and a fourth in Kericho.

4.1.3 Personnel

An essential component of telecommunications evolution in Kenya was the country's successful effort to "localize" its personnel, which greatly reduced its need for expatriate specialists that traditionally were recruited mainly from what was then the British Post Office (BPO).¹ In 1961, of the total EAP&TC staff numbering just over 7,000, 7.6 percent were European, 21.9 percent were Asian, and 70.5 percent were African. Training programs made it possible to reduce the recruitment of expatriates to the small number needed to fill posts requiring very specialized qualifications. By 1975, just before EAP&TC split and KP&TC was formed, less than 1 percent of EAP&TC's employees were expatriates.

4.2 The Economic Context and Its Implications

The Kenya Post and Telecommunications Corporation operates in a rapidly changing economic environment. In the early 1990s, Kenya was experiencing rapid export-led growth and urbanization and a correspondingly high growth in demand for infrastructural services such as telecommunications:

- Real GDP has been growing at nearly 5 percent annually in recent years, considerably faster than the recent growth of the global economy, and faster than the advanced Organization for Economic Cooperation and Development (OECD) countries as a group.
- Kenya has one of the highest population growth rates in the world, averaging 3.5 percent a year from 1985 to 1992. Of the total population of 28 million in 1994, 20 percent live in the urban areas and just over 50 percent are under fourteen years of age. Consumer tastes and spending patterns are changing rapidly.
- Kenya's volume of exports grew at a remarkably high rate in the late 1980s and early 1990s (export volume increased 22 percent between 1989 and 1990 alone), with companies in value-added agriculture (fruits, vegetables, and flowers) and tourism playing a major role.² Meeting the telecommunications requirements of these exporting sectors is exceptionally challenging and crucial to the success of Kenya's national economic strategy (see sections 4.4 and 4.5).

Superimposed on this promising but challenging situation—a rapidly growing economy supporting one of the world's fastest growing populations—have been some special difficulties arising from world market conditions:

- The falling world price of coffee, which dropped 56 percent between 1986 and 1990.
- Problems with the marketing of tea exports.
- The increase in prices of oil imports as a result of the 1990–91 Gulf crisis. In December 1990, the price per barrel was U.S.\$25.42, 35 percent above the level of a year earlier.

• The continued depreciation of the value of the Kenyan shilling (KSh) relative to the U.S. dollar, dropping from a value of U.S.\$0.048 in 1989 to U.S.\$0.017 in 1993.

Agriculture continues to play a very major role in Kenya's economy. In serving the agricultural economy, KP&TC has to build its network and operate its services across a vast and difficult terrain. While there are districts with high population densities (such as Kisii with over 400 people per square kilometer), much of Kenya is hilly or semidesert with large areas of low population density.

Notwithstanding Kenya's high economic growth rate, per capita incomes are still very low. World Bank data, for example, show Kenya at U.S.\$320 per capita, 42 percent below the level in Zimbabwe and 58 percent below Senegal (International Telecommunications Union 1993). Very few rural households can afford a telephone, yet rural telephone service is important for Kenya's economic development. Numerous rural enterprises need telephone service; thus, both public and private telephones play a vital economic role. The government is committed to stimulating small- and medium-sized businesses outside the major urban centers, and the provision of telecommunications infrastructure is essential to the efficient operation of such businesses.

In 1987, on the tenth anniversary of the founding of KP&TC, the then minister for Transport and Communications, Arthur Magugu, stated: "It is the policy of this government to provide the necessary infrastructure that will stimulate economic activity especially in rural areas." The managing director of KP&TC, Kipng'Eno Arap Ng'eny, has observed that a "direct consequence of the economic and social imbalance between urban and rural has been the unidirectional flow of population from the rural to urban centers. The lure of the city has resulted in a serious 'brain drain' from the rural areas, hampering any prospects for future development of the areas." Large amounts of resources have been invested with the aim of improving telecommunications in the rural areas.³

4.3 Telecommunications in Kenya: The Present

4.3.1 Regulatory and Policy Environment

As in most countries prior to the procompetitive changes in industry structure and regulation that became widespread in the 1980s, there was very little separation in Kenya of the regulatory and operational functions. Under the 1977 telecommunications act that formed KP&TC, the minister is empowered to give directions of a general nature to the KP&TC board. Although the minister would be expected to intervene on any controversial internal or international issues, in practice the corporation's management appears to enjoy substantial autonomy both in broad regulatory policy issues and in operational matters.

Nevertheless, KP&TC is subject to certain financial controls. External borrowing must be approved by the government since the treasury guarantees loans to the corporation. Any increase in tariffs greater than 10 percent and all salaries of the man-

agement and staff of KP&TC have to be approved by the government. As a result, KP&TC salary levels are not competitive with those paid in the private sector.

Kenya's telecommunications policy and telecommunications organizational structure has, until recently, followed the "PTT monopoly" approach traditionally employed in European countries and most of Africa. Telecommunications policy in Kenya appears to be just beginning to be influenced by the wave of change toward increased competition that swept the United States, Japan, Europe, and other advanced industrial areas of the world during the late 1980s and 1990s. There are significant early signs of a shift toward a more open and flexible industry structure: specifically, the customer premises equipment (CPE) market opening to competition; the emergence of a variety of special-purpose "private networks," or closed-use groups, operated by business corporations and by nonprofit and intergovernmental organizations; and the arrival in Kenya of various international value-added network services (VANs).

Prior to 1991, all terminal equipment in Kenya except small PBXs (with less than thirty extensions) had to be bought or rented from KP&TC, which also had a monopoly on CPE installation and maintenance. Since 1991, independent suppliers may provide CPE and independent contractors may install and maintain CPE and inside wiring, provided that KP&TC approves the type of equipment used, approves and licenses the installation and maintenance contractors, and conducts a postinstallation inspection of privately installed inside wiring.⁴ The private marketplace was quick to respond to this relaxation, with several CPE companies advertising in the Kenyan press soon after the mid-1991 announcement, including GEC Plessey Telecommunications, Aztech Electronics (selling Sharp brand equipment), Kenya Microcomputers (selling Sanyo), and Samura Communications (selling Nitsuko).

In interviews, KP&TC's top management has stated that its motivation in initiating this move toward liberalization was a desire to improve efficiency by introducing competition and to have the private sector share the increasing financial burden of supplying terminal equipment, thus freeing KP&TC to concentrate its resources on major projects. One user interviewed gave strong evidence to suggest that KP&TC's resources were indeed overstretched in the early 1990s: KP&TC was unable to supply a new PBX on a timely basis, forcing the company to buy its PBX directly from a foreign manufacturer—a purchase that cost the company KSh200,000 (approximately U.S.\$7,400) instead of the KSh10,000 (U.S.\$370) per quarter rental that it would have paid to KP&TC.⁵

Although the relaxation of the CPE monopoly was welcomed and was expected to benefit users and the national economy as a whole, this 1991 deregulation was undertaken to solve specific, immediate problems rather than to reflect a general procompetitive policy trend. Neither major expansion of competition nor privatization appeared to be under serious consideration in the early 1990s. Senior managers at KP&TC have argued that such policies would be incompatible with the corporation's nonprofit objectives, especially the priority given to rural telecommunications investment. One senior manager interviewed during our fieldwork argued that it would be "inconceivable for the Corporation to be privatized until the country's network expansion program has been completed." Based on the experience of other countries, these are not convincing reasons for rejecting the option of privatization and competition.

4.3.2 The Inland Telephone Network

Kenya's inland network in 1993 was still, by world standards, very small: 184,583 working exchange lines in use. The size of the network had more than doubled since 1983,⁶ with major efforts undertaken to upgrade it significantly. The benefits resulting from the most recent modernization (e.g., the installation of digital switches and establishment of a digital microwave transmission backbone between Nairobi, Mombasa, and northeast Kenya), in terms of gains in service quality and capacity, have been significant. In 1990, however, Kenya's long distance network was still severely congested: only 48.1 percent of call attempts on the long distance network were being completed successfully. Of all domestic call attempts made in 1990, the call completion rate was 53.7 percent—about the same rate achieved in 1986–87 (53.6 percent), but worse than the 57.2 percent achieved in 1987–88.7

It is not altogether surprising that congestion was, at the time of our fieldwork, a major problem in Kenya in view of the high rate of traffic growth: the increase between fiscal year 1986–87 and 1987–88 (the most recent year for which data on comparable measurements of traffic are available) was 21 percent, and the increase in the number of direct-dialed calls (though not available to the authors) was certainly much higher.⁸ Matching traffic growth on this scale with an adequate expansion of capacity is a major logistical as well as financial challenge.

