



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

17304

United Nations Industrial Development Organization

**EXPERT GROUP MEETING ON PROSPECTS FOR INDUSTRIALIZATION
POLICIES IN DEVELOPING COUNTRIES TAKING INTO ACCOUNT THE
IMPACT OF DEVELOPMENTS IN THE FIELD OF NEW AND HIGH TECHNOLOGIES**

Vienna, Austria, 4-7 April 1989

Technology Case Study No. 1

TECHNOLOGICAL CHANGE IN TELECOMMUNICATIONS

Implications for Industrial Policy in Developing Countries

Prepared by Kurt Hoffman
UNIDO Consultant

**DRAFT WORKING PAPER
FOR PARTICIPANTS ONLY**

Table of contents

	<u>Page</u>
I. INTRODUCTION	1
II. TELECOMMUNICATIONS: A CRITICAL ELEMENT OF INDUSTRIAL INFRASTRUCTURE	4
III. RECENT TECHNOLOGICAL DEVELOPMENTS IN TELECOMMUNICATIONS	7
1. Exchange technology	7
2. Transmission equipment	8
3. Peripheral equipment	9
4. Integrated digital network	9
5. Broad implications of technological change in telecommunications	10
IV. TECHNOLOGY-INDUCED DOMESTIC REGULATORY REFORMS WITHIN A DEVELOPMENTAL CONTEXT	14
1. Issues of telecommunications regulation in developing countries	15
2. Selective examples of liberalization and privatization in developed countries	17
3. Comparing the logic of regulatory reform with the conditions in developing countries	18
4. Policy options for regulatory reform	20
a. Moving towards greater openness and flexibility in the provision of equipment and services	21
b. Separating central government and the PTT	22
c. Restructuring, reorganizing and re-skilling the PTT	22
d. Recent reform approaches	24
5. Overall conclusions	24

	<u>Page</u>
V. NEW POSSIBILITIES FOR LOCAL EQUIPMENT SUPPLY AND LOCAL LEARNING	26
1. Scale and scope of telecommunications investment in developing countries	27
2. Telecommunications as a 'leading edge' in the accumulation of technological capacity	28
3. Lessons from the newly industrializing countries (NICs) ...	30
4. The critical role of foreign equipment suppliers and government support	32
5. Concluding policy observations	33
VI. PROSPECTS FOR REGIONAL CO-OPERATION AND THE NECESSITY FOR INTERNATIONAL COMPROMISE	37
1. New and unexploited prospects for regional co-operation: Evidence from Latin America	37
2. International regulation and the search for a compromise	38
a. The pro-regulatory stance of the ITU and the developed country position	39
b. Issues of transborder data flows	40
c. A compromise solution	40
VII. GENERAL CONCLUSIONS	42
REFERENCES	44

List of Abbreviations

ASETA	Association of Telephone Companies of CITEI members
AT&T	American Telephone and Telegraph
CITEI	Inter-American Telecommunications Conference
CONTELCA	The regional telecommunications planning body for Central America
GATT	General Agreement on Tariffs and Trade
INCATEL	Central American Institute of Telecommunications
TNC	Transnational Corporation
INTUG	International Telecommunications Users Group
ISDN	Integrated Systems Digital Network
ITU	International Telecommunications Union
IT	Information Technologies
NEC	National Equipment Corporation
NIT	Nippon Telephone and Telegraph
PABX	Private Automatic Branch Exchange
PBX	Public Exchanges (large-scale switching system)
PCM	Pulse code modulation
PTT	Postal, telegraph and telephone agency
SPS	Stored programme controlled
TDF	Transborder data flows
TDM	Time division multiplexing
UNESCO	United Nations Educational, Scientific and Cultural Organization
VDU	Visual display unit
VHF	Ultra high frequency
VHQ	Very high frequency

I. INTRODUCTION

The telecommunications sector has been fundamentally and pervasively transformed by the Information Technology (IT) revolution. The rapid and widespread diffusion and application of digital micro-electronic technology through the whole of the telecommunications sector has given rise to a plethora of new products and services that have proved to be far superior to those based on electro-mechanical technology. The characteristics of these products - lower costs, more features, greater reliability - has led to a tremendous expansion of the worldwide market for telecommunications despite the restraining effects of global recession through the first half of this decade. After expanding annually at more than 12 per cent for nearly a decade, by 1986, global sales of telecommunications equipment had reached US \$109 billion and by 1995 are expected to be close to US \$240 billion annually, in current prices.

In parallel with this, the pervasive applicability of microelectronics throughout the whole of the electronics "complex" of industries - computers, office equipment, components, telecommunications, etc. - has provoked the convergence of these industries, gradually eroding traditional market boundaries. This has led to a rush of new entrants in the telecommunications equipment industry that is severely challenging the established manufacturers. Competition within the sector is now technology-based be it aimed at protecting existing markets or at gaining access to new, rapidly growing markets.

These trends in technology and industrial structure have in turn stimulated a dramatic upheaval in established regulatory practices in what was once, because of its alleged characteristics as a "natural" monopoly, a highly regulated largely monopolistic sector. Pressures from users to gain rapid access to the new array of services have led to pressures from new producers to be allowed to supply this burgeoning demand.

In the face of this, the regulatory structure in place in most developed countries has been or is being completely overhauled. Monopoly public sector enterprises are being privatized; close, even collusive, relationships between public sector procurement agencies and monopoly private suppliers are being broken up and much more competition is now being allowed in both equipment and service supply.

The same pressures for deregulation and liberalization are at work internationally with regard to international flows of telecommunications equipment and services. Established regulatory practices at the international level are being assailed by proponents of open markets and greater competition. The whole machinery of international telecommunications regulation is being forced to respond to what are essentially technology-induced pressures for change.

Among all sectors of importance to the long-term economic development prospects of developing countries telecommunications in the one most profoundly affected by new IT. In turn it is increasingly recognized that a modern, efficient telecommunications system is one of the most critical

elements of the industrial infrastructure. This importance has been enormously enhanced by the central role of digital telecommunications as the "highways of the Information Age". Because of this and because of the pervasive nature of the impacts mentioned above, developing countries are faced with policy implications across a very broad range of fronts. These include not only policy issues relating to the development of the sector and the regulation of the domestic supply of telecommunications services but also industrial policy in its broadest sense, trade policy and strategies for attracting foreign investment.

There is a general presumption that the IT revolution has had largely negative implications for developing countries. The technological frontier is seen to be moving away from the position of most countries at a rapid rate; technology-based barriers to entry are thought to have made most sectors impenetrable except for a few advanced countries; traditional wage-based international competitive advantages are allegedly being eroded by automation in the North.

Whether or not this pessimistic perspective is justified in other sectors is open to question. In the case of telecommunications, it is certainly not legitimate. Technological change in telecommunications has led to developments which on the whole are rather positive for developing countries. Yet there is little appreciation that this is the case or why developments in this sector should be positive when they appear negative everywhere else.

These positive aspects will not, of course, automatically translate into pervasive benefits for developing countries. Policies and strategies need to be designed that exploit the opportunities that are open to developing countries in telecommunications. Such policies in turn must be based on a comprehensive understanding of the full range of technology-led changes in telecommunications - in products and processes, in industry structure and in approaches to domestic and international regulation.

This paper attempts to provide an overview of the main developments in telecommunications and their policy implications. It starts in Chapter II with a brief review of the current situation with regard to telecommunications in developing countries and examines the arguments as to why telecommunications is seen as so important to long-term development prospects. This may seem obvious - but in fact most developing countries have massively underinvested in telecommunications, primarily because many governments has failed to appreciate both the qualitative importance of telecommunications and the scale of the quantitative benefits that derive from investment in the sector.

Chapter III turns to the technological changes that have transformed the sector and sets out the broad general implications for developing countries. Chapter IV examines the technology-induced and developed country-led pressures for change in domestic regulatory practices in developing countries and reviews the policy implications of these. The analysis centers on the fact that there is a critical difference between the policy agenda embraced by the advanced countries in response to change in telecommunications and that faced by developing countries.

Within the developed countries, the basic telecommunications infrastructure has long been in place, telecommunications services are used as an integral part of the productive effort in the economy and there is a wide range of domestic enterprises able and willing to supply both services and equipment under competitive conditions. Given the prior existence of conditions that would allow the operation of an efficient market, their policy moves towards a more open market situation are premised on the view that the social and economic benefits arising from telecommunications will best be attained by achieving the maximum possible degree of market freedom.

With a few exceptions, most developing countries lack the basic telecommunications infrastructure, a viable domestic equipment and service supply sector and the conditions necessary for a properly functioning market that exist in the industrialized countries. Consequently, and in contrast to developed countries, the predominant policy concern and objectives of developing countries in relation to telecommunications must be developmental in character. This implies the formidable task of building the basic telecommunications network and of responding to the needs of a growing economy. This section discusses the logic and the reality of introducing changes in the regulatory environment in developing countries where developmental needs are foremost and where there are many factors at work that distort market operation.

Chapter V discusses how technological and structural change have opened up new opportunities for local production and local learning in telecommunications technology and explores the policy implications in the area of negotiation, technology transfer and local capacity development. Chapter VI deals with the possibilities for regional collaboration and the necessity for compromise at the international level to ensure that developing countries extract the maximum possible advantage from the expansion of global economic activity stimulated by changes in telecommunications technology. Chapter VII concludes the paper with the presentation of some general conclusions.

II. TELECOMMUNICATIONS: A CRITICAL ELEMENT OF INDUSTRIAL INFRASTRUCTURE

There has long been a presumption in the development field that there is a strong positive correlation between the level of communications and the pace and degree of economic development. Starting with the classic work carried out by sociologists such as Rogers, Schramm and Lerner and carrying on through UNESCO's well known correlation study in 1979, sociologists and development economists have sought to show that the expansion of communications possibilities between social groups and economic entities helped create the necessary social and political conditions for dynamic development to proceed.^{1/}

However, despite this body of knowledge and presumption in favour of the role of communications in the development process, the reality has been that investment in the telecommunications infrastructure by developing countries has historically been accorded a relatively low priority. Two broad sets of reasons have been put forward to explain this. First, despite the availability of macro studies which showed a correlation between indicators of communication such as telephones/1000 people and GNP, it was very difficult to enumerate and quantify the national economic and social benefits of telecommunications investment relative to investment in other sectors and activities such as food production, water, power, schools, hospital and roads.

Thus the entities responsible for telecommunications administration in developing countries - often known as postal, telegraph and telephone agencies or PTIs - faced great obstacles in trying to convince their finance and planning ministries to give priority to telecommunications investment. They simply were not able to provide sufficient economic justification for what would inevitably be very large capital expenditures (because of the "lumpy" nature of telecommunications investment) with a very long lead time and very diffuse benefits compared to other infrastructural investments.

Secondly, there was a strong perception, particularly in countries who reached independence after the second World War, that telecommunications services conferred direct benefits only upon a narrow and privileged portion of the population (i.e. foreign and upper income groups). Telephones were therefore considered an expensive luxury - although it was recognized that the telephone system could be financially profitable since the state had the monopoly power to impose high tariffs.

Consequently, the telecommunications network, while exploited as a source of surplus, was not viewed as a legitimate candidate for major investment on equity and developmental grounds. There are notable exceptions, however, as some countries such as the Republic of Korea, Taiwan Province of China, Brazil, Ethiopia and El Salvador have, particularly in recent years, made a determined effort to upgrade their telecommunications and allocate more resources to it. However the number of countries able to maintain this performance consistently is relatively low compared to those countries where performance has been poor.

As a result, the telecommunications sector in most developing countries has suffered from massive underinvestment relative to both demand and economic return. The scale of this underinvestment is manifest in various ways. In many countries, subscriber density is extremely low ranging from a high of 40

telephones per thousand people in Latin America to only 7 per 1000 in Africa, with large areas often averaging less than 1 telephone per thousand people. Demand exceeds supply for even standard telephones by a large margin in most countries and the wait for getting an initial connection can often stretch above five years to even ten years or more.^{2/}

Most of the services that do exist are concentrated in urban centers - in Brazil in 1985, 70 per cent of the telephone lines were in cities accounting for only 20 per cent of the population while in Thailand in 1981, 89 per cent of the administrative districts containing 75 per cent of the population had no telephones. And for those areas where services do exist, the quality of service on offer is often extremely low with heavy call congestion at all times, a high percentage of unmet and broken connections (frequently well above 50 per cent for even local calls, over 90 per cent for international calls) and long periods where there is no service available at all due to equipment failure and poor maintenance.

While the social hardships imposed by these conditions are substantial, the economic costs are even greater due to major efficiency losses throughout the economy. Though making macro estimates of these costs is nearly impossible, there is micro evidence available which indicates they are extremely high.^{3/} There can be little doubt that lack of access to basic telecommunications service is a key constraint on industrial development and overall economic advance.

The shortcomings of the telecommunications system in developing countries are no doubt well known. From a policy perspective, however, it is much more important, to emphasize that recent and ongoing research carried out by the International Telecommunications Union (ITU), the World Bank and others is now yielding incontrovertible evidence that not only is there a direct positive relationship between economic advance and the availability of basic telephone services but that telecommunications investment can be fully justified on economic and social grounds. For example, a detailed review of the results of 10 recent telecommunications sector development programmes partly financed by the World Bank in Africa, Asia and Latin America showed that they averaged an 18 per cent economic rate of return overall, rising to 36 per cent if consumer surplus is counted in.

