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Institute of Urban & Regional Development
University of California, Berkeley

Reprint No. 209

Reprinted from: *Habitat Intl.*, Vol. 10, No. 1/2, pp. 105–114, 1986.

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HABITAT INTL. Vol. 10, No. 1/2, pp. 105–114, 1986.
Printed in Great Britain.

0197–3975/86 $3.00 + 0.00
Pergamon Journals Ltd.

New Communications Technology for Development*

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The revolution in electronic technology carries both a promise and a threat. The promise is for dramatic improvements in industrial productivity, managerial efficiency, educational opportunities, and standards of living. These outcomes are made possible because the new telecommunications permit virtually instantaneous transmission of an almost unlimited volume of information from anywhere to anywhere. The threat is that all peoples of the world may not share these bounties equitably. The gap separating rich nations from poor ones could thus widen as a consequence of these new-found capabilities.

Those two prospects shape a policy imperative for all nations, the developing ones especially. Nations everywhere must hasten to equip themselves with greatly expanded telecommunications infrastructure. Moreover, they must exploit the most advanced technology available. This, the Third Industrial Revolution, could trigger as profound changes as the First that harnessed steam and the Second that unleashed the power of electricity. The Third is releasing the power of information, a major force propelling contemporary processes of development and modernisation. Nations that would profit from those processes must exploit this powerful new technology.

THE ROLES OF TELECOMMUNICATIONS IN DEVELOPMENT

Development is a process of increasing specialisation. People living in the least developed societies are the least specialised. They produce their own food, build their own houses, and perform virtually all the tasks their simple lifestyle calls for. As the course of development progresses, the jobs of maintaining family and society become more finely divided: some people devote all their working time to farming, while others work exclusively on food distribution, and still others on cooking, *etc.* Whatever else it may involve, development is a process of ever-more finely dividing up a society's labour, thus increasing the levels of craft and skill that make for improved qualities of goods and services.

However, specialisation is equivalent to dependency. The carpenter may be self-sufficient in house-building, but he must depend on others for most of what he consumes. In the highly developed societies, where occupations are most specialised, everyone is entangled in extremely complex networks of inter-dependencies involving literally hundreds of thousands — more likely, millions — of other specialists for even everyday needs.

*This is an edited version of a paper presented at the 9th EAROPH International Congress, 20–24 August 1984, in Hong Kong.

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These dependencies can be satisfied only through the workings of incredibly complex social organisations that manage the flow of goods, services, and information. Whether formal outfits like corporations and governments, or informal ones like social clubs and families, these organisations are the stuff of which urban societies are made. By linking specialists to each other, interlocking organisational networks within cities permit each specialised unit to carry out its tasks. The work of each organisation is able to mesh with that of others, because cities provide a medium for effective transaction and interaction. Thus, in this sense, cities are essentially instruments of connectivity — huge depots and switchboards where goods, services, information, and ideas get exchanged.

Indeed, that is why cities developed in the first place, as places where traders could find suppliers and customers, where friends could find friends, where solutions to problems could be found — all within tolerable connection costs. Later, once organisations and specialists had gathered in central places, those places became instruments for fostering further development. By creating connections among increasingly large numbers of organisations, the numbers of pairs having common interests increase exponentially, and so do the numbers of pairs that actually engage in transactions of various sorts. In these and related ways, cities have been not only the consequences of development but also its generators.

Cities are now expanding at explosive rates in the newly developing countries, primarily because they provide higher levels and lower costs of connectivity among interacting organisations than do other places. The fantastic growth of the Third World metropolis is a clarion signal that interdependent organisations operating there have an enormous craving for connectivity that they have been unable to satisfy anywhere in the Third World other than in the largest cities. In contrast, in some of the most developed places — notably the West and Southwest USA — many highly specialised organisations have chosen to locate outside the high-density metropolitan centres, some even outside the orbits of the metropolitan regions.

The phenomenon of spatially concentrated metropolitan growth in places where infrastructure is least able to accommodate it, and spatially dispersed metropolitan growth in affluent, well-equipped places, suggests possibilities for other places not widely recognised. It suggests that Third World cities too might be able to absorb the new employers and new residents, while mitigating some of the high costs associated with the crowding and the consequent misery that have been endemic there. It suggests that, if certain critical traits of the Houstons and San Diegos of the developed world could be transplanted to the Jakartas and Bangkoks of the developing world, densities and congestion might be considerably lowered, while simultaneously making these latter cities economically more viable.

