INDIA

THE TELECOMMUNICATIONS SECTOR: POLICY, PERFORMANCE, TECHNOLOGY AND MANUFACTURING CAPABILITY

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FISCAL YEAR

April 1 - March 31
Abbreviations

AOP  Annual Operating Plan
C-DOT  Centre for the Development of Telematics
CCITT  International telecommunications standards body
CCS#7/SS7  Common Channel Signalling System Number Seven
CGM  Chief General Manager
Circle  Telecom administrate group of secondary switching areas
Crore  Ten million or $10^7$
CTO  Central Telegraph Office
DDG  Deputy Director General
DEL  Direct Exchange Line
DOT  Department of Telecommunications
DTMF  Dual Tone Multi Frequency
DTMX  Digital Trunk Manual Exchange
DTO  District Telegraph Office
E10B  Alcatel Public telephone exchange system
FM  Frequency Modulated
GM  General Manager
Gram Panchayat  Administrative center of a group of villages
ISDN  Integrated Services Digital Network
ITI  India Telephone Industries
km  Kilometer
Lakh  One hundred thousand or $10^5$
LDPT  Long Distance Public Telephone
MARR  Multi Access Rural Radio
MB/S  Mega bit per second
mm  Milli meter
MTNL  Mahanagar Telephone Nigam Ltd.
O/F  Optical Fiber
PABX  Public Automatic Branch Exchange
PC  Pentaconta telephone system
PCM  Pulse Code Modulation
PCO  Public Call Office
PSPDN  Packet Switched Public Data Network
PSTN  Public Switched Telephone Network
RABMN  Remote Area Business Message Network
Region  Telecom administrative group of Circles
RKM  Route Kilometer
RLU  Remote Line Unit
RS.  Rupees
RSU  Remote Switching Unit
SBP  Strategic Business Plan
SDH  Synchronous Digital Hierarchy (see also SONET)
SONET  Synchronous Optical Network (see also SDH)
SSA  Secondary Switching Area
STD  Subscriber Trunk Dialing
TAX  Trunk Automatic Exchange
TC  Telecom Commission
TDM  Time Division Multiplex
TEC  Telecom Engineering Center
UHF/VHF  Ultra/Very High Frequency
VFT  Voice Frequency Telegraph
VSNL  Videsh Sanchar Nigam Ltd. Indian international telecommunications authority
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Preface

Reform of telecommunication systems worldwide has been a significant phenomenon over the past two decades. This reform momentum has been driven and maintained by the very rapid changes that have occurred in telecommunication technology. While there are common issues and objectives of this reform process, the methods and approaches adopted vary across countries dependent upon local circumstances and institutional conditions. Furthermore, the accepted body of wisdom on an ideal reform agenda and its sequencing is still evolving, in part due to the uncertainties generated by the rapid pace of technological change. In other words, a rigidly defined strategic approach to reform may not always be possible or advisable, simply because of the uncertainties that would arise as the reform process unfolds.

This report is designed as an input into an ongoing policy dialogue with the Government of India (GOI) on reform of the telecommunications policy framework in the country. The objective of the study was to provide analysis of the present telecommunication systems and the policies that have underscored technology development and domestic manufacture. However given policy initiatives that have been undertaken in India over the past year, the study was expanded to touch upon some of the broader regulatory and policy issues in the sector. Nevertheless, it is not intended to provide a complete and detailed reform agenda that would be applicable to all the needed areas of change for India’s telecommunication sector. Instead it has sought to focus upon the broader reform issues, with suggestions of possible approaches to change.
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Executive Summary

Introduction

(i) The telecommunication network in India is highly inadequate both in terms of coverage and the quality of service. Telephone density of .54 direct exchange lines per 100 of population is amongst the lowest in Asia, with nearly 25,000 villages with populations over 2000 with no access to any telephone service at all. The gap between supply and the estimated demand for service has been continually widening throughout the eighties. In 1980, the estimated demand satisfaction (based upon waiting lists which understate the true demand) was 85.8%. This had fallen to 72.8% by 1990, and it is noteworthy that this decline occurred during a period when India experienced a decade of historically strong growth in national product, per capita incomes and international trade. Given that there are well over 100 million middle class urban dwellers, it should be apparent that massive scope exists for an expansion of the network. Much of the network utilizes obsolete equipment, which results in high fault rates, and congestion is high, resulting in poor completion rates. In 1990, there were 19.3 faults per hundred stations per month, which is an improvement over 1980 (40.0 faults) but given that well operated networks operate against a benchmark of 1 or 2 faults/100 stations/month, there is considerable scope for improvement in service quality. Also, the long distance networks have not kept pace with developments in the local networks with the result the network is heavily congested.

(ii) This inadequacy represents a considerable constraint on all aspects of the country's economic and social development. Poor telecommunications adds significantly to transaction costs, which in turn undermines the country's competitiveness and inhibits business development and investment. This is particularly germane for India, given that the government has embarked upon a comprehensive structural adjustment program designed to restore viability to the balance of payments through improved export performance and an improvement in international competitiveness in its industrial, agricultural and service sectors.

(iii) The reasons for this present situation are various. The sector has not been accorded a high priority in public sector investment outlays, averaging between 2 to 4% of public sector investment outlays over the past three decades. Of possibly more significance however has been the negative influence of an inappropriate policy environment and organizational structure for a sector that has experienced massive ongoing technological change. The policies adopted, and the organizational structures that have emerged from these policies, have not proven to be sufficiently flexible to optimize the use of those resources that are available. Policy objectives have often become merged, with the result that clarity has suffered and goals have become confused. The fundamental objective, and need, to deliver good quality telecommunication services at reasonable prices, has often been subverted by the desire to protect, and nurture, an uncompetitive telecommunication manufacturing base or safeguard a workforce anxious to preserve existing job descriptions and work practices.
(iv) What follows is a description of the existing policy framework and organizational structure, together with an analysis of the deficiencies in this framework and structure. There is a review of government efforts to improve the situation, together with a possible policy reform agenda and reform options.

**System Structure and Policy**

(v) The provision of public telecommunication services is a monopoly of the Central Government. Notwithstanding some minor organizational adjustments, and a very recent decision to allow private sector participation in the provision of mobile telephone services, the service provider is a highly centralized bureaucracy employing over 450,000 employees. This organizational structure has not evolved at a pace, or in a manner, suitable for an essential infrastructure with rapidly changing technology. The sheer size of the entity, together with its highly centralized decision making hierarchy, has been a constraint and inhibitor to change. While day to day operational responsibility is decentralized to the field units, planning, finance, procurement, technology and service development are totally concentrated in the Department of Telecommunications (DOT) directorate in Delhi. This causes lengthy delays in project implementation and is not responsive to changing consumer needs and requirements. Furthermore, the bureaucratic, civil-service oriented structure leaves little capacity for monitoring unit and individual performance, which in turn has reduced accountability and responsibility.

(vi) There has also been a strong policy desire for the country to be self sufficient in the production of all telecommunication equipment. A great deal of success has been achieved in this objective, with over 90% of equipment and materials procured by DOT coming from domestic sources. Up until the early eighties, the production of telecommunication equipment was reserved for public enterprise producers. Since this time there has been a progressive liberalization, and other producers have been allowed to produce terminal equipment and cables, and most recently switching equipment. This liberalization has brought forth new investment with the result that the domestic competitive environment for cables and terminal equipment has improved significantly and prices have declined. Nevertheless the production of switching is dominated by a large public enterprise, and given high nominal import tariffs domestic manufacturing is largely insulated from international competition, which would allow for the introduction of innovative technologies and further reduce prices.