Kenya's extensive rural network has continued to grow rapidly. In many rural districts, telephone service continued to be based on manual exchanges for a number of years. From a social point of view, in a society faced with the problem of absorbing a rapidly growing population of the "educated unemployed," this slow modernization is not necessarily undesirable, even though manual exchanges utilize society's investment in transmission capacity less effectively than do well-planned and well-maintained automatic switches. In practice, despite substantial investments in new automatic switches for rural areas, the number of manual exchanges in Kenya rose from 269 in 1983 to 338 in 1991. More recently, a program has been under way to replace these exchanges with low-cost, small-capacity digital switches.⁹

In 1993, there were only 0.81 DELs per 100 inhabitants in Kenya, indicating that network expansion still has a long way to go. This level of telephone line penetration is lower than that of many Asian and Latin American countries but in the middle of the range in African countries. Telephone penetration is higher in Kenya than in neighboring Tanzania and Uganda, but it is 65 percent lower than the penetration level in Botswana and 38 percent lower than that of Zimbabwe. In 1993, there were 426,000 telephone sets connected to the public network in Kenya, yielding a density of about 1.58 telephones per 100 inhabitants.

In 1992, 61 percent of Kenya's 126,539 exchange lines were business lines. Since 1983, the number of business exchange lines has grown at an annual rate of 10 percent. In contrast, residential lines have grown 7 percent annually between

1983 and 1992, reflecting the increasing telecommunications demand by the selfemployed and home-based small businesses, the high demand for purely residential service, and the efforts being made to clear a long waiting list. In 1991, the waiting list for residential lines in Kenya was reported to be twice as high as for business lines: 59,000 compared with 26,000.

A country's waiting list for telephone service remains an important measure of how effectively the country's telecommunications operator meets the demand for service. Problems in interpreting waiting list data, however, do exist. For example, when the wait for service is long, some people will put themselves on the waiting list on a speculative basis, even when they are not sure they will be able or willing to pay for service when the time comes. On the other hand, others may simply give up and not bother to join the list at all.¹⁰ Nevertheless, a long waiting list is a strong indication that there is a large amount of unmet demand. And unmet demand, especially for business, means economic loss: applications of telecommunications services whose benefits exceed their costs have to be forgone.

A comparison of a country's waiting list with the scale of the existing telecommunications service provides a good indication of the size of the problem. The problem in Kenya is substantial and greater than in many other developing countries—though not on the crushing scale experienced by Egypt or Nigeria, where the size of the waiting list is comparable to the size of the *entire* existing telephone system.

4.3.3 Pay Phones: An Important Special Case

In developing countries, where the majority of people do not have access to a telephone at home or at work, public pay telephones (pay phones) play, or should play, an extremely important role in supporting the objectives of economic efficiency and distributional equity. Kenya has been an admirable exception to some countries' tendencies to ignore the social importance of pay phones because they are "unglamorous." Pay phones are of great value to poor households and rural communities in developing countries.

Pay phones are also especially important to small businesses that cannot yet afford (or, because of the waiting list, cannot yet obtain) their own telephone line. Economic policy throughout the world is belatedly recognizing the importance of such small enterprises in generating employment, income, and savings; in developing entrepreneurial attitudes, behavior, and skills; and thus in laying the foundations for future growth. Kenya is fortunate in having a strong tradition of such grass roots entrepreneurship.

Long queues and malfunctioning telephones impose frustrations and wasted time on both residential and business users of pay phones. Economic research in several countries has shown that many residential and business customers place high economic value on pay phone communications, are willing to pay for the service at a level at which the telephone operator can make a profit, but are prevented from doing so by their country's low level of pay phone investment.¹¹ Thus, a well-implemented public telephone program can simultaneously achieve high utilization, high profitability, and large social benefits. Although it has been somewhat controversial (see section 4.5), KP&TC's pay phone program is one of its main success stories of the 1980s and early 1990s. Before 1982, public pay phones were rare in Kenya. The existing service was operator-controlled, not automatic.¹² On January 1, 1993, 5,613 public pay phones were in operation—one of the highest country totals in Africa. Moreover, KP&TC appears to have been fairly successful in keeping its pay phones operating reliably by clearing faults promptly and emptying the coin boxes regularly.

The corporation has worked with Danida, the Danish government's bilateral development assistance organization, to upgrade and expand the pay phone service. Starting in 1982–83, Danida funded the purchase of about 3,500 modern coin pay phones from Denmark through a mixture of loans and grants. In 1988, installation of card phones began, adding a further dimension of convenience to the pay phone service but planting the seeds of future controversy.

4.3.4 The International Network

Kenya's international services are provided via submarine cable systems, the Intelsat satellite system (accessed via the standard A satellite earth stations at Longonot, Nairobi, and Kericho), and terrestrial microwave radio links to neighboring countries. Time-division multiple access (TDMA) equipment was installed at the Intelsat earth stations to help meet the rising demand for international capacity.

The Intelsat Business Service (IBS) was introduced to meet a wide range of business telecommunications requirements for voice, data, telex, facsimile, and video conferencing services. The service provides private nonswitched communications (i.e., the functional equivalent of international leased lines) mainly via small- and medium-sized earth stations located near the end user's premises or through a larger country's gateway terminals.

Kenya is connected to the SEA-ME-WE submarine cable system linking Africa to Southeast Asia, the Middle East, and Europe. As of June 1988, there were 896 international circuits in operation between Kenya and the outside world, 810 via satellite, 39 via the SEA-ME-WE cable link, and 47 via Panaftel microwave. A total of 2,500 international circuits, not counting microwave links to neighboring countries, were in operation in the early 1990s.¹³

4.3.5 Mobile Communications and Radio-Based Services

Six hundred radio call subscribers in Kenya are estimated to be using KP&TC's high-frequency (HF) radio communications service to remote stations. In the early 1990s, this service was expected to be phased out officially, but in practice it is still highly valuable to farmers and to the travel and tourism industry; thus, HF is likely to continue operating for many years. In addition, KP&TC provides a VHF radio service for mobile communications in the capital and surrounding districts. This service has a relatively small customer base.

A VHF Community Repeater Service was introduced in 1980, enabling mobile users in the Nairobi area to communicate via a shared repeater station owned and

operated by the KP&TC.¹⁴ There were plans to extend the service to the Mombasa area.

A paging service was introduced within the Nairobi area in 1980. A full cellular service covering eight regions in southern Kenya was introduced in 1992 in collaboration with the NEC Corporation.

Mobile services, and radio-based telecommunications in general, could play a far more important role in Kenya and all of rural Africa than anyone expected in the 1980s. Although the initial infrastructure costs are high, the subsequent advantages from reduced maintenance costs and enhanced reliability are significant, not least because it eliminates thefts of copper overhead plant, a real problem in rural areas. A cellular service in Kenya could easily attract 5,000 to 10,000 subscribers in its early years, with the numbers rising substantially as costs are reduced and the scale of operations increased. It could perhaps even lead to a low-cost personal communications network (PCN) service, such as the Japanese "Personal Handyphone." Such radio-based services could be widely used for fixed communication (i.e., "wireless local loop"), as well as for mobile applications, once advancing technology and increasing scale make them cost-competitive with wired technology.

4.3.6 Data Communications

The dynamism of Kenya's economy and its links to the global marketplace are reflected in the strong demand for data communications. Until recently, data transmission requirements were met mainly through the use of modems over leased analog lines. Poor line quality and congestion made the use of switched voice connections for data transmission problematic, especially for international links; digital leased lines were not available. Growth in the use of leased analog lines for data has been rapid: fifty leased lines were in use in 1980; by 1983, 169 modems were in use to terminate leased data lines; and by the end of KP&TC's 1987–88 fiscal year (June 1988), 307 modems were used in this manner.¹⁵ The total in the early 1990s may have been about 400, but achieving an exact count of modems has become more difficult since 1991, when the CPE market was opened to competitive supply.