To be sure, there are many fundamental differences between the developed and the developing societies and their metropolitan settlements, and we certainly do not wish to obscure the enormous complexities of transposing conditions from the one into the other. But one cluster of traits marking the most-developed metropolises has been largely neglected. Because it is both transplantable and potentially influential, we wish to focus attention on the latent and manifest roles that the connectivity media, especially the telecommunications media, have been playing in the processes of development and in the evolution of metropolitan areas.

Transportation and communication services have always been necessary contributors to the processes of development: indeed, development cannot happen without effective means of transacting business across geographic space — without effective means of moving people, goods, and information. Transportation and communication have also exerted the most powerful

influences on the spatial structures of urban settlements: where ease of movement and east of intercourse are greater, so too is locational freedom. The greater the capacity for transporting and communicating, the more powerful is the engine of development. The more powerful too are the centrifugal forces shaping metropolitan areas. It follows then that investments in media such as seaports, roads, telephones, and telecommunications pay off, not only directly to users of these systems, but also indirectly to virtually all others in the society. As improved connectivity induces further development, the benefits diffuse throughout the increasingly complex social and economic networks that are themselves the signal products of development. It follows too that those investments pay off by contributing to lowered metropolitan density costs and greater access to metropolitan opportunities. A major difference between Houston and Jakarta is simply that Houston is well served with transportation and communication facilities.

Formal research into the relations between telecommunications systems and economic development, though notoriously sparse, has consistently found positive correlations, as, for example, between telephones *per capita* and GNP *per capita* (Figs 1 and 2); but it just as consistently fails to show which causes which. A plausible argument can be made for causation in either direction, of course; but it looks as though *both* forces are at work — that better connectivity is both cause and effect of development, hence that the payoffs from telecommunications investment are *compounded*. The opposite effect must also hold — that deficient telecommunications systems deter development with negative compounding effects.

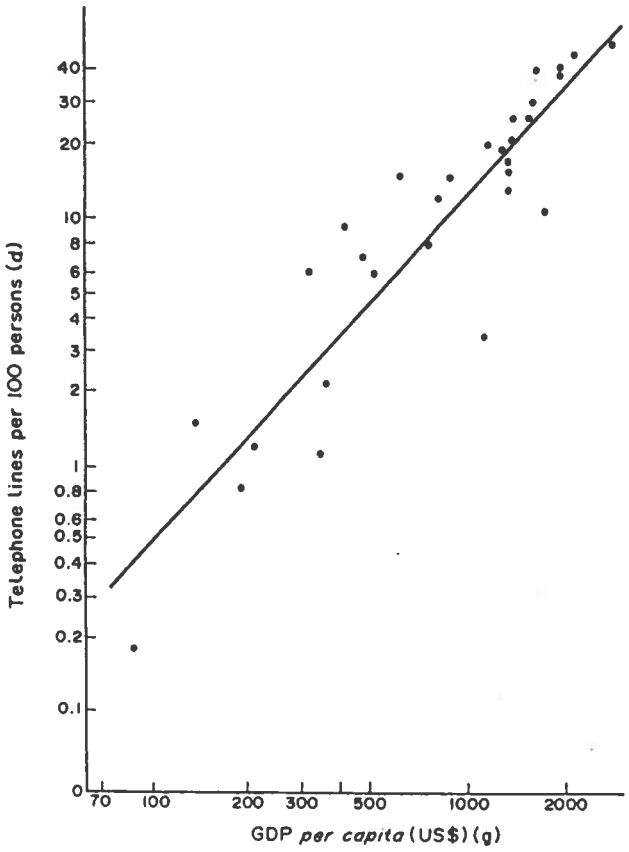

Fig. 1. Density of telephone lines as a function of GDP per capita *for a cross-section of countries, 1965. Source*: CCITT, Economic Studies at the National Level in the Field of Telecommunications *(Geneva, ITU, 1968)*.