(vii) The policy of "self reliance" in telecommunication equipment has not served the network and system well. Up until quite recently, the two large public enterprises (Indian Telephone Industries, ITI, for switching, transmission and subscriber equipment and Hindustan Cables Ltd., HCL, for cables), operated on a cost plus pricing arrangement with the sole purchaser, DOT. Not surprisingly, this resulted in high prices, very poor productivity levels by world standards, poor quality and stagnant technology development. This has, in turn, affected network expansion plans by increasing the cost of expansion and by unreliable delivery schedules. More ominously, the policy focus of reliance on domestic public enterprises has inhibited network planning, resulted in technically sub optimal planning and retarded the use of more up to date technology. For example, obsolete Strowger electro-mechanical switches were still being introduced into the network in 1990, in part to preserve employment and maintain
production lines at ITI. Furthermore, the large digital switch produced by ITI from 1985, is basically early seventies technology with insufficient BHCA (Busy Hour Call Attempt) capacity for the higher traffic metropolitan areas. This results in a proliferation of switching exchanges, which is both cost ineffective and creates increasing network management problems.

Indigenous Technology Development

(viii) In parallel with a policy desire for self reliance in production, there has also been a strong desire to develop an indigenous research and development capability in telecommunication equipment. In 1984, the Centre for the Development of Telematics (C-DOT) was established with a mandate to develop an indigenous digital switch. The basic objective was to develop an alternative technology to that being utilized by ITI, and through a broadening of the switching production base using the C-DOT developed switch, provide DOT with alternative procurement sources. This was an ambitious target, given the rapid pace with which telecommunication technology is changing, and the fact that large scale switch development is costly and dominated by a few worldwide manufacturers with vast resources.

(ix) The achievements of C-DOT to date are significant and this has been done over the past seven years with a relatively small budget by world standards. This is a reflection of the good quality of the engineering and technical staff, and their low cost relative to the economically more developed countries. What is also apparent however, is that the time taken for developments to reach a stage of volume production has been consistently under estimated. At present a 10,000 port switch of 6000 subscriber lines was recently commissioned, and small rural and local exchange switches are being introduced into the network. The C-DOT switching system can provide a part of what the network needs, but the likelihood that this system will evolve into a switch with sufficient capacity for large local and trunk switching applications, in a time frame that does not negatively affect network planning and development, is very slim. To rely upon this switch, and the old E10B version 8 presently being produced by ITI, cannot serve the needs of the system in the most cost effective and technically efficient manner.

Domestic Production

(x) Liberalization of the manufacture of telecommunication equipment has been helpful to the industry and to the network, particularly in cables and terminal equipment. While there is considerable over capacity in these two sectors, which may cause some realignments within the sub-sectors concerned, this should disappear as the network expansion proceeds. The domestic production of telephone cables is competitive by world standards, provided the various inputs (mostly notably copper) are provided at world prices. Quality standards are good and, in most cases production methods are sound. The one possible exception to this is HCL, the central government owned cable producer. Its overhead and staffing levels are high, and overall productivity and efficiency is below the domestic industry average. Nevertheless, this firm has made progress in improving its performance and with continued modernization efforts should continue to improve.
(xi) With regard to local switching production, the broadening of the production base by the licensing of the C-DOT range of switches has been beneficial. Analysis of production costs of the smaller range of switches (RAX 128, MAX-M and ILT 512) suggests that production is competitive by world standards, again provided that all necessary inputs are available at world prices. With regard to the larger switches produced at ITI, this is clearly not the case. This firm has significant productivity and efficiency problems with the result that quality is deficient and productive cost per line of the larger switch is about twice the prevailing world price for equivalent equipment. Given that this public enterprise is at present the only source of large switch production, this has serious implications for the network and the investment cost of its expansion. Some improvements could be effected by internal adjustments in work practices and management approach, however, the scope for significant improvement in the present organizational structure is slim. Fundamental corporate and organizational restructuring, as well as modernization and financial realignment is necessary. The present corporate form will need to be changed.

Network Expansion Plans

(xii) The Government is aware of the deficiencies in the telecommunication system and plans a massive expansion plan over the next decade to increase coverage and the quality of service. By the year 2000, it is hoped that 20 million direct exchange lines will be operating, compared to 4.6 million lines in FY90/91. In the Eighth Plan period (1991-95) the target is to have 5.2 million new telephone connections, resulting in an all-India telephone density of 1.09 telephones per 100 population and .23 telephones per 1000 in the rural areas. To put this effort into perspective, the achievement during the Seventh Plan period (1986-1990) was 1.7 million new telephone connections; thus the planned increase over the next five years is three times larger. This is a prodigious and ambitious target, particularly given the delays experienced in the delivery of the larger sizes of switching equipment. The cost of this investment program is estimated to be Rs.197 billion (or US$7.7 billion for 91-95) and Rs.300 billion (or US$11.765 billion for 96-00). Financial projections by DOT suggest that the bulk of this investment program will come from internal resource generation (about 93%) and the remainder from local market borrowings. It should be noted that there has been a significant improvement in the financial performance of DOT/MTNL (over the past five years) as a result of tariff adjustments and the large increase in revenue earning lines. Operating revenue per line has increased by 121% in nominal terms from 1986 to 1990, while operating costs per line have increased by only 38% As a result, net profits after taxes have increased by about 380%, and the rate of return on assets (revalued basis) has gone up from 7.63% in 1986 to 17.9% in 1990. On paper, the proposed financing plan for the networks' expansion is feasible. However, the proposed expansion is not likely to meet the growing demand and it is doubtful, because of system constraints, that even the projected expansion will be implemented.

System Constraints

(xiii) While there are some anomalies in the cost estimates of this planned network expansion, the main constraint is not financial. It is the policy framework and organizational structure. Since the formation of the Telecommunications Commission in mid 1989, attempts have been made to address the
severe institutional weaknesses inherent in the present DOT/MTNL organizational structure. This has involved a system of Strategic Business Planning, coupled with Annual Operating Plans down to the Secondary Switching Area (SSA) levels. But there are doubts that this internal "fine tuning" will be sufficient to improve accountability and improve productivity and performance. Furthermore, it is felt that unless there is a fundamental change in the organizational structure, which in turn brings a change in staff and management attitudes, implementation problems will inhibit network expansion and the hoped for improvement in service quality may be illusory.

(xiv) Even by developing country standards the number of employees in DOT/MTNL is very high. The number of lines per employee is about 10, compared to 104 in Mexico, 102 in Brazil, 122 in Chile and 198 in the United States. All Government of India undertakings are heavily unionized and DOT/MTNL is no exception. There are thirty seven craft based unions, labor relations are sometimes difficult and fractious, and have been a significant inhibiting factor in past attempts to restructure DOT, adopt new work practices or adjust to changing technologies. Over the past two decades, numerous internal studies, working committees, task forces or job reclassification exercises have been undertaken. Little has been accomplished. Opposition to change has been a consistent norm and this suggests that a significant transformation in the organizational culture may only occur if bold and radical institutional reforms are undertaken. Past experience, in other countries suggests that for large public monopolies, a fundamental change in institutional structure, coupled with competitive forces brought about by the entry of new service providers, improves responsiveness to consumer needs and penalizes the lack of such responses, and inculcates a greater sense of accountability at all staff levels, needs to be undertaken at an early stage in any reform agenda.