No longer holding a monopoly on supply, KP&TC cannot know precisely what proportion of its leased lines or public network exchange lines are connected to independently provided data communications equipment. As of 1992, KP&TC reported that there were 525 pieces of data termination equipment attached to the public telephone network and 4,500 on other networks (International Telecommunication Union 1994). From the leased-line point of view, this count of data-terminating equipment probably underestimates the true magnitude of data users in Kenya, since each termination point could represent several end-user terminals.

In 1991, a new alternative to the use of modems and leased lines became available: the Kenpac packet-switched data network.¹⁶ Kenpac represented a major technical and operational advance for KP&TC, but it was controversial in some parts of the user community at the time of its introduction. Some users voiced concern about the quality of service that could be expected and expressed fears that Kenpac would lead to higher prices for leased lines if KP&TC tried to force a migration from leased lines to public-switched digital services, as some European PTTs had attempted to do.

In practice, marketplace realities and users' bargaining power resulted in this fear being unfounded: because of resistance from users, Kenpac charges were less than half those originally announced.

With respect to ensuring service quality, Kenpac's marketing manager emphasized the company's determination that faults would be dealt with quickly after the customer reported them. To achieve prompt service, Kenpac relied on a team of dedicated technicians organized and managed separately from KP&TC's telephone network staff. During the day, at least two of these technicians were made available to support every Kenpac node. Five professional engineers per day and two per night were scheduled to staff a help-desk facility where two network management computers are located.

4.3.7 Value-Added Services

In 1990, KP&TC created a Value-Added Services (VAS) department. The VAS manager reports to the general manager for Telecoms Services and in certain matters has direct access to the managing director (an indication of the importance placed on this area of business). Value-added services are very broadly defined within KP&TC: the department runs the public telephone service (both coin and card phones), public telex facilities, and Kenpac, as well as being responsible for such services as electronic mail, which are "value-added" or "enhanced services" as these terms are generally used in Europe or the United States.

4.3.7.1 VAS Voice Services

In the 1980s, KP&TC provided no value-added telephone services in the strict sense of the term: there was no voice mail. Automatic toll-free (800 number) service was not available. Increasing numbers of digital switches were installed in the early 1990s, which would in time permit the widespread provision of advanced services, as well as convenience features such as call waiting and call forwarding.

4.3.8 Other Services

A variety of other services complete KP&TC's product line. The most important of these is facsimile. Telex was historically important; although telex is still used extensively, it is in decline.

Telex subscribers increased from 1,750 in 1983 to over 2,031 in 1992. Although the lack of capacity has hampered connections in Mombasa, where the exchange at one stage was 96 percent full, pressures of demand have been relieved by the rapid growth of facsimile. In 1991, telex demand began to drop.

Data are not available on the total number of installed facsimile machines since users do not need to register them with KP&TC. They were thought to number several thousand in the early 1990s, since almost all export companies, for exam-

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ple, had a facsimile machine. In addition, KP&TC has set up "bureaufax," which are facsimile service centers open to the public, in the major towns throughout Kenya. In 1992, KP&TC reported 203 telefax stations and four bureaufax stations. Of the pages transmitted by KP&TC facilities that year, 73 percent were transmitted to international destinations.

4.3.9 Financial Performance of KP&TC

Although KP&TC has achieved success in expanding the network and making its benefits widely available through the public pay phone program, two interrelated areas of major difficulty emerged in the early 1990s: the financial condition of KP&TC deteriorated substantially, and it became clear that KP&TC was drastically overstaffed. Although it was not possible to analyze these issues in great depth during the preparation of this chapter, clear danger signs were visible.

At the outset of the Third Telecommunications Program in 1986, the World Bank, a major funding source for the program, had few concerns about KP&TC's financial health. The corporation's *Annual Report and Accounts* for 1987–88 showed a surplus of about KSh0.5 billion (about U.S.\$18.5 million at the 1991 exchange rate) on KSh2.9 billion (U.S.\$107 million) of revenues. Corresponding figures for the telecommunications business considered on its own showed a KSh0.7 billion (U.S.\$25.9 million) surplus on KSh2.6 billion (U.S.\$96 million) of revenues. The 1987–88 annual report noted that KP&TC's return on equity had risen from 23.6 percent the previous year to 28.5 percent in 1987–88 but that this was "mainly attributed to the increased financial leverage." A large amount of borrowing was indeed taking place. Unfortunately, much of it involved high costs, which eventually would have an adverse effect on future years' financial results.

By 1989, the financial situation had deteriorated substantially: the net surplus, even before adjustment for foreign exchange losses, was less than KSh100 million (U.S.\$3.7 million). The corporation's cash flow was negative in 1989. In the period 1987–89, revenue per unit of telephone traffic carried fell by 2 percent per year, while costs per unit rose at 11 percent annually, an increase partly explained by the growing financing charges associated with the large investment program.

The combined effect of several different factors seemed to be the cause of KP&TC's financial difficulties. One of these was a poor success rate in the collection of accounts receivable. The public sector was the worst offender, with unpaid bills amounting to about two years' outstanding billings from the government. The corporation offset this by not paying the government's telecommunications tax. In December 1990, KP&TC conducted a national crackdown on bill defaulters at the direction of President Moi. In the course of this effort over fifteen government ministries, including the Ministries of Water, Information, Public Works, and Health had their telephone service disconnected.

A second problem area was pricing policy. The government had not allowed domestic tariffs to be increased sufficiently to offset inflation and had not allowed international tariffs to be increased at all during 1989–90, despite the 40 percent fall in the Kenyan shilling against the U.S. dollar over this period.

A third source of financial difficulty appeared to have been a rapid escalation of

the level of capital investment. Much of this increase appears to have been financed from high-cost sources of credit, and it is not clear whether strict economic tests were applied to assess the viability and rate of return of the additional investment projects. The original plans for the Third Telecommunications Program called for a total of U.S.\$90 million in investments. The loan agreement for the World Bank funding for the Third Program was signed in May 1986 and loan disbursements began in 1987, with the intention that the program would be completed in 1991. By 1989, the total of actual KP&TC investments during the Third Program period was far above this figure and may have been in excess of U.S.\$200 million.¹⁷ The difference was apparently due mainly to previously unprogrammed rural telecommunications investments, many of them underwritten with costly financing provided by equipment vendors and other forms of highcost bilateral credit. The annual level of KP&TC's capital spending rose from a level of KSh653 million (about U.S.\$24 million at 1991's exchange rate) in 1983 to over KSh804 billion in 1987-88. In 1991, annual capital investment was running at an annual rate of over KSh1 billion (U.S.\$37 million).

The ability of KP&TC to finance its capital program itself or to attract outside finance obviously depends on the profitability and economic efficiency of the corporation, which in turn reflects productivity, costs, pricing, and the way the capital investment program is financed. Unfortunately, the trends affecting KP&TC's profitability appeared to be quite unfavorable at the time of our interview field-work in 1991. To some extent, this was due to factors beyond KP&TC's control, notably government restrictions on pricing, which limited KP&TC's ability to adapt to the rapid depreciation of the international exchange rate for the Kenyan shilling (which fell 18 percent in 1989, 19 percent in 1990, 17 percent in 1991, and 14 percent in 1992 against the U.S. dollar). To some extent, it was also attributable to the decision made, on social and political grounds, to invest heavily in the rural infrastructure on a scale that was unlikely to provide favorable short-term financial returns.

The corporation's financial problem, however, seemed even larger than could be explained by these considerations alone. Overstaffing seems to have been a major factor in KP&TC's financial woes. There is a very high ratio of staff to the number of exchange lines and telephone sets KP&TC supports, although this low productivity has improved in recent years. In 1990, there were 120 staff members per 1,000 telephones, compared with the target of 62 agreed with the World Bank. Although KP&TC management argued during our program of interviews in Kenya in 1991 that the corporation had a social obligation to employ people to reduce unemployment, the very low productivity had a serious adverse effect on the corporation's financial condition and on the general business disciplines needed for economic efficiency. More recent statistics available indicate that KP&TC's workforce was 13,000 in 1992, or 30.5 staff members per 1,000 telephone sets. The corporation had also achieved staff levels of 62.5 workers per 1,000 working DELs (International Telecommunications Union 1994).