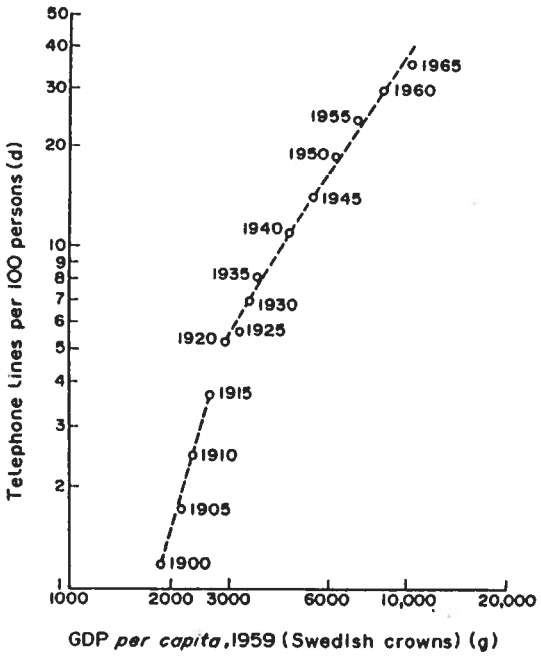

Fig. 2. Density of telephone lines as a function of GDP per capita *in Sweden, 1900 to 1965. Source*: CCITT, Economic Studies at the National Level in the Field of Telecommunications *(Geneva, ITU, 1968).*

Most LDCs (less developed countries) are marked by chronically excess demand for communications services and by chronic underinvestment in those services. The LDCs' share of the world's telephones is even lower than their share of the world's income. In 1981, when the LDCs had more than 70% of the world's population and roughly 17% of its income, they had only 7% of the telephones.[1] In contrast, the USA, with about 5% of the world's population and 23% of its income, had 40% of the world's telephones.[2] Comparative levels of investment are equally dramatic: proportions of the LDCs' GNP invested in telecommunications is about half that of the developed countries.[3] Without a significant shift in government policies, those differences are likely to widen as requirements expand from telephones alone to digital communications systems capable of handling masses of data at high speed.

The social costs of unsatisfied demand for communication services can be gauged on the scales of lost economic opportunities, of high transaction costs and hence inefficient operation of markets, and of lost potential revenues. Where communications services are poor, many firms choose to go elsewhere, and so too do tourists. Where information feedback circuits are clogged, response to shifts in demand for products is likely to be slow. Where information cannot flow freely, markets cannot work efficiently. Even though telecommunications systems typically yield extraordinarily high rates of return, where systems are poor or non-existent, those latent earnings are, of course, never realised.

Between 1970–1980 decade, the US economy devoted on average nearly 5% of its gross fixed capital formation each year to telecommunications plant and equipment. The figure was 1.4% for Kenya and 0.7% for Colombia, while, in a flurry of expansion, the Philippines allocated nearly 10% to the telecommunications sector.[4]

[1]Quoted from Saunders, R.J., Warford, J.J. and Wellenius, B., *Telecommunications and Economic Development*, p. 6. The Johns Hopkins University Press, Baltimore, 1983.

[2]Source: American Telephone and Telegraph Corp., *The World's Telephones*, July 1982.

[3]Saunders, R.J. and Dickenson, C.R., "Telecommunications: Priority Needs for Economic Development", *Telecommunications Journal* 46(9), September 1979.

[4]Source: International Telecommunications Union, Geneva.

These differences suggest that fiscal constraints are not the only reasons for most LDCs' underinvestment in telecommunications. For the most part, we believe, officials in many countries have simply failed to set the right priorities, largely because they have failed to understand the strategic role that connectivity plays in the processes of development, particularly connectivity *via* the communications channels. In turn, misunderstanding stems in part from the difficulty of quantifying the economic benefits generated by improved communications; and it is often compounded by expectation that the benefits will accrue only to the rich.

How then can planners in the LDCs and in the metropolitan areas of the LDCs know how much investment in communications is reasonable and prudent? And, then, how can they know what quality of equipment is appropriate? Given the competing demands upon the nations' limited resources, how much telecommunications is enough? How much comprises extravagance?