Policy Reform Agenda

(xv) Any policy reform agenda for telecommunications in India must start from the basic premise that the present organizational and policy framework is unsound and in need of change. There is need for decentralization of management and decision making, and there is massive scope for service-based and facilities-based competition in India's telecommunication network. Changes in telecommunication technology over the last decade have brought about dramatic changes in the range of services that can be offered and the cost of provision of those services. Minimum network size necessary to be economically viable has become much smaller, with a result that networks can grow in a modular fashion, and allows great scope for competition in the sector. A fundamental objective is to have a telecommunication development policy that is driven by consumer needs and not burdened by other policy objectives. The priority policy framework must be one that addresses a rapid expansion of investment in the network and an improvement in its quality of service, and provides appropriate "ground rules" for this to occur. This policy framework will be an evolving one. Hence, there is need of a mechanism that allows this policy frame to respond to changing technology and consumer needs. What is clear, however, is that there is an urgent need to embark upon reforms in the sector as soon as possible.
Service and Facility-Based Competition

(xvi) A fundamental requirement of a revised telecommunication policy framework in India is an immediate need to allow a greater degree of private sector involvement in the provision of services, either in competition or complement to the services provided by the dominant carrier. This could occur for specific services (digital cellular radio, mobile telephones and data transmission networks, for example), and in the form of overlay networks in specific areas and competition in trunk transmission.

Policy Formulation

(xvii) As a first step, it would be useful to have a separate and independent policy making body supported by a modest secretariat, reporting to the cabinet of the GOI. To ensure effective user representation this "Policy Board" could be composed of a majority of members from outside the government. This "Policy Board" should be delinked from regulatory or operating/service provision functions with no line authority over either function. Its sole mandate should be to develop a policy framework, which takes strong account of user needs and technological and organizational options available to meet these needs. This policy body could monitor the reform agenda, and adjust its content and timetable according to changing circumstances, technology and perceived developmental priorities.

Regulatory Oversight

(xviii) Following formation of a "Policy Board", it would be necessary to establish a "Regulatory Authority" that would be guided by the broad policy agenda ensuring that the goals set are not being thwarted or undermined by anti-competitive behavior on the part of the operating units. This Authority would be independent from the operating units, but would have to have the capacity to monitor performance. It would also administer franchising and operating agreements, oversee interconnection practices, and, where monopoly service elements exist, provide a price regulation function.

DOT Restructure

(xix) There is need to restructure and transform DOT/MTNL. Devolution into a number of separate operating units would be one possibility which would be both beneficial and feasible. These operating units must be discrete entities, with a corporate structure that allows for financial autonomy and accountability to the shareholder, whomever they might be. They would operate under a licensed regime granted by the "Regulatory Authority". Within this licensed arrangement, the service provider would have discretion to provide and enhance subscriber services, make independent technology and equipment choices, raise financial resources in a manner consistent with overall economic policy and impose tariff schedules in accordance with guidelines imposed by the "Regulatory Authority". Whatever the shareholding of these entities, the board of directors should reflect a wider, non-governmental membership.
(xx) In conjunction with a restructuring of DOT, there should be a liberalization of entry by others who wish to provide telecommunication services. The options available for greater private sector involvement in the telecommunication sector are very broad. This could occur in the areas of specific services, or could occur in the form of overlay networks in specific areas.

**Labor Agreements**

(xxii) Whatever decentralized organizational form is adopted, which gives operating units autonomy, the existing public sector workforce need not immediately change and assurances can be given that the existing baseline of benefits will not be lowered or withdrawn. In return, the trade unions should accept that future working practices and norms, and productivity bonuses, should then be subject to agreement between individual operating units and their employees. At the time of the reorganization it would also be useful to enter into a "Technology Agreement" with the workforce that laid down the parameters for accommodation to technology change. In this context, those made redundant by technical changes in the network (e.g., manual operators) would be eligible for retraining in skills within the individual's capacity and inclinations and which, of course, would be useful within the various operating units.

(xxii) This implies that a more intensive retraining and skill upgrading exercise would need to be instituted within the existing training infrastructure. This infrastructure could be made autonomous, and would receive a part, if not all initially, of its revenues from the various operating units on the basis of cost recovery for individual staff trained. It should also be noted at this stage, that some of the courses offered could impart skills that are not only useful to the network, but would also find use in other sectors of the economy. For example, providing good word processing and data input skills could provide opportunities to certain categories of staff in a growing software and data management industry in India.

**Technology Choices**

(xxiii) With regard to the technology that is introduced into the network, the guiding principle must be to utilize the most effective, both in terms of cost and technical efficiency. Individual operating units must be free to choose the type of technology they wish to employ, subject to interconnection capability with the entire network. Tying the service provider to particular producers and equipment types, irrespective of cost and technical capability, will result in sub-optimal network development and significant network management problems in the future. The recent agreement between ITI and its foreign collaborator to produce a more efficacious digital switch (the OCB 283 of Alcatel) is a very positive development, but it is far from certain when such equipment will leave the factory. Furthermore, ITI has its own restructuring and efficiency problems that will need to be dealt with, which could entail a radical transformation of its present organizational structure.

(xxiv) The present C-DOT switch developments, as well as the E10B presently under production at ITI, can meet part of the needs of the Indian network expansion. But, from an optimal network planning perspective, they cannot meet
them all. While the domestic production base is broadened, both in terms of technical capabilities and cost efficiency, it should be recognized that importation of appropriate equipment (most notably large capacity switches) may be necessary. Not only would this ensure more effective network planning, but it would also encourage direct foreign investment, in conjunction with local partners, as the market potential is more fully perceived and the riskiness of such investment significantly reduced.

**Domestic Manufacture**

(xxv) There has been considerable improvement in the policy regime supporting the domestic manufacture of telecommunication equipment. As it presently stands, investment is possible in every area of equipment production. And, subject to type and technical approval, is eligible to be sold to DOT. In terminal subscriber equipment, cables and, most recently, in the production of the C-DOT switches, considerable new capacity has emerged, costs have declined and quality improved. The increased competition in these sub sectors has been beneficial to the consumer of telecommunication services.

(xxvi) **There is limited international competition, however, and nominal protection levels are high.** In effective protection terms, the efficiency of cable production in the more modern plants is good, and if they could obtain their necessary inputs at international prices, then these firms should be quite competitive by international standards. The elimination of the public-sector monopoly of copper rod imports would be a significant advance in this regard. The same can be said of the production of smaller switches, with an ex-factory price per line (before excise and sales taxes) which already appears to be quite competitive.

(xxvii) **The main difficulty in domestic manufacture relates to the public enterprises.** They are significantly overstaffed, with a corporate and management culture that has suffered from three decades of monopoly production rights, with cost plus pricing systems that did little to constrain production costs, and insulated from any form of international competition. In a fully competitive environment it is very unlikely that ITI and HCL would survive in their present forms. Moreover, notwithstanding their poor productivity and high cost structures, the quality of equipment produced and supplied has been deficient. Management of HCL and ITI are endeavoring to rectify the situation in their respective enterprises. In the case of HCL, the transformation of dry core FCUT production lines to PIJF is far behind schedule. When completed however, the outlook for the company is somewhat improved. But if the firm were to compete equally with other domestic cable producers, considerable productivity enhancing measures would still need to be introduced, including a staffing plan that allowed for a progressive rationalization of staff size.

(xxviii) **The problems of ITI are much more acute, and require more radical reformation.** The company is geographically very dispersed, and its product base very broad. It has ambitious plans to increase its output of digital switching (particularly of the latest technology OCB 283 switch in technology collaboration with Alcatel), thereby utilizing the about 8000 staff made redundant by the closure of the Strowger production lines. Considerable
uncertainty surrounds the enterprises' capacity to achieve this in its present organizational form, and considerable capital investments will be necessary to effect this transformation and modernization.