Looking specifically at the rural sector, the returns to investment in rural telecommunications frequently exceed these averages. One example comes from the introduction of long distance telephones in the Amazon region of Peru in the late 1970s which resulted in substantial cost savings and increased revenue in river transportation; in another region of the same country, the use of telex for reservations in a rural tourist town, increased hotel occupancy from less than 50 per cent to more than 70 per cent; in Sri Lanka in the late 1970s, telephone access to market information allowed farmers to place their produce at 80-90 per cent of Colombo prices compared to 50-60 per cent before.

More central to our concerns, a similar and even more impressive body of evidence is accumulating with respect to the returns to telecommunications investment which services the industrial sector. This is important because telecommunications services are used in developing countries mainly for commercial reasons - in 1980 in Thailand, 62 per cent of telephone lines were connected to business subscribers with about 90 per cent of telephone calls

(including 50 per cent of those from residential subscribers) related mainly to productive and distribution activities.

An ITU study in Kenya identified nine mechanisms through which the efficiency of business firms could be improved via access to more extensive reliable telecommunications services - through facilitating business expansion, sales price increases, improved purchasing decisions, reduced inventories, savings in vehicle use, reduction of down time, reduced distribution costs and lower managerial and labour costs. Cost-benefit analyses carried out in the Philippines and Costa Rica using samples of 200-300 small firms and measuring economic gains against telecommunications investment costs established benefit-cost ratios of 25:1 and 48:1 respectively.

Quite apart from this growing body of evidence on the economic benefits arising from telecommunications investment, it is now well documented that, as referred to above, telephone systems remain highly profitable activities even when run poorly.⁴⁷ Taken together, this evidence about firm-level gains supports theories rooted in the economics of information which, a priori, argue that communication, by reducing uncertainty, increases the probability of economic units making correct decisions and achieving their goals at least cost.

In short, it is clear that in developing countries, access to telecommunication services is a crucial factor affecting the performance of both individual economic units and of markets; the telecommunications infrastructure is critical to industrial development. Even on their own, these are powerful arguments, calling for developing countries to devote a much greater share of investible resources to the telecommunications sector.

The issue cannot rest here however. The IT-driven technological revolution that has completely transformed telecommunications has, as will be shown below, strengthened enormously the arguments in favour of increased telecommunications investment. Much more importantly, these developments have made the question of policy and strategy with regard to how these investments programmes should be designed and implemented into one of the critical challenges facing all developing countries no matter what their level of development. These are the main issues being explored in Chapter III.

III. RECENT TECHNOLOGICAL DEVELOPMENTS IN TELECOMMUNICATIONS

The convergence of telecommunications, microelectronics and computer technology has provided a completely new technological base for the telecommunications sector. Old systems have been superseded, previously discrete items of equipment have merged in function and form, and entirely new components, products and services have been developed. The future possibilities arising from the revolution in digital telecommunications could yield great benefits to all countries.

However, a major consequence of these developments is that developing country telecommunications planners are now faced with the difficult task of making choices between a plethora of technical options in relation to system design, component selection and choice of supplier - with all of these choices needing to be made in an environment of considerable uncertainty because of the rapid pace of technological change and constraints of resources. Moreover the planners' problems are compounded by the emergence of unprecedented pressures for change in the way that the telecommunications supply network is organized and managed.

Making the right policy decisions is contingent upon having a competent understanding of the nature and scope of the technological changes taking place and of their broad implications. This is the object of this section which starts with a brief overview of technical developments across the three main elements of technology - exchange, transmission and peripheral equipment. The implications of these changes in telecommunications technology in relation to the question of local production of telecommunications equipment and service availability are then introduced. A more detailed exploration of the policy issues arising from these developments is then undertaken in Chapter IV and V.

1. Exchange technology

Conventional telecommunications systems are based on a standard set of telephones connected by two pairs of copper wire, routed through an electromechanical switching system. Analogue electrical signals are transmitted between the exchanges via coaxial underground and undersea cable. Exchange or switching systems are thus at the heart of both public and private telecommunications systems. Massive investments in R&D during the 1970s by the leading telecommunications companies have led to the development of fully electronic, stored programme controlled (SPS) digital switching systems.^{5/}

Digital exchanges are solid-state (no moving parts) and thus less susceptible to breakdowns and require less maintenance than conventional systems. Software control allows continuous adaptation of the exchange to new traffic conditions without changing the hardware. Digital exchanges also work at a much greater speed than analogue systems, with greater technical efficiency and at greater levels of capacity. Continued price reduction in semi-conductors means steadily declining real prices in exchanges so that large capacity public exchanges are roughly one-half the cost of equivalent analogue systems and further cost reductions are expected.

Not surprisingly, digital exchange technology is now widely accepted as being both technically and economically superior to conventional systems for use in both developed and developing countries. Virtually all manufacturers have switched to the production of digital exchange equipment away from analogue equipment, which of course is still the mainstay of telecommunications networks in developing countries.

This is not a negative development but a positive one. Unlike other aspects of IT, the advantages open to developing countries in the installation and use of digital exchanges are probably greater than those open to developed countries. Most developing countries are only in the relatively early stages of installing and expanding the basic telecommunications systems, while the developed countries are generally still very heavily committed to existing analogue systems. Thus they are faced with the very costly prospect of replacing their entire communications network - while developing countries can literally "leapfrog" directly into digital systems.^{6/}

2. Transmission equipment

As in exchange technology, the pace and scope of technical change in transmission technology has been rapid and widespread. Coaxial cable technology, once the dominant terrestrial transmission medium is now being challenged on a number of fronts. Microwave transmission systems exhibiting greater efficiency and capacity due to pulse code modulation (PCM) and time division multiplexing (TDM) transmission techniques are becoming favoured choices for medium capacity lines and difficult terrains - with costs falling on an average of 11 per cent annually in recent years. Likewise radio telephone using Very High Frequency (VHF) and Ultra High Frequency (UHF) systems also does away with the need for physical conductors in rural areas.

Fibre optics and laser transmission systems boast considerable advantages over conventional systems in terms of greater capacity, speed, flexibility, resistance to interference (thus cutting down on the need for boosters) and significantly reduced installation costs (e.g. the costs of laying submarine cables have been cut by 75 per cent). Steadily reducing prices for fibre optics and recent success in overcoming technical problems means this technology will diffuse rapidly in the early 1990s for medium and high capacity routes.

Likewise, microelectronics-based miniturization has made the use of satellite communications technology much more economically viable for both public and private networks. With satellite communications systems, cost reductions due to technical change have averaged roughly 40 per cent per annum per data/speech channel since the early 1980s thus bringing this transmission technology to the forefront in terms of suitability for developing countries.

As with exchange systems, the trend towards digital transmission systems is a very favourable one for developing countries. By stepping over intermediate technologies, developing countries can avoid more costly and less efficient transmission methods and move straight into a digital transmission infrastructure. Not only are these less costly than previously, but digital systems can simultaneously transmit voice, data, text, TV and various other

forms of information using the same hardware. Developing countries using digital transmission equipment can arrive more cheaply and more easily at the same starting point for the transmission and use of the full range of information based goods and services as the developed economies.

3. Peripheral equipment

Peripheral equipment is equally being driven by the convergence of computer and telecommunications technology. The range of intelligent terminals and telephones, key systems, mobile radios, modems and a variety of office equipment (such as word processors, multifunction micro-computers, electronic messaging and other types of workstations) has expanded rapidly. Importantly in peripherals, the convergence process is leading to the development of single devices capable of acting as a terminal for text, data and other "non-voice" services as well as being used as a telephone.

The rise in private applications and the integration of telecommunications with other IT activities means that demand is growing to link these peripherals with telecommunication systems. Thus many other peripheral products are needed both to provide an interface with the public network, and to integrate electronic systems within firms and institutions.

Once again the developing countries start off absolutely equal with the developed economies in terms of their ability to potentially benefit greatly from this explosion in peripheral equipment both because of lower unit costs and because of greater sources of supply.

4. Integrated digital network

As is obvious from the above, technical change has generated improvements in all segments of telecommunications equipment - improvements that can be directly beneficial to developing countries. While these components can be introduced piecemeal into an existing analogue network, their full potential can only be realized when they are used as building blocks in a totally digital network designed to integrated standards.^{2/}

Such a network can carry many different types of services in addition to voice traffic. The advantages of a fully integrated network lie in its flexibility, scale economies in terms of different services carried as well as capacity and transmission resilience particularly at peak service periods. Computer monitoring within exchanges and on transmission loads allow the whole network to be controlled as system. The flexibility inherent in the technology also allows for simplification in the physical design of the system, in the production of its components and in its installation and maintenance, all aspects which are important features from the perspective of developing countries.

5. The broad implications of technological change in telecommunications

The spread of radical technological change in telecommunications has been pervasive, perhaps more so than in any other sector. These changes have reached a "critical mass" and accelerated into a true revolution that has a number of implications for all countries and for telecommunications policy in those countries. Below three aspects of these implications that are particularly important for developing countries are singled out.^{8/}

(a) Lower barriers to entry in production and more sources of supply.

An important but often unrecognized dimension of the ongoing changes in the telecommunications sector is that there have been equally fundamental changes in production technology. These changes have direct economic implications as they often result in lower unit investment costs due to the lowered costs for basic network components such as cable, exchange termination assemblies, multiplexers, switches etc. on a per bit transmitted basis.

They have also affected profoundly the international structure of the telecommunications equipment supply industry since start-up costs in some segments have dropped from millions of dollars to hundreds of thousands because of the availability of standardized integrated circuits and system software. This situation has positive implications for developing country planners both because it increases the range of choice among suppliers and because it expands the "room for manoeuvre" enjoyed by the host country in any negotiations with foreign suppliers.

Moreover, changes in production technology have also opened up a new range of opportunities for local involvement in the design and supply of equipment which could in turn lead to the development of local skills and expertise in digital technology. Hence these technology-induced opportunities for local learning could have major long term and pervasive benefits for developing countries that would go well beyond the telecommunications sector. This is a unique opportunity that simply is not open to most developing countries in relation to virtually any other segment of IT. This issue will be explored in much detail in Chapter V.

(b) Changing cost structures for all other industries. Rapidly dropping unit costs and the proliferation of alternative communications options are transforming the cost structures of all industries as the cost of processing and transmitting information has declined sharply relative to the costs of other factors. For example, in 1983, it cost US \$14,000 per month to lease the US half of a private transatlantic voice channel. In 1987 that cost was less than US \$5000.

These cost reductions are leading to the extension of "telematics" into more and more areas - in merchandising via integration of point-of-sale systems with inventory and purchasing; in manufacturing via worldwide integration of production with inventory and orders, or via centralized computer-aided design systems directing machine tools halfway around the world; in transport where the worldwide dispatch of planes, ships, trucks or trains can be centrally co-ordinated and optimized.

These systems, by making information low cost and transportable, not only alter the cost structure of industry but are facilitating a major shift towards production that is more knowledge-intensive. Hence, the international competitiveness of conventional manufacturing industry is becoming more and more dependent on access to information and to systems that allow its low-cost, rapid processing and transport within the firm or across the world.

- (c) Creation of new services and new ways of delivering traditional services. Information technology coupled with technological change within the telecommunications sector has had a profound impact on the service sector and on the role of services in economic development in all countries. The question of services and their implications for developing countries are now widely discussed. Four dimensions deserve special attention in the context of telecommunications.

First, traditional service industries (banking, insurance, consulting and engineering, tourism, shipping, publishing, etc.) are now able to offer a greater range of services, at greater speed and at lower cost via sophisticated peripherals connected to greatly expanded international telecommunications networks. In turn, their competitiveness has also become intimately dependent upon access to telecommunications networks.

For example, it is now possible for a book or article to be written in one country, mocked up in a second, typeset by computer in a third, proofread in a fourth and then transmitted by satellite for printing anywhere in the world. Since all of the labour intensive elements of this process can be carried out in low wage countries (if the necessary facilities are available), book publishers going this route gain a significant cost advantage over those who do not. Similarly in the 1990s, to participate in international finance - whether as a major borrower, investor or banker - requires continuous access to digital, voice and data telecommunication information systems that connect all the world's financial centers on a 24 hours basis.

Second, a whole new category of data services and supplying industries in areas such as data processing, software, and data bases have come into being each specially adapted to the specific needs of the user. For example, US judicial opinions are abstracted and entered into an electronic data base by clerical workers in Korea, stored in a US based privately controlled system and accessed by lawyers all over the world - because such knowledge is essential for doing business in the US market: similar data bases exist for tourism, agriculture, medicine, pesticides, etc.; Pakistan produces architectural drawings for architects working in Stockholm on a construction project in Saudi Arabia; computer programmers in India can write software for Texas Instruments in Dallas; and keypunch operators in Barbados and Jamaica can service data processing operations anywhere in the world.

The above represent new services that are distinguished by their "divisibility", rapid growth and, significantly, represent new export opportunities for developing countries. There has also, of course, sprung up a huge amount of international telecommunications traffic involving intra-firm transborder data flows (TBDF) and service flows whose presence and growing importance has attracted a great deal of attention and comment.^{2/} The most well-known of the concerns expressed about TBDF (and an important policy issue for developing countries) relate to the difficulties involved in exerting national control over sensitive data flows.

Third, economies of scale have emerged in the provision of access to flows of data, knowledge and services on a national and international basis. The reason for this is that although the cost of initially creating a digital telecommunications network - nationally or globally - is quite high, once installed, the marginal cost of adding another service or transmitting additional data is quite low. Thus barriers to entry faced by suppliers trying to enter different markets are either raised or lowered depending upon whether or not they are able to "plug-in" to an existing information grid via the telecommunications network. This characteristic also means that even if some developing countries do not require sophisticated services, once a digital system is installed, they will subsequently be able to introduce new services at little extra cost.