Although it is impossible to say with numeric precision, the answer for nearly all countries is clearly *more* — more than they have been investing, more than they now plan to invest. The exceptional nations that have already acquired superior telecommunication systems comprise but a small minority of LDCs, but these are notable for their economic successes. It may be that Singapore leads the field in the quality of its system: and it is no surprise, of course, that its economy is booming and in precisely those industries that are most dependent on instantaneous access to the world's information channels. Most developing nations, in contrast, suffer from severe deficiencies of connectivity — in both the transport and the communications sectors. The deficiencies act to slow the pace of development, and so they contribute to the fiscal constraints that inhibit improvements in the services. Many of these nations are thus involved in a vicious circle that can be broken only through a realignment of investment priorities for infrastructure.

In the past, the approach to telecommunications investment policy in the LDCs has essentially been remedial. Typically, telecommunications needs were analysed in isolation from the global economic infrastructure of a metropolitan area or region. Even today, telecommunications is still seen as "the icing on the cake".

As one consequence, modern firms that do locate in the Third World typically choose sites inside the central core of the large metropolitan areas, where both transport and telephonic access are greatest. As a further consequence, central land values are inflated owing to the competition for space; and rising costs associated with high density and overcrowding, in turn, mirror the rising skylines. In many of these centralising metropolises, low-income residents are being driven to the metropolitan periphery where land costs are lowest, municipal services are most primitive, and commuting costs are highest. The pattern is exaggerated in Latin America's gigantic metropolises where the low-income residences are geographically distant from employment opportunities in the metropolitan centres and where a large percentage of working peoples' sparse earnings are perforce spent on transport.

Spatial separation of jobs and poor people's residences may be least frequent with respect to newly arrived heavy industries that require large plants and large sites, and so have perforce accepted sites on the city's edge. Separation is most common among the service industries that occupy the offices and shops that are amenable to centre-city locations. Of course, these are the industries that trade in information and hence are most dependent on rapid access to information. High-density office concentrations in downtown settings offer a substitute for telephonic connection. In the absence of reliable telephone, telex, and related exchange networks, occupants can turn instead to face-to-face contact. Where telephone systems break down frequently, as they do in most LDCs, occupants

must be able to send runners carrying messages among centre-city offices. According to one estimate, much of Caracas's intolerable traffic congestion is generated by messengers in automobiles carrying pieces of paper from office to office, just because telephones do not work; and Caracas is surely not exceptional in this respect. Not only would the high costs of traffic congestion be reduced, but the capital costs of new roadway improvements might be cut considerably were improvements made to the telephone system instead.

Multinational firms seeking to expand in the Third World are of course highly sensitive to their communication requirements, for branch plants and branch offices must maintain realtime contacts with their headquarters. All other things equal, firms are most likely to locate in nations having superior telecommunications contacts with the rest of the world — both voice and data contacts. Those preferences are likely to be greatest among firms highly dependent on immediate access to the latest information — banks, stock-brokers and tourist establishments — and the growing array in the so-called high-tech sectors — electronics, bio-engineering, space engineering, and much of contemporary military hardware. These are precisely the investors most avidly wooed by development planners everywhere.

Especially at this time in history, when the Third Industrial Revolution is steering the course of economic and social change — especially now when information, knowledge, and intelligence are becoming the major raw materials feeding the advanced economies — ease of access to the world's information channels is an essential condition for economic growth and for development. It is no longer sufficient that information channels link local districts. The entire world is becoming a single and tightly integrated economic and social system, in part, no doubt, as a consequence of the new-found ease of global intercourse. Business firms maintain intimate contact with branch offices wherever they may be and with customers and suppliers everywhere. Governments everywhere are in touch with other governments everywhere. Virtually no place is any longer isolated in its economic, social, and political dealings. Massive flows of goods among the nations by sea, land, and air have substantially eliminated any trace of local economic self-sufficiency. Tremendous flows of information, now made all the more rapid by the installation of communication satellites, have erased most vestiges of cultural isolation and parochialism — at least among the educated segments of the population. No nations, the developing nations included, are any longer isolable from the rest of the complex network that now unifies the planet. In that setting, all nations profit from intimate connection to all others. They thus require ever more elaborate and ever more effective transport and communication links.