There are elements of ITI which do display better productivity levels, and there is no doubt that the organization contains many excellent managerial and technical staff. Herein lies the capacity to effect beneficial change. To achieve this change however it would be necessary to restructure the public enterprise into a number of separate and autonomous firms. In this manner, rehabilitation efforts can be focussed upon those elements most in need of transformation. In the process of this restructuring into separate entities, the shareholding and capital structure could be adjusted by broadening the share ownership base to include the domestic private sector, the state sector, workers (in the form of employee stock ownership plans), the general public and foreign investment. Not only would this enhance managerial accountability, but it could provide some of the needed capital resources for modernization.

It is therefore an urgent necessity that a highly detailed corporate restructuring study of ITI be undertaken that encompasses all departments, its productive base, its staffing component and its financial structure. This study should provide a detailed plan of rationalization, together with appropriate corporate forms and an assessment of equipment requirements. It should also address human resource development issues and suggest appropriate mechanisms for early retirement for longer serving staff or retraining where deemed to be effective and feasible.

Ultimately, the domestic production of telecommunication equipment must be competitive on an international scale. This will only occur when domestic manufacture faces competition from foreign suppliers. To achieve this will require a gradual and progressive decline in the import tariffs applied to foreign sourced equipment. As this occurs, then import tariffs on imported components must also decline, as well as the protection afforded to domestic component producers. Domestic final equipment producers must be able to source their inputs and components in an internationally competitive manner if they themselves are to be competitive. The ultimate beneficiaries of this reform process of course, will be the employees in the domestic producers, as well as the Indian telecommunication service consumers.
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<th>Policy Issues and Areas of Reform</th>
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<td><strong>Policy Framework</strong></td>
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<td>The present framework for the development of the telecommunications sector in India is deficient. The extreme centralization of service delivery, technology choices, equipment procurement, together with a policy of indigenization of technology development and manufacture inhibits network growth and quality enhancement.</td>
<td>Recent policy initiatives have sought to remedy some of the shortcomings of the present system. The manufacture of switching equipment has been liberalized (July '91), DOT has announced its intention to broaden the range of technology and type of larger switches that might be introduced into the network and for certain types of specialized services (e.g. mobile telephone) where private sector involvement is to be allowed. These steps are welcome, however, they are not occurring in the context of an overall policy framework of reform in the sector. What is needed is a telecommunications sector policy reform agenda that sets out a longer term vision of reform objectives and measures. There is an immediate need to allow for competition by private sector entities in the provision of facilities and services. This policy agenda could also address proposed organizational reforms of DOT and the policy and regulatory framework under which this will occur.</td>
<td>The proposed telecom policy reform agenda represents a &quot;blueprint&quot; for change. As this reform agenda is a precursor of any reform effort, it should be completed as soon as possible.</td>
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### Institutional Structure

The present organizational and institutional structure is ill suited to a sector in which technology is changing so rapidly. There is, at present, no competition in service delivery and little autonomy and accountability in both service delivery and project implementation. The present structure of the Telecom Commission creates conflicts of interest between the needs of the network users and the operation of public enterprise producers.

A fundamental tenet of the reform agenda must be a structural reform agenda that creates greater competition and accountability in the provision of services. Furthermore, there needs to be a dichotomy between the formation and monitoring of policy change, the regulation of service providers and the actual operators. As such, this requires three distinct bodies or groups:

1. An independent Policy Board needs to be formed, composed of governmental and nongovernmental members. This should be established, with a modest secretariat, and be responsible through the appropriate Minister to the cabinet and Parliament. Its task would be to draw up the overall policy frame and monitor its adjustment and implementation.

2. A Regulatory Authority independent of operating units should be established to oversee operating/purchasing agreements, interconnection practices, and where monopoly service elements exist, provide a price regulation function.

3. Operating Units should be discrete entities, with a corporate structure that allows for financial autonomy. These entities should have discretion in technology choices, sourcing of equipment, range of subscriber services offered, and

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<td>The restructuring of DOT into Operating Units</td>
<td>This Policy Board would be responsible for drawing up the proposed telecom policy framework. As such, this Board should be established as soon as possible.</td>
<td>This Regulatory Authority could be formed following announcement of the policy framework agenda.</td>
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<td>India's telecom network is characterized by obsolete equipment and a technology policy that is too rigid for a sector where technology developments are changing rapidly. Furthermore, the desire to develop indigenous technological capabilities, and constraining the introduction of equipment to a progress of such indigenous developments has proven to be counterproductive.</td>
<td>While it is not advocated that existing research activities be discontinued, these should be viewed as complementary to international technology developments, and not as a substitute. Given structural reform of DOT, and allowance of private sector involvement in the provision of services, autonomy must be given to operating units to choose the types of equipment considered most suitable to fulfill subscriber needs.</td>
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<td>Domestic Manufacture</td>
<td>Procurement of telecom equipment should be based on more competitive bidding processes. Tariffs on inputs and final products should be lowered. Both HCL and ITI need to be restructured, in conjunction with a dilution of public sector shareholding.</td>
<td>Reduction in import duties on imports and final products should proceed progressively over a period of, say, three years. Restructuring and corporate strategy studies for ITI and HCL should commence as soon as possible, with implementation of needed reforms commencing thereafter.</td>
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<td>in domestic manufacture relates to the public enterprises. Both ITI and HCL are in need of significant restructuring.</td>
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Chapter 1

Current Issues In Telecommunications Policy

Introduction

1.1 The objective of this report is to provide an analysis of the present telecommunication system in India and the policies that have underscored technology development and domestic manufacture. Many developing counties have embarked upon major reforms of their telecommunication systems and the need for this is also manifest in India. As such, we have thought it useful to start this report with a brief overview of how telecommunication systems worldwide are changing and some of the broad issues that are being addressed by these reform programs in other countries. Although this is not a complete inventory of these options, we expect it to be useful in stimulating discussion.

1.2 The pace of technological change in, and demand for, telecommunications has been rapid and accelerating over the past two decades. As a result, traditional models for the provision of telecommunication services have become less appropriate, and, increasingly counterproductive. This revolution in telecommunications offers great opportunities for the developing world to leapfrog to advanced and cost effective options in improving the coverage, supply and quality of their telecommunications systems. Traditionally, in most countries of the world, fairness and efficiency in telecommunications have been sought through a public utility owned or controlled by the government. This model has been based upon the premise that the industry constitutes a natural monopoly. Within the present technological and market framework, this approach often results in an uneconomic allocation of resources and creates strong incentives for overpricing, reduced output and slow innovation of monopoly services.

1.3 There is now widespread concurrence that this earlier paradigm of government intervention in telecommunications through regulation and ownership has imposed significant direct and indirect costs on society. The list of ills attributed to this public utility approach to the provision of telecommunications is long. They include:

(a) wrong signals to users and investors from price distortion through the use of average prices for groups of services rather than individual prices for the services in each group;
(b) the shifting of cost repayments to future periods by using uneconomically low depreciation rates;
(c) cross-subsidization of local services by long distance services;
(d) limiting incentives to cut costs and increase managerial efficiency;
(e) limiting choices available to consumers;
(f) distorting investment decisions, and limiting incentives to innovate in services;
(g) actively discouraging technological innovations in the network; and
(h) generating service reactions that are much slower than the marketplace in responding to changing demand conditions.
It is now generally agreed that many segments of the telephone market are structurally competitive and that the natural monopoly characteristics of a wide range of services has been significantly modified by technological change. This technological change has therefore opened up new policy options and largely eliminated the natural monopoly justifications for the type of government intervention and public sector provision of service that has been so common in the past.