Unlike the net positive benefits accruing to developing countries as a result of improvements in telecommunications technology as discussed above, developments in telecommunications-related services appear to have both a positive and a negative side, and again there is a vast amount of discussion on the pros and cons surrounding this issue.

Most of the worries arise from (a) the extra competitive advantages enjoyed by foreign firms, particularly TNCs, who have mastered information technology and have access to knowledge, data services and communications systems not available to domestic producers, and (b) the difficulty of exerting national control over private sector data flows with financial and/security implications for the host economy.

On the other hand, the potential advantages to developing countries arising from this transformation and proliferation of telecommunications-related services are also numerous ranging from new export opportunities in labour-intensive service provision, the arguably lower barriers to entry in many conventional industries and the greater access to more knowledge at much lower cost.

Obviously, the arguments presented above forcefully underline the point made in the first section about the critical importance of a telecommunications infrastructure to overall economic growth. More to the point, there can be little doubt that the rapidly increasing information and knowledge intensity of production and competition demands that the telecommunications infrastructure in all countries must be digitally based or at least moving as rapidly as possible in that direction.

The current and, more importantly, the longer term competitiveness of domestic producers will depend centrally on this precondition. Consequently, any development strategy which in anyway is dependent on international linkages for finance, technology, goods and services and/or involves the local participation of foreign firms in any sector of the economy will face considerable and growing difficulties in the future if an adequate, modern, digital-based telecommunications system is not in place.

Accordingly, the telecommunications investment decision is clearly not just a question of arranging adequate finance nor does it primarily involve only technical issues that are best left to the national PTT to sort out. Telecommunications policy now constitutes a critical set of strategic decisions with widespread and long-term implications for industrial development and economic progress for the country as a whole.

The next chapter looks at the question of how developing countries can best organize, regulate and administer the provision of telecommunications services within the domestic market. As will be shown, technological change has unleashed enormous pressures on developing country PTTs and governments to reform and restructure their domestic regulatory environment so that the full potential of the new technology and the new services can be positively exploited by domestic producers.

IV. TECHNOLOGY-INDUCED DOMESTIC REGULATORY REFORMS WITHIN A DEVELOPMENTAL CONTEXT

The new technological reality in telecommunications has had two major consequences for national PTTs in all countries who have been responsible for telecommunications services - and who had previously enjoyed a monopoly position in virtually all aspects of telecommunication supply and administration.

First, access to modern, reliable telecommunications systems has become an absolute economic necessity for all major productive interests operating in an economy whether they are domestic or foreign controlled. Second, there has been a proliferation of different means of access to telecommunications services and the costs of this access have been substantially lowered.

These technology-induced changes in the operating environment have led to the build up of enormous pressures upon PTTs - from users for easy access to the entire range of services via the lowest cost system; and on the supply side, where due to ease of entry and lowered unit costs many alternative sources of supply for both telecommunications systems and services have emerged in direct competition to the services and activities of national PTTs.

These pressures on PTTs first emerged in the US (where technological change in telecommunications first began to emerge) some 15 years ago and they eventually led to a dramatic and well-publicized wave of deregulation and divestiture of the public (and private) monopolies such as AT&T which had previously strictly controlled access to telecommunications and the services available to users. In recent years the same process has been at work in the UK and Japan via the privatization of British Telecoms and NTT and in Europe where much greater competition has been introduced in the provision of services and facilities.

There is now ample evidence that the same pressures that forced liberalization in these countries are at work in the developing countries. Large users in both the private and public sector (often including other branches of government, the military, railroads, power sector and other state enterprises), are conspicuously unsatisfied customers in many developing countries, often going ahead and setting up their own facilities without the permission or support of national PTTs.

There is little if anything the PTTs can do about this since aggressive private suppliers of equipment, systems and services are vigorously seeking new customers in developing countries and as the examples show they are finding any number of willing customers. Consequently, PTTs have been increasingly forced to condone this practice and it is now the case that medium and large scale users in both urban and rural areas are building local switched (mobile or fixed) radio-telephone systems connected to satellites for international, or private lines for national connections.

Moreover, many of these systems have spare capacity which can and is being leased back for use by the national PTT such as is happening with the high-capacity optical fibre, "back-bone" network being built by the Indian railways.

As the evidence alluded to above suggests, many national PTTs in developing countries are finding it difficult to cope with the new demands generated by technological change. Yet the internal pressures for some kind of fundamental change in the situation will continue to grow every day. Unfortunately for the PTTs, it is equally clear that there are also major external pressures being placed upon developing countries to take steps to restructure and reorganize their telecommunications policies and systems of regulation.

These pressures are coming from bilateral and multilateral development agencies such as the World Bank involved in providing financial support for domestic telecommunications projects in many developing countries. They are also being applied by national governments of the developed countries who are using their power within international North-South fora and policy bodies such as the International Telecommunications Union (ITU) and the GATT to press for reform of developing country positions vis-à-vis telecommunications issues at both the national and international level. These external proponents of reform draw a good deal of their ammunition from the allegedly highly successful experience of telecommunications sector reforms undertaken in the developed countries, particularly the US and UK.

Two points need to be recognized about the current situation with regard to the arguments for domestic regulatory reform with developing countries. First, there is little doubt that in many developing countries a reform of the domestic regulatory regime and indeed of the nature and role of the national PTT is necessary to allow the full development potential of telecommunications to be realized. This issue cannot be ignored nor can it be treated separately from any discussion of the other policy issues that have arisen as a result of technological change in telecommunications.

Second, it is also the case that the arguments and the rationale being used by both internal and external proponents of reform are far too narrowly cast and often largely ignore both the different objectives of telecommunications policy in a developmental context and unique problems this context implies, particularly when compared to conditions in the developed countries.

Since it is this explicit comparison between the experience of developed countries and the problem of developing countries that in a very real sense has set the context for much of the recent debate over sector reform in developing countries, we shall first look at the arguments and evidence put forward relating to open-market policies, before considering the policy choices open to developing countries in this area.

1. Issues of telecommunications regulation in developing countries

Observers and analysts, looking outward from a perspective informed by the recent experience of the US and other countries, not surprisingly often seek explanations for the problems of Third World telecommunications in the extent and nature of state involvement in the sector. Five sets of reasons are commonly advanced as to why state participation may have caused the observed difficulties.^{10/}

First, as already argued, it is felt that governments fail to understand that investment in telecommunications is crucial to economic progress. Consequently, expansion and improvement of the telecommunications system is given low priority.

Second, the national PTTs are felt to be constrained by government interference in many areas of management and policy. As a result they lack managerial and administrative independence; senior management is frequently shifted in response to political changeover; investment authority is rooted in civil servants; they face restrictions on hiring, promoting and firing and so on.

Third, the PTTs commonly lack the financial independence needed to resolve the perennial problem of underinvestment. They are often not allowed a tariff structure that reflects costs, with pricing being largely dictated by conventional public utility financial criteria - i.e. both connection and service charges are alleged to be excessively low, on economic grounds. This reduces domestic surpluses for reinvestment - even though governments are quite prepared to allow PTTs to make net contributions to their cash starved treasuries. In addition, though the foreign exchange cost of investment is high (50-60 per cent of total costs), PTTs are barred from participating in capital markets and are thus forced to compete with other public enterprises for extremely limited capital resources.

Fourth, it is argued that the management and organization of the PTTs themselves are often very poor, resulting in high expansion and operating costs and a variety of efficiency problems in other areas such as maintenance and repair.

Finally, Third World PTTs are perceived as enjoying a similar, if not greater, degree of monopoly power than PTTs in developed countries. Entry into the industry is strictly regulated to protect the PTT and private bypass arrangements are stringently opposed. Being almost totally insulated from competition or public accountability, they have little incentive to improve performance or innovate. This in turn creates ample opportunities for grossly inefficient administrative procedures that are subject to "irregularities".

Given that the difficulties caused by these problems are greatly exacerbated by radical technological change and the growing demand by large users for early access to new services, it should not be surprising that serious questions are being raised about the ability of PTTs to cope efficiently and adequately with the new context in which they find themselves.

Fundamental changes in the extent and nature of state involvement in the telecommunications sector in developing countries are being called for at many levels and specific aspects of operation but they all point in the same direction: Less and even no state involvement in telecommunications and the introduction of much greater competition in all aspects of service and equipment supply.

This argument has been frequently made, historically and currently, in response to state management of other facets of the economy in developing countries. However, it is being put forward in relation to the telecommunications sector with great passion and conviction because of the alleged success of deregulation in the US, in Europe, particularly in the UK, and in Japan. In light of this, it is instructive to consider briefly this experience.

2. Selective examples of liberalization and privatization in developed countries

The recent experience of developed countries with regulatory reform in the direction of liberalization and privatization has been mixed. The most important positive aspect is that new suppliers have moved quickly into the market to offer the consumer a much broader range of products and services than was available previously. This expansion of consumer choice has undoubtedly benefitted both individual users and the economy as a whole since availability of new telecommunications products and services has stimulated a higher level of economic activity. Another positive aspect is that national PTTs have been forced to place much greater publicly visible emphasis on improving customer service. Direct competition in the supply of services has also led them to expand their levels and rate of investment in new technology well beyond their original plans.

At the same time, the moves towards liberalization and greater reliance on market forces have not always (or yet) had the intended results. For example, liberalization moves in Western Europe and Japan have still left their national PTTs in enormously powerful positions, quite capable of resisting further erosion of their position. Moreover, despite being publicly pro-competition, some governments are quite adept at using non-tariff barriers to prevent or inhibit foreign competition in domestic markets.^{11/} This is quite clear in the recent major conflict that arose between the UK and Japan over the efforts of Cable and Wireless Ltd. to gain a foothold in the Japanese telecommunications market through direct investment. Though Japan is often singled out as being particularly guilty of restricting market access, Cable and Wireless probably would have had just as much trouble gaining access to US, French, Dutch or West German markets - or vice versa.^{12/}

A similar example but one that relates to data services involves regulations of the West German PTT, the Bundespost, that prevent subscribers to foreign information services from having direct access to international leased lines - some intermediate data processing must be undertaken in the FRG before the information can be made available to subscribers over the local switched network. Such policies reinforce the Bundespost's monopoly, increase its revenues and protect domestic data processing firms.^{13/}

Furthermore, as the UK experience with the privatization of British Telecoms shows, such moves do not necessarily lead to the predicted widespread domestic social and economic benefits. Indeed in the UK case, privatization appears, so far, to have benefitted only a narrow range of high income consumers and users, cost the economy billions of dollars, led to poorer (not better) public service, and further undermined the international competitiveness of large segments of the British equipment supply industry. These problems are documented in the academic literature, by advocacy organizations and almost daily in the national press.^{14/} This suggests that the UK experience is hardly the shining "jewel in the crown" of regulatory reform that most advocates of privatization make it out.

3. Comparing the logic of regulatory reform with the conditions in developing countries

If such problems and unintended outcomes arise in a developed country context where the institutions are competent, markets are supposed to work and effective monitoring can be carried out, then what of developing countries?

The net outcomes might be positive. But one could argue just as strongly (with considerable evidence from similar experiences in other sectors) that those features of underdevelopment that in effect define the operating context in developing countries - limited technological and managerial competence in the private sector, inequitable income distribution, a barely functioning market, lack of monitoring capacities and the inefficient manner in which PTTs cope with any sort of complexity - could result in a much worse situation for all parties.

More generally, the context in which developing countries are having to respond to pressures for liberalization and cope with radical technological change is very different from that facing developed countries when they built up their networks. Pressures on PTTs to be competitive and responsive, particularly in profitable areas, were brought to bear upon developed countries after their networks were in place; while developing countries have to face these powerfully "disintegrative" forces well before their networks and local supply industry have become fully established.^{15/}

Three points follow from this. First, even though the problems faced by PTTs in the two groups of countries may seem superficially the same, the causes of these are likely to be substantially different. Second, public and private sector institutions in developing countries are relatively "immature" and exhibit low levels of administrative, managerial, financial and technological competence. There is no guarantee that the responses of these entities to being given the freedom to design and implement market-oriented reforms will actually solve the problems they face.

This, for instance, appears to be the case in the Philippines where telecommunications services are now largely provided by private enterprise after privatization explicitly modelled on the US example was carried out. Growth has been insufficient to meet development needs, the available poor and costly service is concentrated within a few urban areas, and a government review of the situation is now in progress. Similarly, two private firms in Panama allowed to offer international telecommunications services in competition with the public sector are to be absorbed back into the public sector because of poor performance and "irregularities".^{16/}

Third, it cannot be assumed that market-oriented reforms even if introduced will actually have the effects intended, let alone address the equity and welfare concerns of the developmental state because these changes will be occurring within a wider social and economic context that acts to distort the working of the market and the distribution of benefits and burdens across different segments of society.^{17/}

- (a) The equity effect of raising capital by subscription. Consider the solution often put forward to overcome the revenue shortages which is that existing and new subscribers make a "capital" contribution via much higher connection and monthly rental fees than are charged normally. Exploration of this proposal for the Indian case showed that to meet minimum revenue levels for planned investment purposes in the Seventh Investment Plan entirely from internal sources, the annual bill to subscribers would need to be more than doubled from \$350 to \$750. This might seem a reasonable price to pay for a better service from the perspective of western observers or upper income groups in developing countries - but how many Indians could afford it? The answer is: not many. When applications charges of less than \$10 were first tried, the waiting list was reduced by 100,000; and when charges were again increased from \$80 to \$400 the waiting list was reduced by 400,000. If subscribers were in effect now asked to make a capital contribution of \$2,400, the waiting list would probably disappear altogether by eliminating all but the wealthiest fraction of city dwellers - hardly an equitable outcome.^{18/}
- (b) Problems caused by lack of an effective "user" capacity in local firms. Other problems arise when we move to the question of market-oriented solutions to make better and more equipment and services available locally. Many of the proposals for increasing the range of services (particularly new data services) available by allowing private suppliers, acknowledge that many of these would be provided by foreign firms. In this case, the mere availability of more services this would bring about is deemed a positive development - yet it ignores the likely negative impact on local providers of services and a variety of other issues associated with data dependency, revenue generation, predatory pricing by foreigners, etc. that generally fall under the category of transborder data flow concerns.