A rather different conception of telecommunication policy and concomitant investment policy is therefore required to displace the traditional ones. Nations used to consider telephones as pleasant luxuries, as playthings of the rich. That view will no longer do. Voice, video, and data transmission with their related paraphernalia have now become *necessities* of economic development, if not of economic survival. Nations must now come to regard telecommunications as the necessary accoutrements of modern life, as components of basic infrastructure — no less essential than roads, sewers, electric-power lines, and the rest of the mundane apparatus of contemporary society.

A new appraoch is needed. Policy-makers and planners in developing countries must design global *communications infrastructures* rather than merely seeking to expand numbers of telephones *per capita* alone. With the growing importance of the information-processing sector, communications has become an infrastructural sector of central importance. The potential of communications infrastructure as greenhouse for nurturing growth and development of new

activity sectors, in developed and developing countries alike, is awesome and has been barely tapped.[5]

Although only a few of the developing nations have so far been active participants in the emerging electronics revolution, the numbers have been growing, especially in Asia, as electronics manufacturing has spread there. It seems reasonable to expect that these industrial activities will become major economic-development generators in a great many countries, converting LDCs into NICs throughout the Southern Hemisphere. Thus, as producers rather than merely consumers of the new telecommunications, developing countries stand to profit from the technological revolution and the worldwide social and economic integration that the revolution has fostered. For some nations, telecommunications may come to play the roles that coal, steel, and steam played in the process of industrialisation in the 19th Century. For some, it could become the medium of a new economic history, by-passing the natural history that shaped the development of Europe and North America. However far-fetched it might seem to policymakers in nations that only yesterday used the jungle drum as communications medium and to those where the large majority are still living at subsistence level, it might be encouraging for them to recall that, prior to the recent advent of steam and then electricity, the peoples of Europe and North America also endured very low living standards. It does not require much imagination to anticipate comparably rapid development in some currently developing countries, especially those caught up in the present technological revolution.

Even so, it is as *consumers*, as users of the new communications capability that all nations are virtually guaranteed to be beneficiaries. By installing and then exploiting the new media of connectivity, every nation is bound to be a winner. Even if footloose industrialists happen not to locate in a given country, the increased ease of intercourse within the country is certain to raise living standards.

The electronic communications media — both the broadcast and interactive media — may be proving to be among the more influential agents of social change in the Third World. Already, the broadcast media, radio and television, are destroying the cultural walls surrounding parochial societies, exposing the local residents to ideas and values deriving from other cultures. Inevitably, it seems, even geographically isolated people are being led into the international society that had been invisible to their parents. When local newspapers report world events as they would occurrences in one's own village, when radio and television vividly portray and glamorise life styles in other places, when educational programmes present the cumulative knowledge of the world to students wherever they may be, established old ways are not likely to survive for long.

Widespread use of the first major interactive telecommunications medium, the telephone, proved it a powerful force for expanding individual freedom. By permitting one-to-one intercourse over geographic space, persons have been freed from the constraints of local resources. With access to specialised and personalised information, they have been more able to accomplish their personal objectives. Now with new interactive media bringing tremendous information-exchanging capacities, it is difficult to speculate on the potential outcome for individuals. We can only guess that the effects experienced with telephones will be geometrically compounded.

Simultaneously, of course, the new transport media are fostering mass tourism and massive interchange of industrial and cultural products. With these two

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[5] Nicol, L., "Economic and Spatial Impacts of Communications Technology. Reality and Prospects", in: *Technology, Society and Space*, Castells, M. (Editor). Sage Publications, Beverly Hills, 1985.

powerful technological forces at work, peoples' perspectives everywhere are being broadened. Although much rich regional heritage is being eroded by international tides, it is also reasonable to expect that individuals' lives are being enriched at the same time. But whether the net effects are later judged to be positive or negative, it is evident that profound cultural changes are inevitable. The new communications media are now within the reach of nearly every nation, for the newest and best technology happens also to be the cheapest.

THE APPROPRIATE TECHNOLOGY: HI-TECH

The studied wisdom among development planners has long held that the poor nations should husband their sparse resources by using the simplest and cheapest technology: hand pumps rather than electric pumps; animals rather than tractors; indigenous building materials rather than imported ones; bicycles rather than automobiles. That counsel has proved extremely effective. Without sufficient resources, low-cost means are unquestionably the necessary means. Moreover, the so-called "appropriate technology" has often been the only accessible choice. It has often been the strategically correct one as well, given the skills of users and nations' developmental trajectories. But this is not a universally tenable doctrine, for the old telecommunications technology is proving to be quite the wrong choice for developed and developing countries alike.