1.4 The evidence that has emerged from reforms that have occurred in a large number of countries, both industrialized and developing, over the past decade clearly shows that to take advantage of these technological and market advances requires adoption of an array of organizational and institutional innovations. While the exact nature of these needed changes may differ from country to country, the basic focus and objective has been to encourage the development of a telecommunications policy that allows significant entry of new service providers and of private capital and management. In turn, this entry has been supported by regulation that ensures reasonable terms for network interconnection and limits any possible anti-competitive behavior of dominant service providers.

1.5 This emphasis on greater entry reflects a shift in focus away from the concerns and priorities of service providers and equipment manufactures to the needs of the users. This shift in focus is profoundly important as experience has shown that the objectives of domestic hardware producers and single, dominant service providers are often far removed from the needs of users in an age where information has become more and more crucial for competitiveness and economic success.

Benefits of Reform

1.6 Both the quantity and the quality of telecommunications services and networks are extremely important for the generation of exports and the attraction of direct foreign investment. Furthermore, developing countries are often even more dependent on a telecommunications infrastructure than are developed countries. Exports of products that are characterized by rapid changes in style and nature of demand, such as garments, shoes and furniture, are highly sensitive to the availability of a telecommunications network.

1.7 Exports need access to databases concerning demand and pricing conditions in overseas markets. And buyers need quick and direct access to information about product availability, inventory conditions and pricing. Where basic operational and financial information cannot be accessed or effectively transmitted, investors are likely to be wary about creating new centers of entrepreneurial activity.

1.8 Telecommunications is also integral to the supply of other infrastructure. Financial institutions are most obviously dependent on telecommunications, but railways, ports, and trucking services need telecommunications as an integral part of their business as well. Increasingly, international logistics (movement of goods, ordering, invoicing) are being driven through modern telecommunications. Inter-bank payments as well as payments within key industry sectors depend on access to reliable telecommunication infrastructure and open and liberal access to telecommunication services. Future payment services are
likely to develop based on electronic data interchange (EDI) capabilities that today are used largely to transfer inventory and order-related data among manufacturers, distributors and retailers. Major harbors and shipping centers around the world are developing sophisticated systems for tracking freight and integrating shipping documentation into customs clearance systems. For example, a major logistics and tracking system is being developed as a joint venture of the Dutch PTT and the Port of Rotterdam. Similar systems are emerging in Singapore and Hong Kong.

Institutional and Regulatory Prerequisites for Attracting Capital

1.9 The rapid technological and market advances in telecommunication have not only made the services cheaper, more reliable and more versatile, but they also made it easier for networks to grow in a modular way without significantly sacrificing cost advantages. This in turn has made it increasingly profitable for a private entrepreneur to develop small efficient networks, (which may be connected to larger networks where appropriate). This has occurred in many countries. The opportunity now exists to draw at relatively low cost upon this internationally generated knowledge to upgrade existing networks.

1.10 One obstacle to this has been that many countries' telecommunications policy has been driven by the needs of service providers and in some cases by local equipment producers rather than by the user community. This is inappropriate in today's context. A policy targeted at developing specific manufacturing sectors should not be allowed to run a telecommunications policy. The pace of technological change is such that even the largest international companies can hardly keep pace, and international trade in equipment is essential for all nations.

1.11 International trade in telecommunications equipment has grown rapidly in the last decade; consistently faster than capital goods trade, which has itself been extremely dynamic. Many developing countries (especially the East Asian newly industrializing economies) have relied extensively on imported capital goods as a source of new technology; these same countries (even while fostering domestic manufacture) have also relied heavily on imported telecommunications equipment for upgrading their telecommunication network. Growth in telecommunication equipment trade has occurred not only for technologically-simple products, such as telephone sets, but also in switching equipment and other more advanced telecommunication products. In particular, over the past decade, the world's switching industry has consolidated into about half-a-dozen major players who spend vast amounts on research and development. Consolidation reflects the economies of scale in research and development as well as in manufacturing and marketing. At the same time these firms are intensely competitive in selling their products. The beneficiaries are consumers all over the world who are able to receive the fruits of massive technology development investments at competitive prices.

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1 World trade in telecommunications equipment grew at the rate of 15.5 percent per year between 1970 and 1988, while trade in all capital equipment grew at 13.3 percent per year during the same period.
1.12 Coupled with a de-linking of domestic manufacturing policies from telecommunication services, there is need for reduced governmental control over dominant service providers and competitive entry of new providers. This benefits established telecommunication operators (through a less intrusive regulatory environment) as well as having a powerful stimulus effect on the adoption of new and innovative technologies, and, of course attracting investment capital to the sector. To attract these investors who could generate a self-sustaining process of change, the governments need to provide a strong indication of their commitment to institutional and organizational change. Some of these organizational prerequisites are discussed below.

**Institutional Prerequisites**

1.13 A separate policy-making body and a technically sophisticated regulatory agency, both fully independent from any operator, are needed. The principle of separating policy-making, regulation, and operation is widely accepted and is the very basic and core requirement for telecommunications reform.² Institutional specialization is considered desirable for three reasons. First, the tasks involved in each of the different functions require different skills. Second, an independent policy-making body provides the forum for presenting user interests in a strong manner. Finally, an independent regulatory body can prevent conflicts of interest among the various actors in the telecommunications arena.

1.14 Clearly, international experience shows that change does not come from within the established telecommunications system. In the United States, AT&T fought its dismemberment to the last; even the regulatory agency in charge of telecommunications, the Federal Communications Commission, lost control of the process, (irrevocable change was brought about by the Department of Justice through an antitrust case). In Mexico and New Zealand the lead was taken by the Ministry of Finance. In Argentina, by the President of the republic. In the United Kingdom, the Department of Trade and Industry has been the vehicle for telecommunication change.

1.15 Two aspects of the policy-making process need to be distinguished. The first deals with initiating and managing the transition, and the second relates to governing a more permanent structure. An inter-agency coordinating group was established in the process of the Mexican telecommunication restructuring. It consisted not only of representatives of the Ministry of Telecommunications, but also of officials from the Ministry of Planning and Budgeting, the Ministry of Commerce and Trade, and the Ministry of Finance. In Germany and other countries such inter-agency groups have had a crucial role in the process. During Mexico’s final critical phases of introducing new investment in Telmex, the Ministry of Finance took a leading role in collaborating with a Mexican investment banking group, which retained international financial advisers and experts to oversee the process.

1.16 Once the process has been initiated, a permanent policy making body with a strong technical secretariat is needed. If user interests are to be given priority, policy-making must have substantial inputs from user industries and user groups through well-defined channels and not merely in an ad hoc and consultative manner. An option that could be considered is to locate policy-making in one of the user ministries. There has been only limited international experience with such an arrangement, but the limited evidence suggests that user groups can have an effective influence on policy-making. Two examples of such policy-making/advisory bodies are the telecommunications group in the U.K. Department of Trade and Industry and the National Telecommunications and Information Administration, an agency of the U.S. Department of Commerce that provides policy and technical support to the Executive Branch of the U.S. Government.

Independent Regulatory Agency.