A different set of problems could surface because of the character of local users who are to benefit from the availability of the new services brought into being by liberalization. It is often assumed that all users will be equally able to competitively exploit the new services. Such an assumption might hold in the industrialized countries - but is of questionable merit in many developing countries.

Many potential local users, particularly smaller, domestically owned firms, will lack the skills and other requirements necessary to take advantage of the new services. If they are competing against foreign firms who can exploit these services, then they might be forced out of business, causing a net loss of employment and income to the economy. There is evidence that this is precisely what is happening in the tourist sector in many smaller Third World economies.^{19/}

A new international dimension of this problem is exemplified by the role of the Caribbean and Asian economies in the booming US offshore data processing business. Both foreign and domestic firms in these countries are setting up low wage but highly labour-intensive facilities (in what have come

to be known as 'teleports') in order to 'key-in' analog data of various sorts (ticket information, manuscripts, etc.) provided by US firms (airlines, publishing houses, insurance companies). The local firm then sends the digitized results back to the US over newly installed digital telecommunications networks.

The US firms certainly benefit from lower unit costs and the developing countries do gain some employment and foreign exchange benefits. But they get little less from what are essentially 'footloose' and 'enclave' activities that have few, if any local linkages, often require government subsidies to attract them in the first place and can, of course, be closed down without warning and moved to a lower cost country.

The governments and entrepreneurs justify these activities on the grounds that because they involve the new technology, they will provide an entry into the IT age. But in fact, there is virtually no skill or technology transfer involved in these white collar sweatshops nor, as cost effective optical character recognition technology will soon be available to US firms, may there be much of a long-term future.^{20/}

Certainly some countries are benefitting from being able to participate in the expansion of the international market for services from a domestic base - the rapid growth in exports of software from India and Singapore are cases in point. However, these are countries whose governments have already invested substantially in the prior creation of software capabilities. If this process is to occur in the large number of other countries where this prior investment in capabilities has not taken place, then steps must also be taken to create conducive local conditions that go well beyond relying on market forces in the telecommunications sector to bring about downstream linkages - a policy point taken up again below.

Finally, as hinted at above, there is a need to distinguish between the type of country involved when discussing issues of regulatory reform. Those developing countries best equipped to handle the pressures of regulatory reform and to capture its benefits will be the more advanced countries. Their basic needs in telecommunications are close to being met; they enjoy a considerable degree of local supply; they have competent managers in the public and private sector; and, a reasonably well developed absorptive capacity. Moreover, there is a reasonable chance that the public good and national economic welfare would be increased if appropriate reforms were to be introduced.

However, as one moves down the line towards the poorer countries, these conditions are less likely to be met, the inequalities existing everywhere in the Third World and distort the market will be greater, and the possibilities grow that poorly planned regulatory reforms will lead to unexpected, unintended and negative outcomes.

4. Policy options for regulatory reform

With those qualifications in mind a closer look is taken below at policy proposals for reform of the domestic regulatory regime that relate specifically to industry. These broadly fall into three areas - opening up the market for the provision and maintenance of equipment and services by domestic and foreign suppliers; the total recasting and reduction of

government control over PTTs and their ability to set tariff structures and obtain investment capital so that PTTs can operate along lines closer to a commercial business; and alongside of this loosening of state ties, the pervasive reform of PTT structure, operations and management.

a. Moving towards greater openness and flexibility in the provision of equipment and services

For a large number of developing countries, five areas have been identified as being broadly suited for either a reduction in state involvement or a reform of current policy and practice by the PTT:

- (i) the supply of telephones, PABXs and other subscriber equipment by local and/or foreign suppliers. Provided technical specifications are met, such moves theoretically widen the choice and lower the price to users while also greatly reducing load on PTTs;
- (ii) the establishment of separate business networks (e.g. involving fixed station cellular radio telephone) to meet urgent demand and provide high quality voice and/or data transmission. These services should be highly profitable because they are so important to industry and should be able to attract private financing. Moreover they will aid in preserving or creating competitive advantage, and in attracting foreign investment in productive sectors with a high foreign exchange earnings potential;
- (iii) the provision of value added services, such as electronic mail and computer data bases, inventory monitoring, banking networks, etc.;
- (iv) allowing private or state operators of dedicated networks to offer services to other users thereby using up space capacity but within a framework established by the PTT. In some cases it might well be possible to use the exchange of telecommunications capacities among users to promote economies of scale and technological innovation so that static losses (due to equipment duplication) could be offset;
- (v) allowing the contracting out of activities habitually carried out (often poorly and slowly) by the PTT. This would include civil works and maintenance on outside plant, cable ducting and laying, subscriber connection. Where suitable local firms are not available or cannot be spun off from the PTT, these can be developed via contractual arrangements with foreign contractors that ensure appropriate training and technology transfer.

One way of doing this would be to have one contractor design and then supervise cable installation by a different contractor, until the PTTs own design and supervision capability can be built up. Other areas where this approach could be used involve construction and maintenance of buildings, vehicle maintenance, directory production, and data processing.

b. Separating central Government and the PTT

Many of the problems faced by PTTs derive from the nature of its relationship with central government. The thrust of most policy proposals focussing on this area is to distance the PTT from direct control by government and thereby allow the PTT to be managed in line with its new character as a technology-intensive, dynamic productive enterprise.

This is essentially a political decision - albeit one with significant economic and financial implications. It requires, in most countries, a fundamental change in the perspective of the government vis-à-vis the role of telecommunications. Once this change has occurred and the decision to allow greater freedom of operation has been taken, two areas of policy will require innovative solutions. The first relates to the structure and mode of operation of the PTT - these issues are explored under the next subheading.

Second, as the PTT moves closer in character to a commercial enterprise, and as more suppliers enter the market, a completely new set of market conditions will arise, coupled with a new role for the PTT as a competitor driven, at least in part, by commercial considerations. Hence, a monitoring body has to be created which will have both a policy-making and conflict resolution function - both among private suppliers, between the PTT and other suppliers, and between the PTT and the government.

Such a body must be independent of major interest groups, technically competent, and have the power of law behind it to enforce decisions. There are many forms such a body could take depending on the particular circumstances. Whatever this may be, this monitoring body will have to take on board the following tasks:

- to regulate tariffs and financial flows among operating companies to prevent monopoly abuses;
- to ensure that equipment procurement follows local capacity development strategies discussed in the next section;
- to ensure the sector's responsiveness to broader development objectives, equity concerns and rural and regional needs;
- to exercise direct control or monitoring over the provision of international services and the interface between the domestic and international telecommunications network;
- to license and monitor the use of the radio spectrum;
- to set and monitor appropriate service standards for all user groups.

c. Restructuring, reorganizing and re-skilling the PTT

The changes proposed above have enormous implications for the PTT itself. The shift from being a direct arm of the state to a more autonomous entity much more directly responsible for its own survival involves a fundamental change in legal status. Once again there is a variety of models that could be followed with the choice depending on government objectives,

existing arrangements and the competence of current staff and management - transforming a government department into an autonomous state enterprise; spinning off operating parts of the PTT into private or mixed ownership subsidiaries; reorganizing a public enterprise into a corporation under commercial law with differing degrees of state equity, etc.

Whichever form is selected, there are a number of other policy measures necessary to allow the PTT to perform competently in what will be a more rigorous and much more demanding competitive environment:

- procedures for procurement, recruitment, investment approval, etc. will need to be streamlined to allow a quick response rather than allowing the PTT to hide behind bureaucratic procedures that effectively eliminate the need for action;
- steps must be taken to allow the PTT to do whatever is necessary to attract and retain competent and dynamic technical, managerial and financial staff. This is crucial because to survive and prosper in the new environment, the PTT will require much higher levels of expertise and competence;
- the PTT staff and management must be forced to be more sensitive to issues of quality and service not only with regard to large users with political and financial clout but also in relation to small groups of less powerful users;
- innovative measures must be introduced to allow "off-budget" mechanisms for raising investment funds including the selling of bonds, the selling of shares, and perhaps even direct participation of domestic and foreign capital;
- protective mechanisms must be put into place to ensure that decisions are allowed to be taken without undue political interference - while at the same time ensuring that all major issues involving fundamental choices are openly debated and reviewed.

PTTs in developing countries often have a clear vision of the developmental role of telecommunications, and have struggled hard against very difficult conditions to build and operate a network. However, many but not all, have been very slow to realize how the new opportunities created by technological change can be harnessed for the development process. Moreover they are, like all bureaucracies, protective of their own positions and keen to resist any erosion of power diminution of responsibility.

Consequently, they may simply oppose any change at all. As will be seen in the last chapter, they are also resisting developed country pressures for radical changes in the internationally regulatory environment as well. Perhaps the major challenge faced by the government in reforming the PTT will be to alter these traditional perceptions and positions so that the new opportunities created by technological change can be constructively exploited by the PTT both to ensure its dynamic role in the economy and to further developmental objectives.

d. Recent reform approaches

Recent surveys of developments in the sector in the Third World have shown that telecommunications policy-makers are not unaware of both the nature of the problems they face, nor of the winds of technological and regulatory change blowing across the sector worldwide.^{21/} Changes are undoubtedly being introduced - both voluntarily and as a result of a good deal of friendly "persuasion" by the international agencies providing the finance for national telecommunications projects. Most notable among the reforms attempted so far are:

- Malaysia's moves to set up an independently managed company under 100 per cent state ownership to handle operational functions;
- the spinning off of telecommunications operations in Bombay and Delhi as an independent company able to raise funds in the local capital market;
- the privatization of Chile's main telephone company;
- the reorganization of Morocco's PTT into a semi-autonomous office that now subcontracts civil work and cable network construction to private firms;
- the design, procurement and construction of outside telephone plant in Thailand by eight large firms on a turnkey basis;
- the reorganization of Jordan's and Sri Lanka's PTTs as separate companies able to operate independently of state control and able to raise investment capital from domestic and foreign sources.

These examples may well be indicative of a much greater wave of change in the telecommunications regulatory environment in developing countries. However, a crucial point to remember about these examples of shifts towards a more liberal regulatory environment is that all of the cases reported are relatively recent. We simply do not yet know what the eventual short- and long-term impacts of these changes will be on different groups and measures of performance. The net effects must be monitored very carefully before any conclusions are drawn.

5. Overall conclusions

Although the debate about reform of the PTTs and the domestic regulatory environment in favour of greater reliance on market forces frequently centres around the pros and cons of the free market versus state intervention, this focus misses the central point. The most pressing issue faced by developing countries in this area is not one of privatization versus public ownership, but one of monopolistic inefficiency and unaccountability versus competitiveness, accountability and efficiency.

Solutions to the very real problems of telecommunications regulation and PTT operation in developing countries may be found in either of the many public sector or private sector models referred to above. Which one makes the most sense depends on the circumstances involved and cannot be decided simply

on the relative merits of a set of theoretical arguments about the alleged superiority of the free market or about the inherently greater wisdom of the state in pursuing developmental ideals.^{22/}

A second set of points that need to be drawn out relate to the issues raised above about the competitiveness of local service providers, effective user capability and the absorptive capacity of the economy. This argument suggests two things. First care should be taken in assuming the local economy will automatically gain from the market-driven provision of new services. In cases where developing country service providers and users are in competition with international suppliers, given their unequal starting positions in the competitive race and their unequal access to financial, technological and marketing resources, liberalization would almost certainly benefit international suppliers to the detriment of the infant industries in the developing countries.

Secondly, if local users are to exploit effectively access to the new services their own capacities have to be greatly strengthened - and this is unlikely to happen automatically. Hence, the designers of telecommunications policy have to liaise with informatics and industrial policy makers to identify the range of skills, support services and learning facilities that have to be made available to domestic user firms to allow them to compete effectively in the emerging electronically integrated market place.

In relation to domestic regulatory reform, developing country policy-makers are in a classic "second-best" situation because of the existence of major distortions to efficient market operation; and because explicit action needs to be taken to meet the developmental imperative of creating indigenous capacities for supply, and the rapid diffusion of services to those most in need but least able to pay. For these reasons, privatization and liberalization cannot provide blanket solutions to problems of service supply in developing countries. If they are introduced, such measures have to be applied very selectively and judiciously, in order not to counter local capacity and long-term development plans.

The structural problems of PTIs and the gross inadequacies of domestic regulatory policy in most developing countries must be dealt with. The changes already occurring demonstrate just how far technological change has already begun to affect telecommunications policy choices in developing countries. The opportunity costs are simply too high to try to respond within the old monopolistic format to the new challenges and possibilities posed by technological change and the rise of new telecommunications services. The aim of any sectoral reform initiatives on the part of the government must be to achieve complementarity between regulatory reform and developmental objectives. This will not be an easy task - but it is one that cannot be avoided.