Conventional telephone equipment comprises electromechanical switches and twisted pairs of copper-wires. For years this was the cost-effective industry standard. Recent developments in modular electronic switching devices and in optical fibre transmission lines have made the traditional technology obsolete. Computerised switches are more reliable and cost half as much to operate and maintain as their electromechanical predecessors. Optical waveguide fibres cost one-sixth as much to install and ¼ as much to operate as copper cable; even when the price of copper wire rises, the cost of optic fibres continues to fall quickly (Fig. 3).

Moreover, glass-fibre waveguides are immune to induced noise and electromagnetic interference. They can withstand harsh environments, being insensitive to temperature variations, and moisture; and, if damaged, they are readily repaired, using connectors that take only 15 minutes to install.

The positive advantages of the new technology extend to transmission capacity and speed as well. Capacity can be loosely defined as the number of separate channels that the transmission medium can support. Today a strand of optical fibre can carry 250 times the capacity of a copper wire. Next year, the figure will be 500 times. New optical transmissions systems can deliver over 8000 voice channels over a single fibre pair. This figure will soon be doubled. In fact the main limit to the number of calls that can be crammed into one hair-thin optic fibre is the speed of the laser transmitter. This property makes the new medium almost perfectly elastic to traffic demand. Should an optic-fibre line become overloaded, the telephone company needs simply to install a faster laser. Today, the fastest commercial lasers can send over 500 million bits of information per second through a 5 km long fibre. Tomorrow, lasers will be shooting 2 billion pulses each second through a hair-thin glass filament 100 km long without line amplifiers. This speed is sufficient to transmit the entire *Encyclopedia Britannica* in 2 seconds. Sending that much information over a copper telephone line could take days. And telephone lines require costly line amplifiers at 1 mile intervals.

Of course, fibre-optics is not the only alternative to copper wires. Because the uses of communication systems vary so widely, no single medium can meet all requirements placed on a given network. Rather, planners and system designers

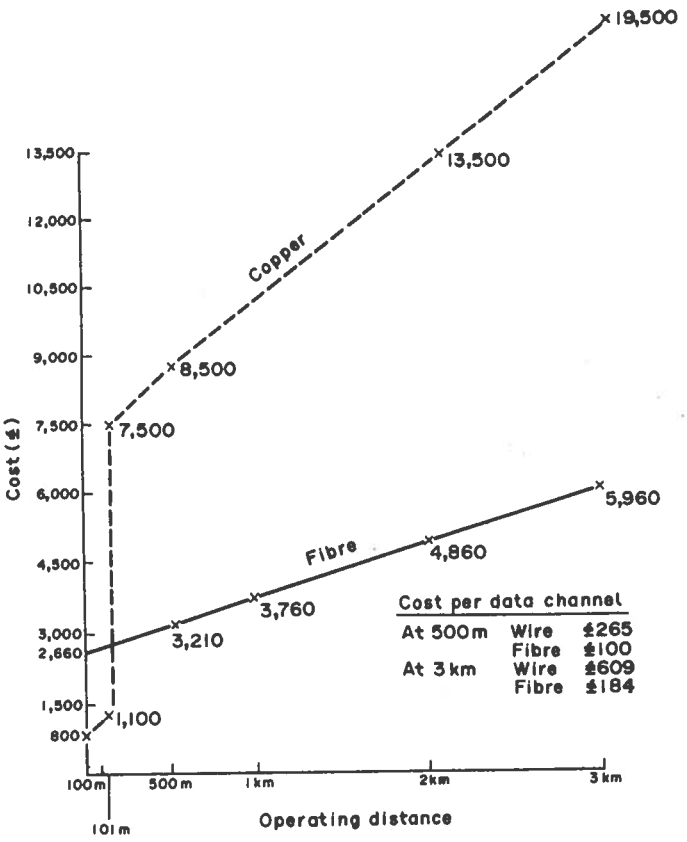

Fig. 3. Wirelfibre cost comparison for a 32-channel, 9.6-kband data link over a maximum operating distance of 3 km. Source: R. Farmer, "Cost-Benefits of Fibre-Optic Systems," Telecommunications, *July 1983.*

often find themselves having to choose among various modes of transmission. In addition to the conventional copper wire, four media are currently in use: coaxial cable, fibre optics, microwave radio, and satellite. The performance of each medium depends on the length and density of the links to be used in particular application; because the parameters rarely remain constant in any network, the optimal network is likely to involve a combination of transmission modes rather than a single one.