1.17 Both conceptually and in practice it is necessary to make a distinction between policy-making and regulation. Policy-makers set the broad agenda based on the needs of users. Regulators ensure that the goals set by policy-makers are not thwarted by anti-competitive and/or inefficient behavior. At a minimum, an effective regulatory structure needs:

- a carefully-defined element of independence from the telecommunication policy-makers and the relevant ministries;
- independence from existing and potential service providers; and
- creation of transparent and accurate accounting systems (e.g., definition of cost centers) in existing and new telecommunications firms.

1.18 In principle the anti-trust laws and executing agency can be used to perform the regulatory task (as in New Zealand); however, most observers agree that a specialized regulatory body is needed. An effective regulator needs core competence in: (a) regulatory policy; (b) price, cost and financial analysis; (c) assessment of service quality; and (d) administrative, legal, and information systems. In most countries regulatory efforts are complemented by other independent bodies responsible for competition policy. In the United States, the Department of Justice is a regular intervenor in proceedings before the Federal Communications Commission. The Director General IV of the European Commission has also played a very constructive and dynamic role in defining the future parameters of telecommunications policy in Europe. Likewise in the U.K., the Monopolies and Mergers Commission must be consulted in revising and amending licenses issued by the Department of Trade and Industry and enforced by Oftel, the regulator. In Chile, the Anti-Monopolies Commission and the ordinary courts of justice deal (albeit so far too slowly) with issues of competition and ownership.

1.19 In all such cases, difficult and complex issues need to be tackled regarding the size, structure, and jurisdiction of the regulatory body. These are addressed once the basic principle of independence of regulation is accepted.
One important issue of jurisdiction is whether the regulatory function should be centralized or whether regional/provincial regulators would be necessary. This need not be an either/or choice but may be a matter of sequencing. As competition and/or multi operator involvement increases and spreads to the local networks, regional regulation may be required in some form.

**Ensuring Fair and Efficient Competition.**

1.20 If one of the policy goals is to attract private investment to the telecommunications sector, the regulator must ensure that there are no artificial barriers to entry. Barriers can arise because of the behavior of incumbent providers but are paradoxically often the result of regulatory goals and behavior. Clarity and simplicity of rules is essential for attracting investors.

1.21 An important issue is whether entry should be restricted to a predetermined level of providers. International experience with entry has been evolving. Most countries have retained some regulatory control over entry either because it is believed that certain segments of the network still exhibit characteristics of a natural monopoly or because it is feared that entry may be disruptive if fly-by-night operators can take advantage of temporary price distortions and other failures as well as unwitting customers. One method adopted in some countries has been to allow a duopoly, which is seen as a transition to more competitive entry. As experience with competitive entry has accumulated, the fear of excess or disruptive entry has declined. At least in a few countries, the move to open entry is unmistakable, although entry policy does continue to vary by segment of the telecommunications network.

1.22 A view held by some competition policy experts is that even if a natural monopoly exists in a certain network segment, open entry is desirable to encourage innovation and prevent high prices for consumers. New Zealand has adopted the most open entry policy so far, and recent developments in the U.K. are potentially important. After experimenting with a duopoly set-up, the U.K. has adopted a very liberal entry policy, for both its long-distance and local markets.

1.23 It is not clear whether transitional market structures, such as duopolies, were adopted for administrative convenience or because it was believed that they were an economically optimal response to the nature of telecommunications technology. Those making decisions today, however, should consider seriously the possibility that entry policy will need to evolve with increasing experience and with changing technological and market circumstances. Thus it is desirable that the policy framework be flexible enough to allow decision-making to respond rapidly as new and better information becomes available.

1.24 Where entry is restricted, rent-seeking behavior is likely to occur. The costs of such behavior are well known. Over time, the most effective solution is likely to be a policy that creates a *prima facie* case for entry, subject to

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3 Limitation of the available radio spectrum also dictate restrictions on the number of operators of some services (eg cellular).
technical constraints such as limitation of the frequency spectrum and sometimes minimum performance requirements for new entrants. The review criteria would need to be clearly defined, the review process would need to be time bound, and the burden of disapproving any request for entry would need to be on the regulator.

1.25 As new entry occurs, it is likely, and highly desirable, that joint ventures be formed with international partners. In the last few years, international alliances in telecommunications provisions have become widespread and are likely to become the norm rather than the exception. This is because modern telecommunications services are highly sophisticated and dynamic. They need an expertise that is not only high calibre but that can continually renew itself by taking into account evolving developments.

1.26 A real danger affecting telecommunication reform is that dominant suppliers can block new entrants by refusing to interconnect them to the existing network, a situation that is fatal for the new aspirant. Dominant suppliers may also price in a predatory fashion to severely discourage new entry; having gained a monopoly hold over the market, they may then be in a position to exploit consumers. Ensuring that new entrants have access to end users is, therefore, an important task of the regulator. Regulatory practice over the past decade has arrived at practical solutions to this problem. Typically, the entrant is expected to negotiate with the monopoly provider for terms of access to the dominant network. The parties concerned are required to negotiate in good faith.

1.27 The regulator's role lies in arbitration and dispute resolution. If negotiations fail, the regulatory body works within guidelines to enforce a connection. Ideally, regulators would require cost information from the dominant provider to determine the price that he should be charging for interconnection. This is one reason why transparent cost accounting is important for effective regulation. However, if cost data are not available, the prices charged by the dominant provider for comparable services to other users can be used as the benchmark instead. Other benchmarks from local and international cost data are also sometimes used. In other words, although the interconnection issue is critical, technical and organizational solutions exist to allow greater entry.

1.28 A delicate balance has to be struck when regulating the dominant carrier. Certain discipline has necessarily to be imposed on the carrier to ensure that its commanding position is not misused; yet sufficient flexibility of operation has to be provided if the carrier is to grow and provide the services demanded. In Mexico, Venezuela, and the United Kingdom, for example, the governments negotiated a concession agreement with the dominant carriers. The Mexican concession agreement included provisions relating to Telmex's interconnection obligations, safeguards with respect to its participation in competitive activities, and provisions relating to its obligations to develop infrastructure in urban and rural areas and meet increasingly demanding quality-of-service standards.

1.29 While regulation is motivated primarily by the need to prevent anti-competitive behavior, it should not be the case that the dominant provider is discriminated against. The established service provider needs the flexibility to respond to the initiatives of new entrants. It must be able to respond to
price cutting by new providers without being accused of predatory pricing practices. Experience in the United States has shown that competition with excessive regulation is a severe damper on the growth of telecommunications. The growth of Regional Bell Operating Companies (RBOCs) is restricted under the existing regulatory regime even though these companies already face significant competition. Some commentators believe that these restrictions have been unwarranted and have unnecessarily reduced the growth of services.

Rate Re-balancing for Attracting Investment

1.30 Historically, in most countries residential and rural customers have been subsidized by business and urban customers. In turn, domestic and international long-distance services have subsidized local services. The international trend in the last decade has been to reduce these cross-subsidies. In a more decentralized and open-entry system, implicit cross-subsidies would have to be phased out as new providers offer demand and cost-driven services and as established entrants seek to respond competitively.

1.31 Rate re-balancing, or bringing tariffs more in line with long-run incremental costs, is therefore a high-priority task in the reform process. The rate structure has a major influence on how much entry and investment occur in particular segments of the telecommunications market. Re-balancing is of critical importance because, in the long-run, local infrastructure investment cannot be effectively financed through cross-subsidies from international and inter-exchange carriers. If cross-subsidies persist, inefficient entry is likely to occur. New entrants would be attracted to those segments of the market that generate high profits for the dominant carrier. If these high profits result mainly from prices not related to costs, spurious entry will be induced leading later to failure and service disruption as, with competition, prices do align with costs.