In its drive to modernize, KP&TC focused too much on additional hardware, thus overextending its investment resources, and did not sufficiently develop the "softer" elements of customer service—marketing, preventive maintenance,

repair, and staff training—that would have enhanced revenue growth and reduced costs. The net result of these factors was a state of financial difficulty that was not possible to diagnose fully from the data available in KP&TC's *Annual Reports and Accounts*. Nevertheless, based on the available information, there was concern in the early 1990s that KP&TC might encounter difficulties servicing its foreign loans due to its large external debt burden, aggravated by the unfavorable trend of the exchange rate.

As KP&TC's position, viewed from a commercial point of view, declined in the late 1980s, its ability to raise capital on a purely commercial basis at a tolerable cost also became more limited. Its relationships with sources of funding on concessionary terms (both grants and loans) also appeared to deteriorate. The issues involved are discussed further in section 4.5.

4.4 Telecommunications Users and User Benefits

The discussion so far has primarily viewed telecommunications in Kenya from the point of view of the network operator, KP&TC, and public policy makers. All of this, however, is relevant only because of the need to produce an end product: service to the user. This section will address users' needs, how well these needs are being served, and how important the service of these needs is to the national and international economy. An in-depth discussion of these issues is possible due to the existence of extensive quantitative economic and business research on this subject carried out in Kenya between 1983 and 1991—possibly more than research on any other developing country.¹⁸

4.4.1 Research on Users and Telecommunications Benefits

In 1981, a study of the role of telecommunications in Kenya's economy was undertaken by the consulting and research firm CSP International Inc. under contract to the ITU. This work formed part of a wider research program on the role of telecommunications in economic development undertaken by the ITU in collaboration with the OECD.¹⁹ Virtually all previous studies in this field used macroeconomic statistics and sought, with only limited success, to demonstrate a causeand-effect relationship between the expansion of the public telecommunications network and economic growth, using data on broad economic trends: that is, a macroeconomic method. The 1981 study for the first time examined the relationship between the expansion of the public telecommunications network and economic growth at the level of the individual business enterprise: a microeconomic approach.

The CSP/ITU study analyzed the impact of telecommunications services (or the lack of such services or quality problems with such services) on the functioning of specific business activities such as purchasing, overcoming production stoppages, or operating vehicle fleets. It was based on nine in-depth case studies of enterprises in Kenya, ranging from a food processing/manufacturing firm to a large exporter of vegetables and a major transport company.

The study identified substantial costs and operational problems associated with limited availability of telephone exchange lines, severe network congestion, and unreliable service. The estimate of potential benefits to the case study companies (increased value added through expanded output and sales and/or decreased costs per unit of output) were large, ranging from 1.3 percent to 9.2 percent of each firm's total revenues. In no case was the potential benefit less than ten times the cost to the economy of expanding the capacity of the telephone system sufficiently to achieve the estimated benefits. Practical limitations of management and organizational behavior within the sampled organizations might prevent 100 percent the potential efficiencies theoretically possible through improved communications (e.g., better scheduling of trucks with return loads) from being fully achieved in practice. Nevertheless, the study demonstrated for the first time that the economic benefits to users, and hence to the national economy, that were achievable by expanding and upgrading the public telecommunications services could be estimated through hard data and a systematic methodology, and that the benefits are large compared with the costs.

In 1987, a further study, again carried out by CSP International for the ITU, was undertaken to determine the foreign exchange benefits that could be achieved by investment in the World Bank's Third Telecommunications Project for Kenya. This study included interviews with twenty export-oriented businesses. Five of these businesses were revisited in 1991 as part of a series of twenty interviews that encompassed five additional user companies; technical assistance, aid, and lending organizations; and KP&TC.

The 1987 study concentrated on Kenya's top telecommunications users within the agricultural, industrial, and tourism sectors. The interviews with additional companies in 1991 contributed further insights concerning the airline, newspaper/publishing, and banking sectors. All the companies interviewed were major players in their fields, making a significant contribution to the national economy. The twenty businesses interviewed in 1987 accounted for almost 20 percent of Kenya's total export earnings in that year; by 1991, they had expanded to contribute 27 percent of total export earnings.

It was evident from the 1987 study that the revenues of the KP&TC were constrained far below their potential level by inadequate capacity and service quality, reflected by the long waiting lists and by service congestion. Slow repairs to faulty facilities were another major cause of lost revenue. During the 1987 study, a technique was developed to estimate the foreign exchange earnings forgone by Kenya's economy as a result of the inability to meet demand for telecommunications services: this predicted shortfall combined estimates of direct effects (foreign exchange that KP&TC could have earned through the international settlements process if it had met the full demand for international calls²⁰) and indirect effects (foreign exchange that telecommunications users would have earned through their normal business operations if these had not been constrained by inadequate telecommunications services). The annual foreign exchange "cost" to the economy of inadequate provision of telecommunications services in this sense was estimated at just over KSh186 million.

The 1991 interviews showed that a minimum threshold requirement for tele-

communications services was being met, allowing companies in Kenya to operate in a modern manner and to do so more efficiently than in the majority of developing countries. However, beyond this threshold there are substantial gains that could be made from a higher investment in network infrastructure and service provision.

The national economy and the demand for telecommunications services in Kenya in the early 1990s were much larger than they were in 1987, and the gap between demand and supply was greater than ever. Consequently, when we applied the same methodology used in 1987 to estimate the foreign exchange earnings forgone as a result of underprovision of telecommunications services, we derived a substantially larger estimate (see section 4.4.6).

Such estimates cannot capture the full range of benefits to Kenya's economy from expanded and improved telecommunications. For example, improved communications would further enhance Kenya's attractiveness as a location for the "footloose" activities of multinational corporations in Africa.

The users that benefit the most from higher investments in telecommunications are exactly those who also contribute the most to Kenya's foreign exchange revenues. Kenya is in danger of being caught in a vicious circle involving frustrated telecommunications users, slower export growth, slower growth in KP&TC revenues, and hence greater difficulty on the part of KP&TC in sustaining an adequate level of investment in the expansion and upgrading of the public network.

The following sections assess the implications of inadequate availability and quality of telecommunications services on three key economic sectors. Difficulties encountered by end users are summarized in terms of lost managerial time, reduced sales, and higher inventory levels that are directly attributable to telecommunications problems.

4.4.2 Service Quality

In the earlier review of service quality data (specifically data on call completion rates, a measure of network congestion), we noted that these data did not show any clear improvement over time. Improvement targets set in the Third Telecommunications Development Program called for increases in call completion rates to 75 percent for local services, 60 percent for long distance, and 50 percent for international calls. In 1989, the overall call completion rate was only 54 percent. By the early 1990s, these targets had still not been met.

The general view among users is that service has improved substantially since 1987. For example, the users we interviewed focused more on the total disruptions of service that are periodically experienced than on congestion, a significant but lesser consideration. Between 1989 and 1991, our interviewees told us, the problems previously encountered in the rainy season, when water often entered the cable plant and service was sometimes completely interrupted for long periods, had been greatly reduced in most areas.

The continuing concerns expressed by users focused mainly on the availability of service and the degree of service reliability and congestion in rural areas; specific local problems in the Nairobi industrial area (where a large amount of industrial activity takes place) and the Jomo Kenyatta Airport area outside Nairobi; delays and unpredictability in the installation of new exchange lines and leased lines; and delays in repairing faults.

In the Nairobi industrial area, network congestion was still severe at the time of our interview fieldwork in Kenya in 1991. This has continued to be a concern for some companies located in this area.

Our interview respondents felt that the situation in the industrial area had not improved. The situation at the airport had its own specific problems: old exchange equipment; a shortage of "junction" circuits to Nairobi, with consequent congestion; and frequent outages of junction circuits, including those used as leased lines. Respondents attributed these outages to water ingress in the rainy season and to cable theft.