Ironically, in constructing their communications infrastructure, both developing and developed countries face a similar challenge in the 1980s. The former still have to build up basic communications systems, often from scratch. Although it is true that conventional communications technology might meet the current and short-term requirements of some LDCs, it is wholly unlikely to do so in the longer-term future. Eventually they, like the developed countries, will be plagued with the cost of rebuilding the system in its entirety.

The nations of Europe and North America are currently racing to overhaul their antiquated voice-grade systems, inherited from the 19th Century, and of laying out data-communications networks that meet the requirements of the emerging online information economy. In both developing and developed countries, substantial human, capital, and time resources will go into acquiring rights-of-way, digging trenches, and installing transmission lines.

Because the long-run social opportunity costs will be tremendous, the right choice of transmission technology is critical. Literally tens of billions of dollars are being spent in developed countries to upgrade or replace the inherited

copper-wire systems with high speed, wideband digital links. In two years, the USA alone will be laying more than 2 million km of optical fibre annually. By 1990, the yearly total is expected to reach between 7 and 8 million km. Some already predict that the end of conventional copper wire could come as early as the turn of the century. And yet, LDCs are still busily installing copper wires.

To install the same obsolescent technology in the LDCs will inevitably yoke them for many years to the same technological backwardness that has been one source of their current dilemma. Moreover, obsolescent or inadequate communications infrastructure will increasingly remove these countries from the major international data highways and, in turn, from sources of technology transfer in this and other fields.

In the long run, then, information blackout can only aggravate existing regional imbalances among and within developing countries. If the new nations install the old equipment, they will soon be faced with the same problems that plague the communications infrastructure of all developed countries today. At that point, LDCs will have to undergo a costly reconstruction process while trying to catch up with a technological world light-years ahead.

Inadequate communications are a major impediment to development in the post-industrial economies of Europe and North America. Telephone networks are being called upon to perform tasks they were never designed for. The twisted copper pair is a transmission medium well suited for transporting analogue signals such as voice communications. Because of inherent bandwidth limitations, telephone lines are not as adept at carrying high-speed digital signals; thus they have come to represent a major bottleneck to data communications.

Today, the much celebrated Bell telephone system is the Achilles' heel of the American information sector. Note that this shortcoming is not the result of system decay, but rather a reflection of the failure of conventional voice-grade lines to meet the communications needs of the computer age. Connecting computers with data-output rates in the million bit-per-second range with telephone lines that transmit at rates in the thousand bit range is akin to connecting two pipelines with a drinking straw. As a result, communications have become a major cost of doing business, inhibiting the growth of the online information services industry.

Information is of little use if it is not easily accessible. Likewise, a major incentive to acquiring new information and knowledge is lost if it cannot be diffused. This simple fact explains the critical importance of communications within advanced, *i.e.* information-intensive economies. To deny the same role to communications in developing countries on the basis of currently limited consumption and production of information services is short-sighted. To be sure, the existence of advanced communications infrastructure cannot alone guarantee development of the online economy. Lack of adequate data-communications infrastructure, on the other hand, almost certainly reduces opportunities for developing countries to participate in the ongoing information revolution.

The pace of development in the LDCs will to a considerable degree depend upon the quality of connectivity provided to multinational firms seeking new locations and to their own citizens seeking enriched economic and social opportunities. No developing country in the world has anything approaching the quality of transportation and communication services called for by contemporary demands. Neither does any developed country. Expanding dependence on information and intelligence and the current explosion in information-handling technologies is making every nation's communication system inadequate, if not obsolete. Those countries most able to expand their communications infrastructure, to exploit the advanced technology, and to build their own national networks while tying into the international networks, are most likely to reap the benefits of development soonest.