1.32 Brazil presents a recent example of major rate re-balancing. International telephone calls from Brazil are among the most expensive in the world. International services plus domestic long-distance services substantially subsidize local calls. In 1989, real local telephone rates were only 20 per cent of the rates in the 1970s. Since then, local rates have been raised very substantially, and the process of re-balancing is expected to continue. Such realignment of tariffs is viewed as an essential precondition for restructuring of Telebras (the dominant carrier) and attracting private investment.

Distributional Concerns

1.33 Legitimate social and long-term development objectives are part of any reform process. New policy initiatives would need to ensure the protection of critical societal necessities for some telecommunications services that might not be fully met through market-driven policies. Certain social objectives may be set by the Government. These may include: access (which ensures that either public or private telephones are within reasonable reach of the population), and contingency plans for interconnection of networks (when the system fails). These can be achieved in two ways:
It has been the practice (even in New Zealand, which has gone farthest in the reform process) to legislate a "golden" share for the government, to signify the obligation of telecommunication operators to provide reasonable access and even redundancy in the network in case of system failure.

Tax-subsidy schemes, could be useful. For example, where certain services are taxed to subsidize socially desirable activities that would not be provided through competitive forces. The right way to approach subsidies however, would be to substitute open and transparent subsidies for the untargeted transfer payments embedded in the pricing structure. However, direct government subsidies, subject to annual budget cycles, can be difficult to implement over a sufficiently long time, as needed for proper system development/planning.

1.34 Subsidies raise the difficult issue of defining the target group. The social objective clearly is to subsidize the lowest income groups or those groups which would otherwise have no access to service (eg. rural populations). However, in practice this is not generally feasible. The subsidy could be restricted to new buyers of telecommunication services in selected parts of the country on the assumption, say, that their incomes are, on average, lower than the incomes of those who already own telephones. Moreover, the subsidy need not be provided to the end-user directly but to investors who develop networks in areas that would otherwise not be served. These are options that would need to be reviewed in light of economic efficiency as well as administrative ease.

1.35 In the longer run (say, in 5 to 10 years) it is expected that subsidizing of socially desirable services will become largely unnecessary. New technologies have emerged that make it more economical to serve dispersed users at low cost. Regulatory measures that allow independent entrepreneurs to serve rural areas can create conditions that attract business investors. Such private ventures, however, may need to cross-subsidize certain services within their jurisdiction, which will require flexibility in pricing. What is clear from international experience however, is that rural investors are often in a position to make substantial investments. Furthermore, many rural consumers are able and willing to pay for telecommunication connections.

1.36 Once subsidies have been largely eliminated and prices reflect costs, the overall rise in prices (particularly in monopolistic segments) would be monitored. Once again, international experience has allowed the development of basic principles of price regulation. Without elaborating these in detail, the rise in price of telecommunications services is usually restricted to a limit that is lower than the general price rise. It is assumed that productivity gains in the telecommunications sector will be higher than in the rest of the economy, justifying the lower rate of increase in prices. The exact productivity factor that creates the gap between a general price rise and a telecommunication price increase varies and would need to be tailored to a specific country situation and revised from time to time. In general, investors prefer such self-executing price-cap schemes, which provide limited leeway for politically-motivated price tampering.
Dominant Carrier Reform

1.37 The transition of a dominant provider could potentially occur in a number of stages, from government department to state or parastatal enterprise, followed by state-owned company, and finally varying degrees of private ownership. Such transitions have occurred, and are occurring, in many industrialized and developing countries. Not all these stages need necessarily be gone through, and, indeed, some stages are being skipped by various countries. How the transition is effected is a matter of strategy based on the conditions prevailing in a particular economy and in the telecommunications sector.

1.38 Operators in large industrialized economies, such as the U.K., Japan, and Germany, as well as in smaller economies, such as Denmark, New Zealand, and Australia, have moved away from direct governmental control to increasing autonomy and, in some cases, to private ownership. In virtually all these cases, the respective governments have also introduced, or plan to introduce, varying degrees of competition ranging from competition in the provision of value-added and mobile services, to long distance competition via limited duopoly arrangements, and gradually to full liberalization of service provision.

1.39 Within Asia, telecommunication utilities in Malaysia, Sri Lanka, Nepal, Papua New Guinea, and the Philippines operate as corporations. In Latin America, Mexico, Chile, Argentina and Venezuela have privatized the operations of telecommunication utilities, and most other countries in this region are contemplating similar moves. Various other mechanisms are being used to stimulate telecommunication development and attract private capital in Asia. Pakistan, Sri Lanka and Thailand now permit private companies to provide mobile telephone services; Philippines has introduced competition in mobile and international services; Thailand has contracted a private investor to build-transfer-operate (BTO) an additional 2 million telephone lines in Bangkok and has sought proposals to let a similar contract for provision of lines in provincial areas. Indonesia is studying alternative methods for providing a comparable expansion of services.

1.40 The approaches adopted vary from country to country depending on specific local conditions and structures. Before privatizing its telecommunication utility, the New Zealand government first converted the utility into a corporation. This corporatization experience, while exceptional in some ways, offers interesting and instructive clues to successful public sector corporate operation:

- As the principal shareholder, the government set financial objectives; however, full financial autonomy in raising and managing funds was provided to the management.

- Government representation on the board of directors was completely precluded, and the directors instead consisted of distinguished private sector managers, user-groups, and labor.

4 In the Philippines, the main operators are privately owned.
A chief executive with substantial international experience and wide knowledge both of technical and organizational matters was appointed. These changes were regarded as central to high quality and autonomous functioning of the corporation.

1.41 In addition to conventional revitalization or restructuring, new energies could be brought into an organization through collaborative ventures with local and foreign private capital. Besides expanding the network and creating new services, new partnerships are also a mechanism for solving the employment problems of a dominant operator. In addition, partnerships between the existing elements of the government-run network could help in rationalizing service and improving call completion rates. Among newly industrializing economies, Brazil has recently made a concerted effort at crafting public-private partnerships. Significant portions of Brazilian network construction have been opened to private business. Publicly owned telecommunication operators like France Telecom, Deutsche Telekom, and the Dutch PTT have found innovative ways of approaching the restructuring process. Rather than take head-on a difficult and controversial task of restructuring a major existing operator, they have used a more decentralized and incremental approach. This has involved the creation of new business units in partnership with specialized sources of private capital and expertise.

1.42 A further method adopted to extend a network is to use a franchising scheme, whereby the telecommunication operator would organize itself to provide services both on a retail basis (directly to subscribers) and on a wholesale basis. Operating as a wholesaler, the telecommunication operator would enter into contractual agreements with independent entities that would undertake responsibility for installing facilities to link a subscriber’s premises to the operator’s interface point. The franchise agreement would establish technical standards for franchisees, a formula for dividing revenues, and other marketing or operational obligations imposed by the franchisor—the telecommunication operator.

1.43 Creating new business units as franchisees through contractual ties could provide the telecommunication organization new flexibility and energy. Employees could be permitted to keep their pension and employee rights but would be encouraged to strike out as entrepreneurs. Employees who become entrepreneurs as franchisees could ultimately acquire shares in the telecommunication organization, not because of their past service to the telecommunication operator, but because of their current contributions to establishing new income streams for telecommunication operators.