V. NEW POSSIBILITIES FOR LOCAL EQUIPMENT SUPPLY AND LOCAL LEARNING

Technological change primarily involving digital semiconductor technology has led to massive upheaval in the international telecommunications supply market.^{23/} The transition from analogue technology to microelectronic, digital systems has forced 'traditional' equipment suppliers in the US and Europe to restructure their operations in both industrialized and developing countries. All major suppliers now produce digital systems and have broadened their product ranges to include other elements of information technology (IT).^{24/}

This process of technological convergence is gradually leading to industrial convergence and the blurring of historically stable market boundaries between the telecommunications, computing, office equipment and semiconductor industries. As a result, competition has intensified greatly, both among the traditional suppliers, and because of the market entry by large, vertically integrated information technology corporations from Japan, and more recently, Republic of Korea and Taiwan Province of China who are determinedly challenging the established 'electro-mechanical oligopoly' of the western firms.^{25/}

In response to these dramatic changes, government policies during the 1980s in the advanced economies such as the US have focused on ways to promote the competitive performance of indigenous equipment suppliers and facilitate the speedy development and introduction of digital transmission and switching facilities. Such policies exhibit two features. The first is massive if sometimes well-disguised programmes of government support by all leading industrialized countries for R&D and technology development in the private sector in most segments of the complex of IT industries including telecommunications.^{26/}

The second, more widely discussed, feature of policy has been the promotion of much greater competition in equipment supply and service markets, including the breaking up of 'cosy' and sometimes collusive relationships that existed between purchasing PTTs and equipment suppliers.^{27/} The assumption is that opening these markets and relationships up to increased competition will not only reduce costs but also lead to greater investment in R&D and hence more rapid rates of innovation.

Given the importance of the telecommunications sector both as the key infrastructural element in the emerging information economy and as a major segment of the burgeoning international market in information technology, the role of state policy in helping to promote and maintain the innovativeness and competitiveness of the sector is perceived as legitimate and fundamental.^{28/} This is particularly so since both domestic competence and international competitiveness in the new IT industries is viewed as a critical determinant of national economic well-being in the future.

In the current context of developed countries, government is fulfilling this role by a combination of direct support for innovative effort and the legislated unleashing of market forces. Such policies assume the prior

existence of a technologically competent domestic supply industry capable of responding to incentives - however they are offered. Western pro-market analysts often forget, however, that their industry was allowed to grow to technological maturity under the extremely favourable conditions afforded by state protection of its markets precisely because of its perceived importance to the national economic interests of the industrialized countries.

There are similarities yet are more important differences between the above features and the conditions governing telecommunications equipment supply in the developing countries. As in the North, the telecommunications system is a critical element of the economic infrastructure in developing countries. Similarly, the new generation of digital technology will provide services and facilities centrally important to the future competitiveness of firms in these economies.

Within this context, the overarching policy objective of industrializing economies (like in the developed countries) should be to ensure that communications capacity develops in line with domestic economic, political and social needs. However, unlike western economies, the domestic equipment industry of most developing countries, with some important exceptions, is poorly developed and still in its technological infancy. Given this, the creation of a domestic supply capacity - in line with their market size and technological and economic capabilities - is a defensible, if contentious a priori policy objective for developing countries.

The possibilities for developing countries to go some way towards achieving these objectives have, as alluded to in Chapter III, been enhanced, rather than retarded, by technological change - provided, of course that appropriate policy measures are taken. In light of the vast differences in the status of their supply industries, the new possibilities for creating a local supply capacity are, contrastingly, both a source of conflict between developed and developing countries as well as providing potential grounds for long-term co-operation between them. These issues are examined below.

1. Scale and scope of telecommunications investment in developing countries

Most Third World countries are currently installing and expanding their basic telecommunications infrastructures. As argued in Chapter II, according to measures of what would ideally be required to put the sector on a sound footing, current levels of investment are far too low. However, even the scale of investment currently underway and planned is such that developing countries face the task of managing projects of unprecedented proportions whose financial dimensions are large by any relative standard of industrial development. Together, the ten largest countries spent at least an estimated \$9.5 billion on telecommunications equipment in 1987 expected to rise to \$11.5 billion by 1990.

At the country level, these aggregate figures translate into a sizeable expenditure of scarce resources. China, with the ninth largest equipment market in the world, for instance, invested \$1.8 billion in the telecommunications sector in 1987 out of a total of \$5 billion planned by 1990. India, the 12th largest market, invested \$1.5 billion in 1987 and

Mexico \$950 million in the same year out of a planned total of \$6.5 billion by 1990, while Brazil spent more than \$900 million despite severe financial difficulties.

1987 expenditures in 'second tier' countries such as Indonesia, Taiwan Province of China and Argentina averaged \$700 million each and also stand at exceptionally high levels, with Venezuela registering \$428 million in investment last year. Further down the scale, the national plan for Colombia calls for telecommunications investments of \$300 million over the medium-term, slightly less than is expected by Thailand which is also a medium sized economy. Even large but relatively poor countries such as Pakistan (\$320 million in 1987) and Bangladesh (\$246 million) forecast total expenditures over the next five years of well over \$1 billion each.^{29/}

While such figures do not approach, in aggregate terms, developed country expenditure in the sector, they are notable within the Third World context for three reasons. First, infrastructural investments on this scale were not even conceivable in these countries as recently as 20 years ago. They undoubtedly compare on a relative basis with efforts by the advanced countries to develop the railways, power and communications sectors during their own periods of industrialization.

Second, given the present rate of investment, the bulk of the telecommunications infrastructure in developing countries, with the possible exception of Africa, will be in place 20 years from now. Telecommunications investment at the level now being undertaken will not be repeated. And once in place, the particular configuration of systems chosen will determine the telecommunications trajectory of these economies for many decades.

Third, and of greater significance, these infrastructural investments are occurring at a unique moment in technological history. Partly this is because relatively low cost, robust and flexible digital systems offer developing countries the opportunity to 'leap-frog' from less efficient, more costly, earlier vintages of technology. Because these economies are still installing their basic network, they do not face the onerous 'economics of scrapping' decision that confronts many developed countries. As was argued in Chapter III, this ability to leap-frog from earlier technologies could provide important economic benefits to latecomer economies and is the key reason why most observers agree that even the poorest countries should invest in digital as opposed to analogue telecommunications systems.^{30/}

2. Telecommunications as a "leading edge" in the accumulation of technological capacity

More importantly, though the availability of a telecommunications network has always played a key facilitating role in the development process, any indigenous technological capacities created via local participation in the design, production, installation and maintenance of previous vintages of equipment were of relatively little use outside of the telecommunications sector. This is not the case with digital technology where many of the skills derived from involvement in design and production of IT based

telecommunications products and systems are generic and will be transferable across the many sectors where IT will play a major role.

The pervasive role that information technology will play in the future industrial development of all countries means any digital capacities created in the course of developing the telecommunications infrastructure will ultimately have wide applicability throughout the economy. This process is roughly analogous to the way that the machine design and build skills accumulated within the capital goods industry were so crucial to the early industrial development of the advanced economies.

By the same reasoning, the wide range of capacities required to design, manufacture, install and operate digital equipment can act as a 'leading-edge' in the accumulation of human resources and firm-specific skills on which the whole economy can subsequently draw in a future dominated by information technology.

The reason why this is possible is bound up with the nature of digital technology.^{31/} Digital technology is intrinsically modular and horizontal, so that a system is comprised of a range of independent but compatible modules that form the building blocks of an expandable telecommunications network. The same logic holds in the manufacturing process where microelectronic components both constitute the building blocks of the product and increasingly resemble the final good itself.

This sharply contrasts with the vertically integrated production process in electromechanical technology that involved a large number of specialized components such as relays, screws and connectors. These analogue components were manufactured by the equipment suppliers themselves, a process which required specialized knowledge and a thorough-going and large-scale fine engineering and electromechanical interfacing capacity in virtually all stages of production, installation and maintenance.

Thus, the actual manufacture of crossbar systems is far more complex than the production of digital systems which resembles a simple assembly process whereby most of the components are standard and can be bought in from outside semiconductor manufacturers. The software-intensive design stage is crucial in digital technology, but though the skills involved are specialized, they are also generic, required in smaller numbers and are easier and less costly to build up over time. These characteristics imply a far higher degree of technological and capital "divisibility" than was the case with earlier vintages.

Divisibility in turn implies more opportunities for smaller investments in specialized product areas - even in highly complex exchange systems - and means it is possible to master the design and production process by stages, thereby gradually learning and accumulating skills to tackle more complex products and systems.

The divisibility of the technology itself as well as the design stage and production process makes for potentially much lower barriers to entry by developing countries into the less complex products such as peripherals (intelligent terminals, modern and codec equipment, key systems, mobile radio, VDUs, etc.) and some elements of transmission equipment (such as PCM and TDM equipment).

Likewise, the modular nature of modern exchange software may also provide opportunities for entry by some of the more advanced developing countries into the design and production of smaller scale private exchanges - where the number of US suppliers has grown from 4 in the 1970s to over 1000 in the 1980s. Modularity means it is now possible to continuously improve and upgrade a single system. Brazil, for instance, has demonstrated that it is possible for a developing country to develop and produce not only simple digital equipment, but fairly complex small public exchange systems as well. It first developed a 1000 line exchange for rural use, built on this work to produce a 4000 line system and intends to expand into medium and large scale exchanges on the basis of these developments.^{32/}

Obviously, as will be discussed below, the prospects for particular developing countries successfully entering telecommunications equipment production differ greatly depending on their market size, stage of economic and technological development, government policies, etc.

However, the key points to note here are that it is now much more feasible for developing countries to gradually 'learn' their way up the chain of technological complexity with digital telecommunications technology than it was with earlier vintages. In the course of doing this, it is also likely (and indeed has happened) that many of the problems of "inappropriateness" that plague imported digital equipment used in developing countries (because it was designed for the very different technical conditions and operating environments found in developed countries) can be overcome.^{33/}

More generally, it is much easier for these countries to accumulate widely applicable information technology-related skills through "learning-by-doing" in telecommunications than in other segments of the IT complex. And finally whereas the social and economic case for investing in telecommunications is widely accepted as valid for all developing countries (and being acted on by many on a large scale with extensive international support), this of course is not true with other IT industries where many legitimate questions have been raised about the need to establish these industries in developing countries.

It is this conjuncture of investment scale, technological evolution and infrastructural development which demonstrates powerfully that developing countries are in the midst of a period of historic importance. Thus for those countries able to justify the effort on social and economic grounds, the process of building up a digital telecommunications network could be a crucial cornerstone on which their technical progress and industrialization will depend in the decades ahead.

3. Lessons from the newly industrializing countries (NICs)

An appreciation of this dimension of the telecommunications situation confronting developing countries is critical to the development of policies to exploit it. Many countries are either not yet aware of these possibilities or so far have not yet made a major effort to exploit them. However, some governments in the smaller NICs and larger economies are indeed fully aware of the new and more dynamic role that investments in digital telecommunications can play in industrialization.

Because of their relatively stronger economies and more sophisticated cadre of policy-makers, these more advanced countries have been in a position to respond positively to the possibilities discussed above - and in the course of doing so have become major factors in the international market. The nature of their success and the strategies they have followed suggests a way forward for other countries - but also indicate potential areas of conflict and co-operation between public and private sector actors both domestically and internationally.

Among the most notable successes have been the Asian NICs such as Republic of Korea and Taiwan Province of China who, in line with their overall strategies, have pursued interventionist policies in support of local equipment supply firms that promoted their export orientation and international competitiveness. Amazingly, some of these firms are now emerging as competitors to international telecommunications suppliers in particular segments of the market.^{34/}

Similarly, large, import-substituting countries such as China, India, Brazil and Mexico, while not yet competitive in world markets, have developed a broad indigenous technology development and supply capacity in the public and private sector that increasingly incorporates products based on digital technology. Brazil's experience in developing and locally manufacturing 1000 line 'tropicalized' exchanges is of particular relevance.

Four policy-related points should be noted about the success of these countries in developing an indigenous telecommunications industry. First, empirical studies examining how these gains were achieved document a process of gradual learning, as the countries accumulated digital design and production capacities on a step by step basis.^{35/}

Second, their achievements in telecommunications parallel their considerable accomplishments in other technology intensive sectors where they have likewise developed an export base and strong domestic supply. As in telecommunications, the evidence shows clearly that these advances were due to the active involvement of local firms and research units in design and production, in turn supported by deliberate government intervention to facilitate R&D, technology transfer and the development of local input supply.^{36/}

Third, as will be discussed below, the effective assimilation of imported technology and, in some cases, co-operation with foreign equipment suppliers played a significant role in the capacity accumulation efforts of these countries. Finally, there is substantial debate and disagreement in the literature over the short and long run costs and benefits of these policies both in relation to telecommunications and other sectors. Critics argue on straightforward comparative costs grounds that the equipment and technology developed under these policies could have been imported more cheaply and the benefits from its availability passed on more quickly to local users.^{37/}

While this argument has some validity it is hardly universally applicable. It fails to recognize adequately both the evidence and the arguments made above about the unique entry and learning possibilities inherent in digital telecommunications technology and the long-term benefits to these economies of acquiring indigenous capacities in information technology. Given these possibilities, a judgement as to whether it is best

to import on short-term comparative cost criteria or to invest in local learning and local development on long-term benefit criteria can only be taken on a case by case basis.