Most of the companies we interviewed expressed concern about the time delay in installing additional exchange lines and the unpredictability of the delays. Sometimes companies that planned for a long lead time were caught out by an unusually rapid installation. One of the banks interviewed requested a leased data line one year before it calculated that the software it was developing would be ready. In fact, the line was delivered after three weeks and was consequently lying unused. In interviews, users also expressed dissatisfaction with KP&TC's maintenance procedures and maintenance delays, although in the early 1990s there were indications that the situation had improved.

Overall, then, the telecommunications picture in Kenya is one of significant but uneven improvement in service quality, with the most extreme problems of service interruption being overcome in most locations (with important exceptions) and congestion, slow installation, and repair as continuing concerns. It is indicative of the significance of these problems that telecommunications difficulties figured prominently in the controversy in the early 1990s over an (unsuccessful) proposal to relocate the world headquarters of the United Nations Environment Program (UNEP) from Nairobi to Geneva.

In the following discussion, we draw on details gained from our interview program with individual businesses to assess the economic significance of problems resulting from the availability and quality of telecommunications services.

4.4.3 Agriculture

The export of high value-added cash crops is one of the most dynamic elements of Kenya's economy. While total exports grew (in volume terms) by 22 percent in 1990, horticultural exports grew by a record 40 percent in volume terms and nearly doubled in value terms from KSh79 million in 1989 to KSh140 million in 1990. This success story is as important from a social standpoint as it is from the standpoint of the achievement of macroeconomic goals. Export-oriented agriculture is an important direct source of rural employment and indirectly generates a large amount of economic activity in other rural occupations. Kenya's rural areas today employ over 75 percent of the labor force, and it is the rural economy that will have to create most of the several million new jobs that will be needed by young Kenyans in the mid- to late 1990s.

Kenya's horticultural export subsector, which grows and exports fruits, vegetables, plants, and flowers, has become a highly dynamic and internationally oriented business community, with a mixture of both large and small farmers. Kenya has several of Africa's largest flower farms and is the single largest supplier to the Dutch flower market. Kenya has also become a premium fruit and vegetable grower for top supermarket chains throughout Europe. Local businesses grow, process, clean, trim, and package the produce—highly labor-intensive activities. One farm ships 180 tons of flowers weekly to Europe, employing over 2,000 staff either directly on the farm itself or indirectly in the supporting transportation, freight, and baking activities that support the business.

The agricultural export businesses are highly dependent on communications to keep in touch with prices in the European market and to monitor the movement of their extremely perishable goods across Kenya to the Nairobi airport and on to their international destinations. Some farms even have on-line data links to obtain current market prices, rather like the foreign exchange traders in the financial markets. The pricing of agricultural exports must respond promptly to changing market conditions: a telecommunications failure can result in suboptimal pricing, mistakes in shipping produce, and disappointed customers. Farms and rural areas are not generally well served by Kenya's public network despite large investment expenditures by KP&TC in rural expansion in recent years. Such issues as cutoff calls and crossed lines (or "crosstalk"), in which a conversation on one circuit interferes with another circuit, are often cited as recurrent problems.

Other interviews provided insight into the specific ways in which inadequacies in public telecommunications services harm the effectiveness of horticultural export operations in regard to specific business functions, such as packaging, purchasing, shipping, maintaining customer relations, and pricing.

Product Packaging. A major Kenyan pineapple producer told us that it must communicate from its farm to the factory regarding changes in the size of the fruit being delivered, since this determines the setting of the plant's fourteen processing lines. When telecommunications problems prevent such communication, processing lines often have to be shut down unexpectedly and reset, which slows the plant to only 60 percent of its normal production capacity. Management thought that cellular telephone service in the future could greatly enhance plant productivity, enabling its export output to increase.

Buying. A Kenyan horticultural company that performs the marketing for a number of small farms described the significant problems it encountered in communicating with its buyers on the road. A buyer is authorized to buy a set number of boxes of beans at a certain price per box but has no authorization to buy at a higher price if an insufficient number is available at the lower price. When the buyer cannot find a working telephone to gain authorization from the head office to buy at the higher price, he or she returns without the required amount of beans and the company is unable to fill its export orders. Similarly, if the buyer's vehicle breaks down, it can take many hours for the driver to reach a public telephone (which may or may not be working) to request assistance and inform the office that the delivery will be delayed. These types of delays have a harmful effect on both freshness of products and customer satisfaction.

Freight Transport. The case study interviews showed that difficulties in communicating with farms when there are dockside delays, or when air freight space is canceled, resulted in inappropriate harvesting and delivery of perishable produce. If the docks or airport authorities can get through by telephone to the head office of an agricultural enterprise, the company can usually resolve the situation by sending a driver to the farm with a message. In extreme cases, however, a whole shipment may be ruined or sold at a lower than optimal price in the home market.

Customer Relations. Foreign customers of some Kenyan produce and flower growers like to be informed of the number of boxes that have been dispatched to them so they can make the necessary arrangements for delivery. If the telex is out of order for an extended period of time, as it was for ninety-three consecutive days for one flower grower in 1991, it is not possible to provide the level of service the customer expects.

Pricing. Other case study interviews were in the tea and coffee-growing industry. World markets are complex and volatile. Kenya's Tea Development Authority, a public-sector agricultural marketing organization, explained in a case study interview that it must obtain quotes from at least twenty-five agents. Telex congestion, however, often made this impossible in 1991 and earlier years, reducing the chances of getting the best prices. Kenya's coffee producers are also very dependent on up-to-date information on market movements and use Reuters Monitor, an international on-line information service providing commodity price data, for this purpose. When failed data lines prevent access to this critical information, Kenyan producers are at a major disadvantage in bargaining with buyers in Europe and elsewhere.

4.4.4 Manufacturing/Industrial Business

In 1991, Kenya's manufacturing sector contributed 12 percent of the country's GDP, but it has not yet become a significant export sector. Kenya's manufacturing industry contributed to the balance of payment by supplying products to the domestic market that otherwise would have to be imported. At the same time, this sector is one of the largest users of imported raw materials, parts, and equipment. Any savings that manufacturing companies can make in the cost of imported inputs will make finished goods more competitive, thus displacing imports, encouraging exports, and contributing to the growth of the economy.

According to our interviews, a variety of business functions of Kenya's manufacturing sector have been adversely affected by telecommunications problems, including purchasing, licensing, inventory control, production coordination, freight transport, and sales and pricing.

Purchasing. A petroleum company interviewed in one of our case studies told us that it buys six million barrels of crude oil per year on the often volatile world spot market, relying on good communications to buy at the best possible price. But diffi-

culties in placing international calls from Nairobi have delayed the negotiation and closing of deals, resulting in higher costs. In one factory interviewed, the inability to get through to suppliers by telephone forced the factory engineer in several instances to drive into Nairobi to obtain new parts or quotations, with a consequent waste of management time and vehicle expense. The inability to get a sufficient number of quotes because of communications difficulties also caused the same company to pay a higher price for materials than it might otherwise have done.

Regulation and Import Licenses. In 1991, we found that a Kenyan chemical company was encountering problems in obtaining such licenses on a timely basis because of the restricted number of telephone lines into the Ministries of Agriculture, Livestock, and Commerce where the licenses were issued. Instead of being able to monitor the progress of a license via telephone, a company representative was often forced to travel to the ministry in person.

Inventory Control. A Kenyan importer of automobiles in "knockdown kit" form experienced problems with inventory control for spare parts in its fourteen sales outlets due to telecommunications failures. Since parts were often not available when they should have been, the company lost spare parts sales and its customers were dissatisfied.

Production Coordination. We found that a Kenyan battery manufacturer had to call the smelting manager in Athi River from Nairobi ten times a day. Because it frequently required thirty minutes to get through on the telephone, a considerable amount of management time was wasted.

Freight Transport. A Kenyan petroleum company experienced problems coordinating the transport of products because of Kenya Railways' frequent inability to reach the company by telephone to inform it of the daily loadings. Cargos can be shut out of the rail freight schedule because of the arrival of fertilizers or other priority goods; consequently, several days' loads may arrive at the same time, which incurs "demurrage" costs and overtime payments while the backlog is cleared.