4. The critical role of foreign equipment suppliers and government support

It is obvious that despite the greater possibilities for local learning and local equipment supply, scale considerations and technical factors mean that the opportunities open to different countries will very much depend on market size and the existing technological and economic infrastructure. For this reason most smaller countries, and indeed many of the larger economies, must accept that they will remain dependent for their equipment and technological requirements on outside suppliers to varying degrees. In all but a few cases, this technological dependence will be coupled with a requirement for financial assistance to support their investment programmes.

However, the evidence suggests that such relationships need not be either as onerous on developing countries or as unprofitable to the equipment suppliers as is the case in many other sectors. Most of the great strides forward in technological terms have occurred and are occurring within the PTTs of the advanced countries or within the R&D laboratories of the international equipment suppliers such as ITT, Siemens and Ericsson.

Consequently, access to the technology and know-how developed and accumulated by these firms is absolutely essential for the future development of telecommunications capacities in developing countries. The more advanced countries have recognized this fact and have successfully sought to establish various forms of co-operation with foreign suppliers while at the same time striking the best possible terms for the deal.

Competitive conditions in world markets are in fact currently structured in favour of developing countries. Many large suppliers have based their expansion plans and justified heavy R&D commitments, particularly in digital exchanges, on the basis of capturing a large share of telecommunications equipment markets in developing countries. These markets are of interest to the equipment suppliers for two reasons. First, they are already fairly large in specific categories in both relative and absolute terms. For example, the Latin American market for digital public switching currently accounts for 16.3 per cent of world sales, compared with 27 per cent for Europe and 28 per cent for the USA. Second, rates of growth are, in general, higher than in the advanced countries, particularly in areas like peripherals and switching technology, where an explosive annual rate of growth of 25 per cent through the first few years of the 1990s is predicted for developing countries.^{38/}

The key characteristic of these markets is that in contrast to the de facto closed markets in Japan, Europe and the US, developing country markets are uncommitted and relatively open to competitive bidding. Access to and success in these markets is crucial to international equipment supply firms who by the early 1980s had collectively spent well over \$6 billion to develop 16 major systems - all chasing annual uncommitted export markets of only \$2-3 billion.

As a result, competition for market access has become increasingly fierce between established and new suppliers. Several large and medium-sized developing countries have recognized the existence of this "buyer market" and utilized the monopoly purchasing power of their PTIs to 'encourage' competition between suppliers not just on price but on criteria such as increased local manufacture of systems by subsidiaries of foreign firms, and in some regions, large scale technology transfer agreements and co-operation in joint ventures.^{39/} In addition, the suppliers' home government is frequently brought in to "sweeten" the bid with offers of financial support and other types of assistance. Some firms and governments - such as those from the US and UK have resisted these pressures - and lost contracts as a result.

The trend towards much greater competition between suppliers and the culmination of deals involving genuine technology transfer and government support is well established and widely documented. One of the many examples comes from the struggle between ten major suppliers to win a recent Indian contract for switching systems. Eventually the French system (from CIT-Alcatel) won the order - but only after CIT-Alcatel agreed to transfer exchange technology and the French government was obliged to step in and offer an 'aid for trade' cheap loan arrangement and support for a major training programme involving French scientists. This is a tactic that the French have employed vigorously to win contracts in Singapore, Chile, Argentina, Brazil and Venezuela - and are using right now to try to win a contract to establish a 300,000 line digital exchange plant in China.^{40/}

Similar cases could be cited involving Ericsson (of Sweden) in Brazil, Venezuela, Ecuador, and Costa Rica, Cable & Wireless (UK) in China, Siemens (FRG) in Taiwan Province of China and Indonesia - all of which feature the same elements of market access exchanged for financial support, technology transfer and local production as in the French/Indian example. A similar set of deals involving Japanese firms offering low price and favourable technology transfer terms to governments in Latin America and Asia has been proving particularly worrying to the established suppliers because it marks a further breakdown of their longstanding traditional alliances with these governments. Firms such as NEC (now the third largest supplier of telecommunications equipment to developing countries), Fujitsu and Oki have already employed these tactics to gain large shares of Third World regional markets - and will undoubtedly aggressively continue with this strategy in the future.^{41/}

5. Concluding policy observations

Over the longer term, developing countries will gain much benefit if they can constructively use the need for large scale investments in telecommunications to build up their domestic technological capacities. Such a strategy must exhibit a number of components.

First, the main regulatory and procurement authority must recognize the development of local capacity as a main priority and equally must appreciate the significant opportunities open to it to exploit both the competitive market conditions and the divisibility of the technology to achieve these objectives. On the one hand this may mean moving away from the reliance on a

"cosy" relationship with a single supplier towards more open competition - with a critical criteria for selection being the commitment of the supplier to effective technology transfer.

This implies that a prime initial policy objective must be to build up within the PTT or regulatory authority the skills and expertise to devise such a multi-faceted strategy. These include, *inter alia*, the sophisticated technical, financial and economic analytical capacities to evaluate alternative switching and transmission design, financing and procurement proposals which have capacity building elements in them.

Second, developing countries must recognize that the process of capacity creation will, in most cases depend on fairly extensive collaboration with foreign suppliers. In line with this, developing countries should appreciate the need for suppliers to receive a minimal rate of return and other considerations if full co-operation is to be forthcoming.

At the same time, they must also take steps to ensure they have the knowledge of technology trends, the international market conditions facing suppliers and the particular strengths and weaknesses of those suppliers in order to design an effective strategy that exploits the "buyers market" that currently exists. Such knowledge of course is also necessary to make sure appropriate equipment and training is actually provided. There are already a number of examples of countries who have made digital equipment purchases only to find out later that the equipment line provided was subsequently discontinued.

The same sort of pitfall must be avoided where "technology transfer" is involved. Realistic targets must be set by the host country - and the training delivered needs to be assessed to make sure the right knowledge and skills are being supplied. This is not an easy task but has been accomplished elsewhere.^{42/}

Third, to support the above efforts, there must be an accurate information base regarding local market conditions, the capacities and weaknesses of local suppliers and the learning possibilities inherent in the technology being sought. This will allow the design of a realistic strategy of technology acquisition coupled with support for local skill development. Of course, care must be taken to ensure the learning programme does not incur substantial opportunity costs due to overlong learning periods on the part of recalcitrant and inefficient local suppliers only interested in the financial rewards.

This suggests that an important part of policy measures in this area should be the use of competition or the threat of competition to ensure local suppliers take all the necessary steps to learn and produce efficiently. This could include requiring local suppliers-public and private-to submit to price, quality, technology and delivery-time targets based on international standards, with penalties, including opening up to foreign competition if the targets are not met.

Finally, since part of the justification for investing in capacity accumulation in telecommunications lies in the gains flowing from the wider diffusion of these skills throughout the economy, an important element of this capacity development strategy must be to identify the mechanisms by which this can take place. There are a number of ways this can be tackled.

Foreign suppliers can be "encouraged" to provide start-up assistance and training to new firms in areas related to telecommunications technology, for example, in software design and peripheral production. At the same time, more people than are directly necessary could also be trained during the main training phase of the investment project. Given that conditions differ greatly between countries, different domestic manufacturing strategies would be required.

- Leaving aside the NICs, if first the larger economies such as India and China are considered, their market size and broad equipment requirements suggest the need for access to foreign knowledge on a large scale, including support for training and local R&D in the design and manufacture of central exchanges, transmission and peripheral equipment.
- For smaller, "second tier" economies such as Thailand, Indonesia, etc., the needs are similar but not so extensive. These countries have to build up their software and hardware design capabilities to allow them to modify imported technology to suit local conditions. They do not need a central exchange capability - yet - but do need to negotiate contracts which give them the training, facilities and support structure to carry out a limited amount of manufacturing and technical change in peripherals and transmission equipment.
- Finally for the much larger group of smaller, poorer countries in Asia, Africa, the Caribbean and other regions, market size, local capacities and the purchasing power of their PTTs are substantially lower than in the larger economies. Thus their aims and policies will need to be less ambitious than those of the NICs and the larger economies. Nevertheless, these countries will or should eventually be making sustained investments in their telecommunications infrastructure and the learning possibilities inherent in these investments must be explored rather than simply written off from the beginning. Training in planning, installation and maintenance is necessary of course and must be an element of any contract or technical assistance agreement negotiated. Access to manufacturing know-how, however, should really only be pursued in relation to some peripherals - and perhaps some transmission equipment depending on market size. It is in relation to these countries that the prospects for regional and international collaboration need to be explored most aggressively. (These issues are discussed in Chapter VI.)

One final area of policy action to be discussed relates not to local producers of telecommunication equipment and services but to local users in the industrial sector. As suggested earlier, simply having access to a sophisticated telecommunications network and having services available do not guarantee that local users will benefit. Much more needs to be done, though the steps that need to be taken are to be integrated with elements of education, informatics, foreign investment and industrial development policy. Here some of these elements are only briefly mentioned.

First, care must be taken to ensure the services that are made available are those that are most needed by local users, foreign and domestic. As there is likely to be considerable mismatch between the needs of local users and what is available, this suggests new product opportunities for local service

providers. Identifying these and supporting their development might be an area for government support.

Second, if foreign users - as is to be expected - will take greater advantage then steps must be taken to identify the training and support services necessary to allow local firms to effectively use the new services as well. Doing this might initially require the mounting of an education and awareness campaign to show local users how on-line access to data bases, marketing information, etc. can be an effective element of competitive strategy. This has proved to be a very difficult objective to accomplish quickly even in the developed countries. Educating and convincing users on the importance of telecommunications services and indeed IT in general in developing countries is likely to involve a long-term commitment.

Third, and beyond the above, support may be needed to assist in the selection, design and installation of the necessary equipment and software as well as monitoring the learning period, providing training for managers and support staff, etc. Again there are opportunities for local suppliers that should be explored. If these are scarce, joint venture arrangements might be explored with foreign suppliers to help establish local support and training services. This would also be a good area to involve trained personnel (involved in software programming, system design, product engineering, technical education, etc.) from the universities and public sector R&D institutions in the supply of these services since it would also expose them to the realities of an industrial environment.

There are many other steps that could be taken in these areas. Ideally such policies should be designed purely with reference to telecommunications but as part of broader country-wide efforts to formulate and implement an informatics policy aimed at ensuring that the country takes the right decisions with regard to the acquisition, introduction and effective use of all aspects of Information Technology.

VI. PROSPECTS FOR REGIONAL CO-OPERATION AND THE NECESSITY FOR INTERNATIONAL COMPROMISE

Technological change and related pressures for regulatory reform in telecommunications are creating both opportunities and contentious problems for developing countries at regional and international levels. The same factors that have led to new possibilities for individual countries to exploit the "buyers market" in telecommunications to negotiate better terms and open up learning opportunities operate at the regional level as well.

Similarly because of the unique character of telecommunications as a critical part of the international infrastructure and as "global highways" for the Information Age, developing countries are facing major pressures to accommodate radical open-market oriented changes in the regulation of international flows of telecommunications-related services. The policy issues arising from these areas are explored in this last chapter.

1. New and unexploited prospects for regional collaboration: evidence from Latin America

The changes discussed earlier have created many new opportunities for regional groupings of developing countries to explore ways in which they can use their common need for telecommunications to overcome some of the problems posed by small size in relation to both procurement and local design and manufacture. It is easiest to discuss and illustrate these possibilities in relation to a specific region. The following comments on regional collaboration issues focus on Latin America where comparatively good information on investment plans and existing collaboration agreements exists.^{43/}

Excluding Brazil, Mexico, Argentina and Venezuela, the four largest countries in terms of telecommunications demand, the remaining Latin American countries account for approximately 25 per cent of total sales - around \$455 million in 1985. This constitutes a substantial demand overall and there are plans in individual countries to install digital technology which in turn open up some limited possibilities for local learning and manufacture. For example, in Colombia, which at sales of \$105 million in 1985, has one of the largest of the smaller country markets, a shift to fully digital technology is planned during the 1990s. Imports from European and possibly Japanese suppliers were expected to make up the bulk of the investment - but in fact the Colombian PTT could use its procurement power to stimulate local involvement.

There are some examples of local development revealing a surprising degree of expertise in telecommunications technology. For example, Uruguay has developed and installed 100 line SPC automatic telegraph exchanges. However, by and large the countries are heavily dependent on imports and their small markets pose serious constraints.

Nevertheless, if one looks closer at their investment plans, possibilities for collaboration do reveal themselves. For instance, Colombia's proposed expansion of telecommunications in the Amazon region could

be an opportunity for co-operation with Brazil which is also involved with communications projects in the region. Similarly, Paraguay because of its large demand for rural exchanges is supporting development work in two electronics institutes. This effort could be strengthened greatly via collaboration with Brazil which has developed rural exchanges and is willing to engage in technology sharing. Virtually the same situation exists with reference to Costa Rica and its need for rural exchanges.

In Peru, where the equipment market is expected to reach \$80 million annually by 1990, there are plans to set up an R&D centre to support a shift to SPC technology and the possibility of local participation in peripheral and perhaps transmission equipment. Virtually the same scenario is forecast in Bolivia and Chile, both heavy importers, both switching to digital technology, and both looking for ways to build up local capabilities.

It appears that for any of these individual hopes for local development and local capacity creation to reach fruition, regional collaboration is essential. In this context it is noteworthy that one of the key characteristics of telecommunications is the need for regional countries to co-operate in the establishment of technical compatibility in international communications.

These forms of regional co-operation do exist in Latin America (and in other regions) and could be strengthened and built upon - CONTELCA and INCATEL in Central America (including as members Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua); CITEI and ASETA in the Andean subregion. In the past some joint projects in installing microwave systems and regional training have already been undertaken. Indeed in 1981, a basic scientific and technological co-operation agreement was reached in Peru involving 10 countries that could have laid the groundwork for extensive collaboration in purchasing and technology development.

Some of these projects have succeeded whereas a number have not - for instance ASETA had established plans for wider integration in the region via a major satellite programme but this appears to have been abandoned. There may be good economic, technical, even political reasons for this and other failures but the fact remains that, as of the mid-1980s, despite many possibilities, little progress has in fact been made towards regional telecommunications collaboration in Latin America.

In Latin America, and in other regions as well, there is far greater scope for technology sharing, trading agreements and specialization in manufacturing than has so far been achieved. These are costly opportunities that are being wasted - and once missed will not reappear. This suggests that aggressively exploring the possibilities for regional collaboration should be a priority item on the agenda of telecommunications investment plans in all developing countries.

2. International regulation and the search for a compromise

Within the international regulatory sphere, the principal area for discussion, debate and decision-making is the ITU (the International Telecommunications Union), a specialized agency of the UN which has traditionally been the main forum for setting regulations governing

international telecommunications.^{44/} The ITU has also become a major actor in support of developing country efforts to build up their telecommunications sector.^{45/}

During the 1980s, the main pre-occupation of the ITU has been with how to manage the international dimension of the ongoing transition from a stable era of international exchange based on conventional telecommunications to a period featuring the rapid growth of a variety of services due to the convergence of digital telecommunications, computing technology and media broadcast technologies.

A central feature of this new context is that the same tensions which exist between regulatory and developmental concerns at the national level (as discussed in Chapter IV), have also permeated international telecommunications relations between advanced and developing countries. These struggles have produced contentious and often acrimonious debate and discussion and so far many of the main issues have not been settled. Finding a solution will demand major concessions from both sides.

Over the past decade the impact of technological advance, new specialized uses for international networks, the rapid diffusion of new services and pressures for openness in international trade have placed great strain on the ITU and its operating groups.^{46/} New market entrants, supplying a wide range of information services for education, commerce, banking, industry and many other areas, have emerged as autonomous service providers - outside the jurisdiction of the traditional PTT carriers and the ITU.

As a result, it is widely agreed that the existing regulations (decided upon in 1973) are now out of date and need to be fundamentally overhauled. Though the technical aspects are complex, the two main issues facing the ITU can be simply stated as (a) whether the new international telecommunications services should be regulated at all, and (b) if so, to what extent they should be regulated. The next round of ITU international conferences in late 1988 and 1989 are viewed as a major test case in its ability to provide a broad regulatory framework for the 1990s and beyond.

a. The pro-regulatory stance of the ITU and the developed country opposition

The ITU wants to extend its jurisdiction over new services (and their providers), and wishes to make compliance with ITU recommendations mandatory. However, there are many powerful opponents to the ITU's moves to maintain close regulatory control over international flows of telecommunications services.

The US, the UK and the large International Telecommunications Users Group (INTUG) in particular argue that the ITU should adopt a minimal regulatory approach, to be applied only to basic transmission and service provision (i.e. telephone, telegraph and telex). In short, they believe that compulsory standards and regulations would limit consumer choice, prevent competition, restrain innovation, and in effect 'strangle the new information technology revolution at birth.'^{47/}

The ITU's case for extending regulatory control to services and their providers rests on the need to consolidate the worldwide operation of one integrated standardized service network, and to ensure that individuals and countries have equitable access to both basic and enhanced services - a position that is largely endorsed by the developing countries.

b. Issues of transborder data flows

One specific fundamental area of conflict is in the regulation of transborder data flows (TBDFs) - which itself is part of a much larger contentious North-South debate over trade in services that will begin to be formally tackled within GATT this year. Third World countries are still highly dependent on developed countries for data processing and information services and they fear that control over TBDFs by private sector entities - both large and small - in the developed countries could in fact limit the transfer of information to the developing countries either because access will be denied outright or because the terms of access will be too stringent and costly.

Another major concern is that TBDF can occur between TNC parent and subsidiaries without the knowledge and control of the government and could then be used to the commercial advantage of the foreign firm and result in loss of revenue to the developing country. They may for example, be able to place bids for mineral exploration rights based on knowledge not available to domestic firms or devise strategies for negotiating with the government based on insider knowledge.^{48/}

Some developing countries have therefore registered strong disapproval at moves to prevent the ITU to have any say in the regulation and content of TBDFs. The stage is thus set for a contentious set of debates over the general issue of TBDF and the specific ITU proposals on this topic described earlier. At this time it is unclear what the outcome will be.^{49/}

Given the very high stakes involved in the decisions to be taken at the forthcoming ITU conferences, the possibility exists that if the ITU and the developing countries do not give way on developed country demands for flexibility and minimal regulation in major areas of conflict (including also the allocation of satellite services), the latter groups will remain equally firm thus throwing the whole system of international telecommunications regulation into a state of fundamental uncertainty.^{50/}

c. A compromise solution

These damaging conflicts have arisen at the international level because each side believes its position to be mutually exclusive. It could be argued, however, that there are large areas of complementarity between them but that to find these, each side has to recognize the validity of the others position.

The thrust of this argument is that a pluralist approach needs to be pursued in relation to the contentious issues now separating North and South in telecommunications. The ITU and the developing countries should recognize

that the massive increases in financial resources required to meet their basic infrastructural needs can only come from international sources. These resources can best be generated and supplied within an international economy that is growing rapidly.

The rapid global diffusion of telecommunications services and resources is critical to stimulating global growth because of the expansionary effects of these services and the new technology on all areas of economic activity. Deregulation and relatively free exchange within the industrialized countries is the best way to achieve this - and thus create the conditions for resource transfer. The major concession required of the ITU and developing countries therefore is that they accept that market allocation principles could be applied to the question of new service regulation within a framework administered at the international level.

The developed countries should at the same time recognize the legitimacy of Third World fears that the single-minded pursuit of total de-regulation and an unrestrained market free-for-all, without making allowance for telecommunications resource transfers, could increase the gap between North and South at an extraordinarily rapid pace and effectively eliminate whole segments of the Third World from participating in the most dynamic sectors of the global economy in the future.

Thus, the western countries would have to accept the need for regulation of the basic international infrastructure. At the same time, they should make major commitments to support a planned expansion of telecommunications in the poorer regions and to ensure adequate access to international resources in the future.^{51/} Ideally this should be done within the framework of the ITU (and the new Centre for Telecommunications Development) by making more funds available and seconding technical and training staff. Steps should also be taken to ensure the more effective participation of developing countries in the deliberations of the working committees of the ITU by contributing financial assistance and extending training and information to those involved.^{52/}

These moves would allow the ITU committees to carry out their important work with regard to ISDN and other issues that are of primary interest to developed countries, while at the same time ensuring that the needs of the Third World can be met as well. In return for this, developing countries should drop their reluctance to allow the work of the committees on these issues to go ahead.

VII. GENERAL CONCLUSIONS

The developmental concerns of the Third World with regard to telecommunications are legitimate on historical, economic and technological grounds. The rapid expansion of their telecommunications network is a key determinant of economic growth - but this expansion needs to be carried out in a planned and equitable manner that also allows for the creation of indigenous technological capacities when this is feasible.

The structure and management of the telecommunications network reflects many of the problems characteristic of the conditions of underdevelopment - underinvestment, limited availability and poor service; inadequate and often myopic management; excessive regulation and state interference and the biased allocation of resources towards the high income urban groups away from subsistence income rural populations. These difficulties are compounded by the unique pressures, opportunities and dangers caused by technological change and the ongoing revolution in international telecommunications and the accompanying explosion in transnational flows of information and services.

Two broad challenges face the developing countries as a result of the above. First they need to take steps to transform telecommunications and their main service providers into dynamic, efficient engines of development at three levels - rapid expansion of the basic infrastructure giving due weight to rural requirements, via investment in the creation of human, enterprise and institutional capabilities in information technology for design, service and, where feasible, manufacture of equipment and peripherals; and by ensuring that the telecommunications needs of the commercial sector are met as efficiently as possible. This will certainly require major reform of PTTs to push them in a more efficient, competitive and innovative direction as well as a recasting of the nature of government involvement particularly in the financial area where a way needs to be found to put more resources into the sector rather than taking them out.

Second, development implies greater integration with the world economy and inevitably greater dependence on the developed economies. This is particularly the case in relation to telecommunications both for technological reasons and because the investment levels required are far beyond the capacity of most countries - external resources are essential. If developing countries wish to capture benefits from the growth of the world information economy they will have to do their part to ensure that conditions exist that will stimulate global exchange and economic growth - this means facilitating the relatively rapid and free diffusion of new services. At the same time, they need to reach a mutually advantageous accommodation with international firms both in terms of their domestic operations and vis-à-vis the international exchange of services.

Making progress towards both goals does not demand that developing countries privatize, break up their monopolies, allow foreign competition or cede national sovereignty and autonomy to outside entities in matters of regulation and information flow. In some cases, however, liberalization may bring benefits. The more advanced developing countries, for their part, have to realize that they may be moving into a position where they could benefit overall from relaxation of the more restrictive elements of their regulatory

regime. This is particularly the case where the pursuit of exports is an objective and where steps must now be taken to ensure the international competitiveness of domestic producers and the existence of an environment attractive to foreign firms.

Nevertheless, some regions of the developing world - particularly the poorer countries - are not yet sufficiently advanced to take advantage of the powerful ability of liberalization policies to stimulate improvement in performance. This requires a minimum degree of indigenous, dynamic technological and industrial capabilities coupled with a stable institutional framework that, in effect, defines the "rules of the game" and allows the advantages of liberalization to be captured by the whole economy. Unless these minimum conditions exist, market oriented solutions could well have the effect of further reducing public accountability and transferring income to the already most favoured groups in the economy.

The challenge the developing countries face is trying to formulate policies that address both their equity concerns and the need for efficiency and innovativeness within the domestic context; while also finding the right balance between independence and interdependence in their relations with the global economy and developed countries. These are difficult accommodations to achieve. But their importance to the long-term prospects for economic advance in the Third World means these issues must be tackled with great urgency in the current period. The costs of not doing so are likely to be unacceptably high.

References

- 1/ For the classic studies on communications and development see Lerner, D.(1964) The Passing of Traditional Society, (New York: Free Press Inc.); Rogers, E.M. (1976) Communication and Development, (Beverly Hills, Ca.: Sage Publications); Schramm, H. (1964) Mass Media and National Development, (Stanford, Ca.: Stanford University Press); and UNESCO (1979) Communications and Society, UNESCO, New York, CC-79/WS/143. For a review of these points see Saunders, Robert J., "Information Policy in teh Developing World: The Infrastructural Constraint", Telematics and Informatics, Vol.1, No.4, 1985.
- 2/ For the information on which the discussion in this section is based see Independent Commission for Worldwide Telecommunications Development, The Missing Link, (Geneva: International Telecommunications Union, 1985); Wellenius, Bjor, "Beginnings of Sector Reform in the Developing World," paper presented at Seminar on Telecommunications Sector Restructuring and Management, Commonwealth Telecommunications Organization, Kuala Lumpur, 17-19 November, 1987; and Agi, Michael, "Communications and Third World Development", Transnational Data and Communications Report, Springfield, Va., June 1987 for examples of social costs and returns to investment in rural telecommunications.

For the studies on Kenya, the Philippines and Costa Rica, see Communications Studies and Planning Internationa, The Impact of Telecommunications on the Performance of a Sample of Business Enterprises in Kenya, a Research Report to the International Telecommunications Union, January, 1983; and Jonscher, Charles, "Telecommunications Investments: Quantifying the Economic Benefits" in Telecommunications for Development: Exploring New Strategies, Conference proceedings (available from the International Telecommunications Union), October 1986.
- 3/ See The Missing Link, ITU, 1985 for a full discussion.
- 4/ For example, the telecommunications sector will transfer \$2.1 billion (60 per cent of gross revenue) to the Moroccan Government over 1987-1994 as value added tax, income tax and import duties. The Brazilian Government received nearly \$900 million from telecommunications in 1986 alone. See Wellenius, 1987.
- 5/ British Telecom is reported to have spent over \$1 billion in R&D expenditure in order to develop its "System X" digital exchange system.
- 6/ For further discussion see Hobday, Michael G., "Telecommunications - A leading Edge in the Accumulation of Digital Technology: Evidence from the Case of Brazil", Vierteljahresberichte, NO.103, March 1986; and Hobday, Michael G., Telecommunications and Information Technology in Latin America: Prospects and Possibilities for Managing the Technology Gap, UNIDO Technology Division, Vienna, April 1985.
- 7/ See ITU, 1985 for a discussion.