Sales and Pricing. We found that a major Kenyan cement producer suffered considerable sales price penalties because poor communications made it difficult to contact buyers in such markets as Rwanda, Burundi, Tanzania, and Uganda where higher prices could be obtained.

4.4.5 Tourism

Tourism overtook agricultural exports as Kenya's most significant source of foreign exchange. In the late 1990s, however, the sector's performance continued to be constrained significantly by telecommunications problems in several important areas.

Customer Relations/Sales. For example, in one of our case studies, a Kenyan car rental company reported that it often lost business because of the time required to phone in to the main switchboard from sales desks in hotels and other locations.

Due to this congestion, it could take up to thirty minutes to confirm with the workshop whether or not a vehicle was available. A travel agent interviewed reported similar difficulties.

Similarly, a Kenyan touring company told us that it lost a large amount of business between November and April in its coastal office because the very limited number of exchange lines were constantly busy, and it was unable to react quickly enough to inquiries for railway/road tours and safaris. Travel agents had to send messengers in order to make bookings or confirm arrangements.

Reservations. Although there is a central reservations service for the hotel industry in Nairobi, hotel managers told us they lost significant amounts of business because of problems communicating with the service. Kenya's hotel companies were moving to computerize their reservation systems in the early 1990s, but by 1991 this had been accomplished only in Nairobi, with no leased-line links to other reservation centers because of the poor quality of the lines. Consequently, reservations were still communicated to the center by mail, courier, telephone, and fax.

Communication with Lodges. The remote location of tourist lodges in game parks makes communications very difficult. The problem has to some extent been resolved by the use of HF radio, but frequencies have to be shared, which leads to problems of congestion and confidentiality. Calls made by guests from the lodges could be an extra revenue source if direct lines were available. One travel operator estimated that it could justify a 1 percent price increase if telephone facilities were available for guests.

4.4.6 Economic Implications

These 1991 interviews confirmed the earlier findings, which showed that there are specific, quantifiable costs to Kenya's economy resulting from the inadequate availability and quality of telecommunications services. Furthermore, our results showed that these effects can be assessed and often quantified by detailed study of the impact on specific business functions and that losses of export revenues (foreign currency earnings) or additional import costs are often involved.

Specific effects of these telecommunications service problems include:

- Production stoppages due to machine breakdowns, spare parts shortages, raw material shortages, or other factors that could be avoided or mitigated with improved communications.
- Failure to obtain the best possible export price.
- Growth constraints as a result of poor communications restricting access to customers or suppliers.
- Wasted managerial time.
- Price penalties paid as a result of the inability to gain sufficient quotes for parts and raw materials.
- The cost of financing large inventory (stock) levels made higher because of reordering delays or unpredictable resupply exacerbated by poor communications.

 Increased transport costs because of the need to send messengers when phone contact is impossible: as much as 50 percent of the total transport cost to the business was an additional import cost (fuel and vehicle depreciation).

Data from the interviews were used to update the 1987 study's estimate of potential foreign exchange earnings forgone as a result of inadequate availability and quality of telecommunications services. The volume of earnings forgone, expressed as a percentage of Kenya's total exports, decreased from 0.75 percent to 0.65 percent over the four-year period 1987-91 as a result of the modest gains in service quality noted earlier. The trends in the availability and quality of service were clearly in the right direction. The improvement, however, was not yet sufficient to meet the full service requirements that arose from the explosive increase in exports and the increasing demand from local industries in that period. As a result, the total burden on Kenya's economy caused by telecommunications deficiencies had actually increased. We calculated the foreign exchange loss to Kenya's economy in 1991 resulting from the inadequacy of public telecommunications services at KSh271 million (U.S.\$10 million) per year,²¹ underlining the strong case for continued high levels of investment (of the right kind) in the public telecommunications infrastructure if the government aims to stimulate the expansion of the export economy.

4.5 Trends and Issues

4.5.1 Telecommunications and Electronics Manufacturing

Kenya has the small but promising beginnings of a manufacturing sector for telecommunications, electronics, and information technology. "Informatics policy" has been incorporated within the national development plan, and government policy favors local participation in the manufacturing of electronic equipment. In practice, manufacturing has so far mainly meant assembly of imported parts in "screwdriver plants." Sanyamco, for instance, started assembling radios in Kenya from imported parts in 1967. Although the employment and added value (and hence gross national product contribution) generated in Kenya per unit of sales is relatively small, local assembly using imported parts represents a first step on the ladder toward a more fully developed electronics manufacturing sector for Kenya.

High prices are commanded by imported computer hardware in a market protected by tariffs. This has created an attractive opportunity for local computer assembly, which Kenya Microcomputers has seized. The company began operations in 1986, and in the early 1990s offered a clone of IBM's PC XT with a matrix printer for KSh78,000 (about U.S.\$2,900). Within fifteen months, 400 of these machines were installed in Kenya, with exports to Uganda, Tanzania, Rwanda, Ethiopia, and Zimbabwe. Other local computer industry companies have concentrated on backup support services while acting as agents for computer manufacturers in the United States and the Far East and also developing specialist sector-specific software packages. The small scale of Kenya's electronics industry is mirrored by the small scale of technological education in the country. Approximately 20 to 30 technicians with "City and Guilds" diplomas leave Kenya Polytechnic every year, with a similar number graduating from Mombasa Polytechnic. In addition, 120 students graduate from the Electronics Faculty of the University of Nairobi and 40 from the Faculty of Technology at Moi University.

Kenya's only significant manufacturing activity for telecommunications equipment was a joint venture between KP&TC and AT&T's Irish subsidiary, Telectron, to manufacture cables and KP&TC's manufacturing complex at Gilgil, where telephone handsets, small PABXs (private automatic branch exchanges), and manual exchanges are assembled both for KP&TC and for export (mainly to other African countries). In the former arrangement, AT&T sent the raw materials for cable manufacture to Kenya—where labor costs are very small—and then bought back the completed cables; however, by 1993, AT&T phased out its participation in this line of business in Kenya.

In 1989, KP&TC's managing director suggested that neighboring countries in Africa should jointly develop local manufacturing: "Through regional cooperation, many African telecommunications administrations can succeed in manufacturing telecommunications equipment, whereby financial and human resources can be marshaled to achieve the required economies of scale."²²

4.5.2 Service Innovation

One of the more intriguing aspects of telecommunications in Kenya in recent years has been the establishment of a variety of special-purpose networks making use of state-of-the-art technology to solve specific communications problems. The majority of these have been established by international public-sector organizations, by universities and other research institutions, by nonprofit organizations, and by the financial services sector.

4.5.2.1 Public-Sector International Organizations

In northern and eastern Kenya, UNICEF, the United Nations Children's Fund, and other United Nations agencies conducted a large-scale relief effort in the early 1990s to assist vast numbers of refugees from Sudan, Ethiopia, and Somalia. The project required immense logistical and communications capabilities. In April 1989, UNICEF installed Inmarsat-C mobile satellite communications terminals at its Copenhagen logistical base; in Khartoum, Sudan; and in project fieldwork areas in Kenya and Sudan. These terminals access the satellites operated by Inmarsat (the International Maritime Satellite Organization), which were originally intended for communications to ships at sea. The terminals can in practice be used on land for both fixed and mobile communications, and they have been used to coordinate the distribution of food and aid in Sudan and northern Kenya. The Inmarsat-C is a compact and lightweight terminal allowing two-way storeand-forward data messaging via satellite. It provides reliable service and uses very little power (15 to 50 watts).

The Food and Agriculture Organization of the United Nations (FAO) and the

European Space Agency (ESA) devised a satellite communications application— DIANA (Data and Information Available Now in Africa)—designed for rapid distribution of data obtained from remote sensing satellites on environmental and agricultural matters. The overall program, which was being implemented in the early 1990s, is known as ARTEMIS (Africa Real Time Environmental Monitoring using Imagery Satellite). User facilities were planned for Accra in Ghana, Nairobi in Kenya, Niamey in Niger, and Harare in Zimbabwe. The information is intended to help identify areas where severe crop failures may be expected due to adverse weather and to pinpoint locations where moisture and vegetation growth may favor an infestation of locusts and grasshoppers.

The FAO, World Bank, and United Nations Development Program (UNDP) also funded a worldwide agricultural information network, the Consultative Group Network of Agricultural Research (CGNET). This data network provides three organizations in Kenya with databases, travel reservation systems, information services, telex, and fax links to over 150 offices and organizations in other countries via packet-switched networks.

The Kenyan office of the African Regional Standards Authority is linked into the ARSONET information system funded by CIDA, the Canadian development agency.

4.5.2.2 Universities and Other Research Institutions

Five universities in Kenya, Uganda, Tanzania, Zimbabwe, and Zambia are collaborating through ESANET (East and Southern African Network), a data network, to experiment with network technology and to link researchers worldwide. The GreenNet conferencing system is available to users at the University of Nairobi and one other data network location in Kenya. GreenNet serves as the gateway to ESANET.

The International Centre for Research into Agroforestry has established a network similar to CGNET. Another new network, WedNet, links Kenya to several other countries and is dedicated to research on natural resources and women's issues (Godard 1994).

The University of Nairobi also participates in a five-country collaboration involving Tanzania, Uganda, Zambia, Zimbabwe, and Kenya for electronic textmessage communications between health care professionals. This network uses a small satellite, HealthSat, launched in 1991, in low-earth orbit. Unresolved regulatory issues within Kenya prevented the University of Nairobi from acquiring a license to access the satellite for a while, but now this link is fully operational.

4.5.2.3 Nonprofit Organizations

In 1990, the Kenya Computer Institute, working with the African Medical Foundation, the Red Cross, St. John's Ambulance, and the Nairobi Hospital announced a prototype project in disaster management communications that would allow authorized institutions to broadcast messages and update information on resource availability. In an international communications program similar to those being pursued by the agricultural research centers, the Environmental Liaison Center in Nairobi was also planning a way to communicate with organizations via electronic mail. These efforts are being assisted by the establishment of an Internet node by the Kenya Computer Institute and the local universities. Organization by UNESCO and funding by Korea and Italy contribute to the Regional Informatics Network for Africa (RINAF) in many countries of the continent. Kenya's Internet node is expected to be operational in the near future.

Currently, the widest international data access is gained via FidoNet, which is the least expensive way to connect to bulletin boards, news, and E-mail for many computer enthusiasts (usually through timed dial-up). FidoNet is a relatively informal worldwide network, developed initially by users themselves. Many of the new data communications networks emerging in Kenya are structured to accommodate FidoNet protocols (Godard 1994).

4.5.2.4 Financial Services and Commercial Sector

Kenya's membership in SWIFT, the global electronic payments network based on packet switching, was promoted by the Kenyan Bankers Association in 1994. Integration of Kenya's banking sector into SWIFT enhanced the telecommunications sector's performance and hence the competitiveness of Kenya's economy as a whole. Prior to the initiation of SWIFT, Visa card payments were settled by courier. This was costly, resulted in time lags, and posed the risk that information on stolen cards would not arrive in time.

Citicorp's internal worldwide satellite network, which includes links to its Kenya locations, is designed to achieve a competitive advantage by providing timely information and rapid execution of transactions.

With fifty-one members and eighty-one travel agency locations, SITA, the global affinity-group data network for airlines, also has a strong presence in Kenya. There were SITA nodes—at Nairobi, Mombasa, Kisumu, Nakuru, and Eldoret.

CompuServe, an information service that is offered commercially to users throughout the world, is available in Kenya via dial-up lines.

4.5.3 Business Challenges for KP&TC

In the early 1990s, KP&TC and its current and potential sources of capital, such as international lending agencies, faced a major dilemma. On the one hand, there was overwhelming evidence of vast excess demand for telecommunications services in Kenya, as demonstrated by huge waiting lists and by the congestion resulting from the many call attempts exceeding the capacity of the network.²³ On the other hand, there were indications that KP&TC would find it more and more difficult to finance a sufficient level of capital investment to catch up with demand, either by self-financing from retained profits (since profitability has been falling rapidly) or through outside loans or other forms of funding.

The financial deterioration of KP&TC in the late 1980s and early 1990s occurred in part because of a hugely expanded investment program, as we noted earlier. Commitments extended far beyond the projected level of investment for the Third Telecommunications Development Program that KT&PC agreed to with one

of its major lenders, the World Bank, in 1985–86, and they appear to have strained the limits of KP&TC's financial ability to sustain its capital spending program.

Also, KT&PC's relations with the World Bank and other lenders and donors deteriorated in the early 1990s. In addition to relations with the World Bank, several bilateral relationships appeared to be troubled. The Danish aid program, Danida, as well *es* a similar Swedish program, both reduced their level of funding for telecommunications in Kenya. In Danida's case, the problem appears to have been (at least partly) a reflection of a controversy over the KP&TC pay phone program, in which KP&TC initially favored card phones using prepaid cards of relatively high denominations over the easier-to-use, lower denomination cards favored by Danida that would be more practical to low-income people. This issue was eventually overshadowed by a larger controversy with several aid donors over alleged corruption in the Kenyan government, which for a time resulted in the suspension of new aid from Denmark. Also, assistance from Norway ceased as a result of a disagreement over human rights (rather than telecommunications) issues.

The net result of these events was that KP&TC, with reduced access to finance on concessionary terms and with a weak financial position that limited its ability to self-finance its own capital investment program, appeared in the early 1990s to be depending increasingly on credits from equipment suppliers or their homecountry governments to finance its telecommunications. Such credits can often be expensive and restricting.

Finding the right level and composition of investment in the network, balancing the need to catch up with high and growing demand against the requirements of financial solvency, continues to be the major challenge facing the management of KP&TC.

4.6 The Future

The future prospects for telecommunications in Kenya are poised between great promise and significant problems. The promise arises from the strong base for future growth provided by KP&TC's technical skills, the introduction of digital technology into its network, and the skills of its numerous sophisticated and demanding telecommunications users. The problems arise from the difficulty of lending to a large capital program at KP&TC on a financially sound basis. We believe that the telecommunications policy debate in Kenya over the next few years should, and probably will, focus on six key subjects: technology choices, the financing of the capital investment program, regulatory reform, "liberalization" (i.e., the policy option of allowing or even encouraging increased competition), "parastatal reform," and privatization. Following are our views on each of these areas.

"Technology choice" refers to the widening range of technology options available for expanding the network and especially the local loop. Issues of special importance are the following:

- What role should satellite communications linking small earth stations ("very small aperture terminals" or VSATs) play, especially in serving rural areas and large multipoint user applications?
- Is there a case to be made for providing direct optical fiber links to the largest users?
- Should the newer radio technologies, including digital radio, be used only for mobile services, or should KP&TC's strategy work from the outset toward a radio-based infrastructure ("wireless local loop") that can, in an evolutionary way, replace wired local loops as a means for providing user access to fixed services and mobile services?

In our judgment, the rate of advance in technical capabilities and cost reduction in all three areas is such that extensive use of these new technologies deserves serious consideration.

With respect to financing the capital program, notwithstanding KP&TC's financial difficulties of the early 1990s, the fundamentals that determine whether it is intrinsically feasible to finance a high level of capital investment in telecommunications continue to be favorable. Demand for service from users is strong and includes a large amount of demand from major business users who are willing to pay for substantially greater use of telecommunications (at profitable prices for KP&TC), especially if the quality of service is improved. The existence of a strong network infrastructure should enhance the return on additional investment in the network, provided that the investment program is planned and implemented appropriately. Finally, expanding access to the network and reducing congestion will generate additional international traffic, and hence foreign exchange revenues for KP&TC, as a result of the international settlements process, as long as KP&TC continues to experience a large surplus of incoming over outgoing traffic.²⁴ It may be possible to use settlements revenues as security for the loan financing of elements of the capital investment program, as has been done in other countries (notably the Philippines).

In the regulatory arena, Kenya clearly needs to adopt the principle, increasingly accepted in other countries, of separating responsibility for regulatory control of the telecommunications sector from the operational function of building and operating networks and providing services. An independent regulatory agency should be created that works at arm's length from KP&TC and the central government and is charged with both ensuring the economic viability of KP&TC and protecting user interests. Such an agency would be more likely than a centralized government agency to adopt a sound pricing policy rather than "squeezing" KP&TC with either no price increases or small increases at a time of inflation and major exchange rate depreciation that result in falling revenue in real terms per unit of traffic. Such independent regulatory supervision would be essential if any additional steps toward open markets and competition are to be undertaken.