- 8/ Nulty, T., 1987. "Telecommunications Policy for Less Developed Countries," paper presented at Seminar on Telecommunications Sector Restructuring and Management, Commonwealth Telecommunications Organization, Kuala Lumpur, 17-19 November 1987 covers many of the points raised in greater detail.
- 9/ For a succinct and excellent review of the main issues in the general area of services and the developing countries see Aronson, Jonathan D., "The Service Industries: Growth, Trade and Development Prospects", in John W. Sewell and Stuart K. Tucker (eds.) Growth, Exports and Jobs in a Changing World Economy, (Washington, D.C.: Overseas Development Council), 1988. The issues raised by TBDF concerns though a subset of service-related problems, are many and complex and cannot be dealt with in any detail here. For an analysis of the subject see Meheroo Jussawalla and Chee-Wah Chea, The Calculus of International Communications: A Study in the Political Economy of Transborder Data Flows, (Littleton, Colorado: Libraries Unlimited, Inc.) 1987. See also the Special Secretariat of Information, "Transborder Data Flows and Brazil: The Role of Transnational Corporations and the Effects of National Policies", SSI, Brasilia, 1982 for the classic statement of the developing countries concerns and policy position.
- 10/ Wellenius, 1987; Saunders, 1985.
- 11/ See Naraine, Mahindra, "European Telecommunications Policy: The Standards Issue", Mimeo, Department of Politics, University of Lancaster, October, 1985 for an excellent discussion on how European PTTs have successfully resisted most liberalization pressures.
- 12/ See Vaitzos, Constantine V., "The New International Economics of Major Technological Changes", Paper prepared for UNCTAD Secretariat, Geneva, 1987 for extensive discussion of how developed countries use non-tariff barriers to maintain markets in key IT sectors closed to foreign competitors.
- 13/ Feketekuty, Geza and K. Hauser, "A Trade Perspective of International Telecommunications Issues", Telematics and Informatics, Vol.1, No.4, pp.359-369, 1984.
- 14/ A just published consumer survey that in five categories of public service British Telcoms was providing poorer service in 1988 than it did in 1983, the year before privatization. However, some groups have done well from the break up of the state monopoly into a private duopoly of dubious competitiveness. The stock underwriters who guaranteed the BT stock offering made commissions of approximately \$650 million, while the loss to the public that resulted from undervaluation of the initial share offer was estimated by the UK Institute of Fiscal Studies to be nearly \$7 billion!

Unfortunately though, the great British public who were supposed to be the direct beneficiaries of privatization because of the opportunity given them to buy shares in BT did not take up the offer. By 1985, the proportion of BT shares held by private investors had declined to 13 per cent. Which, "BT-Still Out of Order?", Published by the Consumers

Association, London, June 1988. House of Commons, Public Accounts Committee, "Sale of Government Holding in British Telecommunications", London, HMSO, HC 35, 1985.

A more comprehensive review of the impact of BT privatization on business users and equipment suppliers summed up the now widespread feeling in the UK that his exercise has failed to achieve most of its major economic and technological objectives.

"The balance sheet reveals some mixed results with gains having to be set against costs some of these costs are to be found in a deteriorating trade deficit, growing dependence on foreign-designed at home, without having gained entry to closed markets abroad. Without heroic optimism, it is difficult to see the UK telecom industry regenerating itself in these circumstances." Morgan, Kevin. "Breaching the Monopoly", 1987, p.49.

- 15/ Nulty, 1987.
- 16/ Wellenius, 1987.
- 17/ For a discussion of the Latin American experience see Mattelart, Armand and Schmucller, Hector, Communication and information technologies: Freedom of choice for Latin America? Translated from the French by David Buxton, (Norwood, New Jersey: Ablex Publishing Corporation, 1985).
- 18/ Chowdary, T.H., "Indian Telephones: Troubled by Underinvestment", Telematics and Informatics, Vol.3, No.1, 1986.
- 19/ Poon, Auliana, "The Future of Caribbean Tourism - A Matter of Innovation", Mimeo, Science Policy Research Unit, University of Sussex, September 1987.
- 20/ Details taken from Posthuma, Annie, "The Internationalization of Clerical Work: A Study of Offshore Office Services in the Caribbean", SPRU Occasional Paper Series No.24, Science Policy Research Unit, University of Sussex, February 1987.
- 21/ Wellinius, 1987.
- 22/ See the discussion in Wellinius, 1987 and Nulty, 1987.
- 23/ Sustained technical advance and falling real costs of equipment stimulated rapid market growth throughout the 1970s and 1980s, despite recession in the international economy. The total world telecommunications equipment market stood at an estimated \$109 billion in 1986 and is forecast to reach approximately \$240 billion by 1994. The telecommunications equipment sector is one of the largest international industries comparable in size with the automobile and aerospace sectors. Market size data cited in Financial Times, "Survey of the Telecommunications Sectors," London, 19 October 1987.
- 24/ Such as semiconductors, office and computing equipment and telematics and informatics systems.

- 25/ Most major firms have now formed webs of strategic partnerships and technological joint ventures to meet these new challenges from within and outside the industry. See Financial Times, "Survey ... for a discussion of recent mergers, takeovers and joint ventures.
- 25/ In the case of the US, in the late 1970s government funding for civilian R&D in communications was primarily funneled through the space and energy programmes; by 1983, when US government contracts with an R&D component for high technology products and services was running at \$55 billion annually the Department of Defense had taken over as the prime source of government funding for private sector R&D.
- For data see Savage, M., Catoe, G., and P. Caughran, "Manned space station relevance to the commercial telecommunications satellites: a prospectus to the year 2000", paper presented at the AIAA/NASA Symposium, Arlington, Virginia, July 1983; OECD Secretariat, "Space Products Industry: A Sectoral Study" OECD Department of Science, Technology and Industry, (DSTI/SPR/83.104, 9 May 1984), Paris.
- 27/ As is well known and widely reported, the US has taken the lead here but similar steps have also been taken in the UK Japan, France, Italy and Germany. For a comprehensive and comparative review of the experiences of the developed countries see Bruce, R., "The Experiences in Industrialized Countries: An Overview of Options and Developments in the Telecommunications Organization. For a discussion of Japanese and US efforts to de-regulate see The Economist, London, 17 October 1987; the UK, Morgan, Kevin, "Breaching the Monopoly: Telecommunications and the State in Britain", Mimeo, Science Policy Research Unit, University of Sussex, January, 1987; for Europe see Caty, G.F. and Ungerec, H., "Telecommunications: The New European Frontier", Futures, April 1986.
- 28/ This is so even if, for various political reasons in countries such as the US such support cannot be provided in an overtly direct manner, while the support that is given is felt to be inadequate and even misdirected by some analysts.
- 29/ Estimates for telecommunications spending by developing countries are from Financial Times, 19 October 1987; Telephone Engineers & Management, 3 January 1988 and private communication from Mkie Hobday.
- 30/ See "The Missing Link" and Mahajan, D.R., "Telecommunications for Development: A View from India", Telecommunications, February 1988, pp.33-36 for the arguments.
- 31/ For a full elaboration of this approach and empirical support see Hobday, Michael G., "Telecommunications and Information Technology in Latin America: Prospects and Possibilities for Managing the Technology Gap", UNIDO Technology Division, Vienna, April 1985.
- 32/ See Hobday, "Telecommunications - A Leading Edge", 1986.
- 33/ See The Missing Link, 1985; Mahajan, 1988 and Communications International, "Survey: Development Telecoms", p.36, September 1986 for discussions on these problems.

- 34/ See Hobday, Telecommunications and Information Technology in Latin America ..., 1986 for data on export performance. To lay the ground work for this, Republic of Korea, who like Taiwan Province of China embarked on export-led industrialization in the 1970s, invested \$6 billion between 1982 and 1986 in the telecommunications industry within the context of protected markets for mainly public but also some private sector domestic producers. Over this period, the number of subscribers increased from 240,000 to over 5 million using an automatic switching network connecting 22 major cities; and the R&D and technological framework was laid for the introduction of domestically designed and produced optical fibre cable systems, the development of a Korean digital switching system with a capacity of 10,000 lines, the domestic development of videotex and teletex terminals; and the early introduction of ISDN. See "Fruits of Investment; South Korea", Communications International, October 1986.
- 35/ See Hobday, Michael G., Telecommunications and the Developing Countries: The Challenge from Brazil, (London: Harcourt Publishers, 1988) for a review of the empirical literature.
- 36/ This concept and its importance is now a central percept in mainstream thinking about industrialization. There is a voluminous literature on this subject but for a review see Dahlman, C.J. Ross-Larson, B., and Westpal, L., "Managing Technological Development: Lessons from the Newly Industrializing Countries" World Development, Vol.15, No.6, June 1987; and Bell, R.M.N., Ross-Larson, B. and L. Wstphal. "Assessing the performance of infant industries", Journal of Development Economics, Vol.16, 1984, p.101-128.
- 37/ See the contrasting positions taken on the Indian case in Mahajan, D.R., "Telecommunications for Development: A View from India", Telecommunication, London, February, 1982, for the positive viewpoint, and Chowdary, T.H., "Indian Telephones: Troubled by Underinvestment", Telematics and Informatics, Vol.3, No.1, 1986, for the negative position.
- 38/ Communications Systems Worldwide, London, May 1987 and September 1987.
- 39/ The centralized nature of most telecommunications investment and purchasing is unique within the complex of other IT industries, where purchasing is usually carried out by a wide range of public and private sector users. Conversely, the large bulk of equipment is normally purchased by a government-owned or controlled agency. This monopoly power has, in many cases, proved critical in the bargaining between PTTs and foreign suppliers for favourable technology transfer agreements and developing country PTTs are very unlikely to relinquish it under any circumstances.

For details on the Siemens and Taiwan deal see "News", Communications South East Asia, August 1985; for other examples of technology transfer arrangements and home country government support with developing countries see "Survey: Development Telecoms", Communications International, September 1986.

- 40/ For a discussion of French tactics in Latin America and the Mexican collaboration with ITT see Mattelart, Armand and Schmucller, Hector, Communication and information technologies: freedom of choice for Latin America? Translated from the French by David Buxton, (Norwood, New Jersey: Ablex Publishing Corporation, 1985).

Ericsson of Sweden was particularly quick to recognize that co-operation with developing country industrialization strategies could provide them with competitive advantage over other competitors, especially in the large market countries. In response to government requests in Brazil, Mexico, Venezuela, Ecuador and Colombia, Ericsson have transferred technology and, where appropriate, adapted their systems to suit local needs and introduced local training schemes for indigenous personnel.

- 41/ NEC now ranks as the third major supplier of public switching equipment to the Third World, after ITT/Alcatel and Ericsson. For details of corporate market share according to region in developing countries see Communications Systems Worldwide, May 1987, pp.36-38.

- 42/ For an extensive discussion of this issue see Hoffman, Kurt, Managing Technological Change: The Impact and Policy Implications of Microelectronics, London: Commonwealth Secretariat, 1985.

- 43/ See Hobday, Telecommunications and Information Technology in Latin America, 1986.

- 44/ The role of the ITU is paramount in international telecommunications matters. It is responsible for establishing interconnection standards and agreements on equipment, operating procedures, signalling and routing between the many national networks as well as setting charges and accounting procedures. In addition, the ITU is responsible for regulating and distributing the radio frequency for point to point telecommunications such as telephony and telegraph, as well as mass media communications; and since the 1960s it has regulated the geo-stationary satellite orbit, a crucial part of the overall communications capacity of most countries. The ITU is an extremely powerful and necessary body and it is in the interest of all countries that it work successfully.

- 45/ The current strength of this focus was underlined by the findings of the Maitland Commission (published as The Missing Link) that highlighted the enormous inadequacies of telecommunications systems in developing countries and the establishment in 1986 of the Centre for Telecommunications Development to respond to the many requests it receives for technical assistance from the Third World.

See Renaud, Jean-Luc, "The ITU and Development Assistance", Telecommunications Policy, pp.179-192, June 1987 for a discussion of the ITUs gradual move towards Third World issues and the tensions this has created within the organization and its committees. See Finnie, G., "A Brisk start for the Development Centre", Communications Systems Worldwide, October 1987 which describes the problems that the CTD is having in attracting funding from developed countries who are reluctant to contribute on political grounds.

46/ Within the ITU, there are three main committees dealing directly with standards and regulations: The CCITT (the Consultative Committee for Telegraph and Telephone), the CCIR (the International Radio Consultative Committee) responsible for all radio and broadcast matters, and the IFRB (the International Frequency REGistration Board). The detailed discussions and negotiations that go on within these committees are critical in determining the final proposals that are put to member governments for agreement.

The mechanism for achieving international agreement on telecommunication resource distribution and standardization are through the resolutions agreed to by ITU members during large international conferences such as the WARC (World Administrative Radio Conference) and the WATTC (World Administrative Telephone and Telegraph Conference), the next rounds of which are being held in 1988 and 1989.

These follow on from previous world conferences and establish the reules for telecommunications operations, sometimes for periods of up to ten years and beyond. The tensions between the desire to promote the growth of telecommunications internationally and trade in related services through de-regulation and privatization, and the need to maintain control over standards and provide for the basic requirements of the developing countries, are manifest both in the work and functioning of the committees and in the deliberations of these conferences.

47/ These arguments are put forward succintly in Communications Systems Worldwide, London, November, 1987.

48/ See Telephony, Chicago, Illinos, 27 April 1987.

49/ For a discussion of the outcome of the most recent conference on mobile radio regulation see FCC Week, Alexandria, Virginia, 26 October 1987.

50/ It is clear from the statements of INTUG, the EEC, US and UK delegates, and other interested groups, that if the "arch-regulatory" stance of the ITU were to be adopted at the next interantional conferences, it would be rejected in practice. See Renaud, 1987 and Aronson, 1987 for a specific and a general discussion of these possibilities.

51/ See the discussion and examples given in Hudson, Heather, "Toward Greater Developing Country Access to Telecommunications" and R. Hoen, "Financing Development and Telecommunications in Africa", in Telecommunications for Development, 1986.

52/ There are problems at the North-South divide even in these committees. For instance, developing countries are unhappy that private sector firms from developed countreis (who are allowed to be represented on working groups) represent a majority on all 18 study groups of the CCITT. Other problems arise from poor attendance by developing country members, inadequate technical preparation that the committees are not working on issues that have much relevance to their problems. See Renaud, "The ITU and Development Assistance", June 1987 for an extensive discussion.