Is there, in fact, a case for further movement toward competition? During our interview fieldwork, KP&TC's management argued strongly against such changes, primarily on the grounds that significant scale economies would be lost (because Kenya's national network is relatively small) and because "cream skimming" of profitable traffic by new entrants would undermine KP&TC's ability to

bear the high costs and limited revenues derived from serving rural areas. On the other side of the issue are the benefits of innovation, customer responsiveness, business discipline, and cost/price reduction that have clearly arisen from the transition to competition in telecommunications in other countries. Although the concerns expressed by those on the anticompetition side of the debate have some merit, policies can be developed that satisfy these concerns and still permit competition to develop and yield large benefits.

Whether or not competition in the telecommunications services business arrives in Kenya in coming years (as it already has in the CPE market), there is no doubt that KP&TC will continue to be by far the biggest provider of telecommunications services in Kenya well into the next century. Its performance is therefore a matter of critical importance for Kenya's economy. A wide variety of proposals for improved management of parastatal bodies such as KP&TC are under discussion worldwide under the heading of "parastatal reform."²⁵ The general idea behind such reform is to introduce into parastatal enterprises, such as KP&TC, a more commercial orientation, with greater cost consciousness, innovation, and responsiveness to users.

The World Bank is increasingly making parastatal reform a condition for many of its investments in developing countries. In the case of KP&TC, we understand that the World Bank has made the recommendation that the posts enterprise be separated from telecommunications; that the regulatory framework be restructured and regulatory ground rules made more favorable to competition; and that KP&TC be run as a commercial entity. The possibility of privatizing KP&TC may also have been discussed. Kenya's treasury, however, was arguing that certain parastatals should be excluded from this reform program because they are of strategic importance to the state. The Kenya Post and Telecommunications Corporation would be considered one of these. In 1995, Kenya's Parliament reviewed legislation to separate KP&TC postal and telecommunication divisions. Formal separation of these two divisions took place in 1996.

Leaving aside the issue of privatization, there is a pressing need for parastatal reform to stimulate KP&TC to improved economic performance through more commercial management. At the same time, however, the corporation needs to maintain its social obligations with respect to, for example, the provision of service in rural areas.

The option of privatization returned for debate despite strong opposition. Even more than the successful privatization of British Telecom and of NTT in Japan, the decisions by developing countries such as Mexico to privatize their PTTs, and the successful results, are likely to have a major impact. If Mexico, which has a long tradition of sensitivity to issues of economic independence and national control of the economy, finds that it has been beneficial to privatize Telmex (subject to certain continuing limitations on foreign shareholdings), it will be difficult for policy makers in other developing countries to ignore the precedent.

In short, telecommunications planners and managers in Kenya, and national policy makers considering policy toward the sector, are likely to have a very full agenda. Fortunately, they can draw on a substantial reservoir of Kenyan expertise and experience developed over the last several decades.

Notes

1. The BPO's telecommunications business subsequently became British Telecom.

2. Note that between 1985 and 1991, the value of Kenya's exports, as measured in U.S. dollars, grew 5 percent annually. This rate of growth for export value is lower than the rate of export volume growth due to the impact of the falling exchange rate of the Kenya shilling against the U.S. dollar.

3. Statements from documents made available by KP&TC and interviews conducted during our fieldwork in Kenya.

4. To ensure that all met the approval and licensing standards, KP&TC announced courses on a fee basis for staffs of private contractors.

5. During mid-1991, when this information was gathered, the exchange rate of the Kenya shilling was approximately 27 Kenya shillings to 1 U.S. dollar.

6. The increase in working lines in 1993 over 1983 was 122 percent (International Telecommunications Union 1994; Mulugua 1994).

7. These data were provided by KP&TC in an interview conducted by H. Renfrew in 1991; additional data on call completion are contained in the KP&TC annual reports. This measure includes call failures for all reasons, including "called party does not answer." Nevertheless, the very low figure for long distance call completion certainly reflects a significant problem of congestion.

8. High traffic growth is evident. Between 1983 and 1987–88, telephone traffic more than doubled: automatic dialed units grew from 565 million in 1983 to 1.2 billion in 1987–88. More recent comparable data on domestic traffic (i.e., traffic stated in automatic dialed units) are not available. Statistics showing growth in operator-dialed calls, despite a dramatic increase in automatically dialed calls, are another indication of total traffic increases in Kenya: the annual volume of operator-controlled national calls is 42 percent greater in 1990 than in 1983—an indication of high traffic growth despite increased automation on the domestic network. International traffic has also increased, assisted by network automation: the annual volume of outgoing international traffic in 1989 was 107 percent more than traffic in 1983. The percentage of international outbound direct-dial traffic from Kenya rose from 68 percent in 1985 to 97 percent in 1992 (International Telecommunications Union 1993).

9. This is compared with 62 percent of all rural exchanges in 1987 (Mulugua 1994).

10. In Kenya, this problem of interpretation is compounded by discrepancies between the data available from KP&TC and those reported in the ITU's *Yearbook of Public Telecommunications Statistics*, the other standard source.

11. See chapter 12 in Saunders, Warford, and Wellenius 1983.

12. In 1978, there were only 1,490 such phones in Kenya, including rented coin phones (coin boxes) on private premises such as hotels and restaurants.

13. It is difficult to reconcile data from different sources on Kenya's international circuit capacity. For example, the ITU Yearbook of Common Carrier Statistics cites 680 international circuits serving Kenya in 1992.

14. In 1980, the VHF system had twenty-four subscribers, with capacity for ninety-six. By the end of June 1988, the system still had the same capacity but with forty subscribers sharing six frequency channels.

15. Inferences on total leased-line growth cannot be derived simply from comparing the 1980 leased-line figures and the 1988 modern figures, because domestic leased lines used for data require two moderns (i.e., one at each end of the line), while international leased lines require only one modern for the Kenya end of the link.

16. Dial-up X.28 and X.32 and dedicated X.25 access are available at speeds between

300 and 9,600 bps. Where access is via dial-up network or analog leased lines, KP&TC advises that type-approved modems be bought from Racal or NCR and installed by KP&TC personnel or their authorized agents. There are two switches in Nairobi and nodes in Kisumu, Nyeri, Mombasa, and Nakuru. Gateways give X.75 access to IPSS in the United Kingdom and Telenet in the United States. We were told by KP&TC that Kenpac will support a wide variety of data communications protocols: X.28, 3270 SNA DSP, SDLC, 3270 Bisynchronous DSP, and X780 Bisynchronous (2780/3780) after conversion to the standard interface protocol, X.25. During our interview fieldwork in 1991, however, some users questioned whether the full range of planned protocol-support capabilities was fully effective.

17. The World Bank loan for the Third Telecommunications Program was approved by the World Bank board in June 1985: the loan agreement was signed in May 1986. The original loan amount was U.S.\$32.6 million.

18. For another example beyond the research discussed in detail here, see Cleevely and Walsham 1980.

19. The methodology and findings are described in Tyler and Jonscher (1982).

20. By "full demand" we mean the volume of traffic that would occur if all customers wanting to rent exchange lines and make calls *at the currently prevailing prices* were accommodated.

21. Based on the exchange rate of the Kenyan shilling at 27 KSh to U.S.\$1 at the time this field research was conducted in 1991.

22. From documents made available during our interview fieldwork in Kenya.

23. Strictly speaking, the evidence shows that there is large excess demand at KP&TC's current levels of pricing, which are probably below economically efficient levels because of government restrictions. However, in our judgment there would continue to be a large amount of excess demand at any reasonable level of pricing.

24. In 1990, there were 26.1 million minutes of incoming telephone traffic to Kenya and only 21.2 million minutes of outgoing traffic. By 1992, outgoing international traffic was 22.3 million minutes, showing a modest 5 percent rate of growth.

25. See, for example, Wellenius, Stern, Nulty, and Stern 1989.

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