Conclusion

1.44 We have sought in this chapter to provide a brief overview of recent international experience in telecommunication sector reform. A more detailed analysis of this, and its applicability to India are shown in Appendix I of this report. We now proceed to an analysis of the Indian telecommunications system and the deficiencies and weaknesses of the present policy framework.
Chapter 2

The Telecommunications Sector in India

Introduction

2.1 India has a large telecommunications network, necessitated by a large land area (approximately 3.3 million square kms) and widespread dispersal of population centers (both urban and rural). Despite this large system however, network coverage is highly inadequate, service quality is poor and public dissatisfaction with the telecommunications system is high. Waiting times for a telephone connection are excessive (up to seven years in many areas); many rural parts of the country have no telephone facilities whatsoever; call completion rates are low; there is a very high percentage failure of local interchange calls due to equipment malfunction or trunk system congestion and very high failure rates for subscriber trunk dialing due to both system congestion and poor maintenance. The long distance network has not kept pace with local networks. Annual network growth in the eighties averaged about 7.5%, whereas the perceived demand (which is lower than actual demand because many potential subscribers are unwilling to pay the necessary registration fee to be on the waiting list) has grown by 10% p.a. over the same period. As a result, density is amongst the lowest in Asia. In addition to the inadequate telephone service, telex and more advanced telecommunication services, which are vital for business, particularly international trade and finance, are also poorly developed and unreliable.

2.2 There is little doubt that this inadequacy represents a considerable constraint on other aspects of the country's economic and social development. Furthermore, the country has embarked upon a comprehensive structural adjustment program designed to restore viability to the balance of payments through improved export performance and an improvement in international competitiveness in its industrial, agricultural and service sectors. Success in this endeavor will be crucially dependent upon the efficient provision of infrastructural support, and in this context, comprehensive and reliable telecommunication services will be crucial.

2.3 The reasons for this present situation are various. The sector has not been accorded a high priority in public sector investment outlays. Up to and including the Sixth Five Year Plan (1979 to 1984), investment in telecommunications averaged about 2% of public sector investment outlays. Furthermore, organizational and institutional arrangements have been highly deficient, with large delays in plan allocations and excessive centralization and regulation that is unsuited for a high technology activity. The Department of Telecommunications (DOT) project sanctioning rules and procedures are very complicated, with inadequate delegation of authority to local levels which has resulted in little accountability. The poor quality of service is mainly caused by (a) substandard equipment from domestic manufacturers; (b) poor maintenance; (c) lack of spare parts and tools; and (d) ineffective traffic management.

2.4 In recognition of these difficulties, and the detrimental impact that the poor service was having upon future growth and economic development, the
Government of India (GOI) has sought to remedy the situation. The investment outlay in the Seventh Five Year Plan (1985-90) was increased to 4% of public sector investment and important institutional changes were introduced. In 1985, the DOT was reconfigured as a separate department in the Ministry of Communications; services in Delhi and Bombay were put under the control of a separate statutory corporation (April 1986) and the Center for Development of Telematics (C-DOT) was established in 1984 with a mandate to develop sophisticated technology indigenously with a goal to digitize the entire Indian telephone network. Another significant organizational change occurred in mid 1989 with the establishment of the Telecommunications Commission (TC), with complete policy and coordination responsibility for a revitalized and greatly expanded telecommunications network in the country.

2.5 The TC has drawn up an ambitious program to remedy many of the deficiencies of the system in the context of the 8th and 9th Five Year Plans (1990-95 and 1995-2000). The focus of this effort is to increase telephone lines in service to about 20.0 million by the year two thousand (from about 4.6 million in FY 89/90). Furthermore, it is hoped that through technology and equipment standardization, not only will the system be gradually modernized, and hence more efficient, but system maintenance will improve and become more responsive to system failures and faults. Finally, the TC has initiated a system of internal reorganization within DOT designed to improve accountability, upgrade individual and group performance and create more monitorable performance criteria.

2.6 The goals set by the TC will require a prodigious effort, not least of which will be a significant resource mobilization effort. Furthermore, considerable doubt surrounds DOT's implementation capacity, notwithstanding planned organizational adjustments and staff training, and its capacity to improve with sufficient speed to meet the planned targets of both expansion of the system and improvements in its performance parameters. The internal DOT organizational adjustments that are presently underway do little to change the fundamental organizational structure are not sufficient to rectify the organizational culture and efficiency ethos of an entity with over 500,000 employees. Doubts also exist as to the choice of technology that will be introduced into the network, and in particular the decision to develop indigenously, digital switching equipment. The choice of switching technology will have a significant influence on network planning and architecture, which could be sub optimal given the present global state of switching and transmission technology. A final serious caveat relates to the indigenous manufacturing structure, capability and efficiency. Serious difficulties have been encountered in the past, particularly with switching equipment, and pervasive reform will be needed if these problems are to be remedied.

Study Coverage

2.7 It is apparent that telecommunications in India is in a state of transition and the environment for policy change has improved. In some areas of domestic manufacturing (terminal equipment and cable production), domestic competition has increased. Some progress has been made in indigenous technology development, and some procedural and management reforms have been introduced within DOT designed to improve operational efficiency. It is in this context, that the present sector review is undertaken. The main objective of the report is to evaluate the
Government's proposed telecommunication development plan for the next decade and the policy framework in which this plan will fit, in light of the experience of other developing countries that have initiated reform of their telecommunication sectors.

2.8 The remaining part of this chapter will provide a brief overview of system performance and deficiencies. Chapter 3 will discuss the organizational structure that presently provides telecommunication services in India, and the operational difficulties encountered with this structure. Furthermore, this chapter will outline the Governments' policy objectives and reform agenda, together with a description of the network expansion plans, documenting physical targets and estimated resource needs.

2.9 The policy framework adopted by the Government to bring about improvements and expansion of coverage of the telecommunications system obviously has implications for the likely pace of change and achievement of performance parameters and physical targets. As such, the report examines more closely, the human resource and management issues within DOT in Chapter 4. The desire for indigenous development of telecommunications technology is a major focus of the TC's longer term development strategy. Clearly this is an ambitious objective given the rapidly changing nature of technology in this area, and success or failure could have important ramifications for the quality of India's telecommunications over an extensive period of time. Chapter 5 therefore provides a documentation and evaluation of ongoing indigenous research efforts, with particular emphasis on switching technology, although some evaluation is made of efforts being made in transmission. Technology choices and organizational structures also have important implications for network planning and the operational difficulties that may flow from such planning. This issue is examined more closely in Chapter 6.

2.10 Another major focus of telecommunication policy is the desire to be self reliant and self sufficient in the domestic production of telecommunications equipment. Considerable success has been achieved in this objective (with over 90% of final equipment needs being drawn from domestic producers). However it is not apparent that this has resulted in an economically efficient use of the country's resources. Up until very recently, the entire gamut of telecommunications equipment production has been highly protected from international competition, and the domestic market structures were not conducive to internal competition on the basis of price and quality. This has changed somewhat since the mid eighties, with investment delicensing for much of terminal equipment and cabling which has brought forth new capacity, and hence increased domestic competition. Considerable doubt surrounds the domestic production structure for switching equipment however, and the degree of international protection for all equipment is still very high. Chapter 7 provides an examination of India's telecommunication manufacturing sector, with particular emphasis on an assessment of the economic efficiency of production for switching and cables.

2.11 At the end of each chapter, a summary and consolidation of the chapter's contents is made, together with appropriate recommendations for the problems and anomalies identified. Chapter 8 however provides a possible reform agenda that integrates the range of regulatory, organizational, operational, technological
and manufacturing reforms and issues that are considered appropriate in improving the provision of telecommunication services in India. Obviously, with any reform agenda, there are a variety of options, particularly with regard to the pace of reform, but also with regard to organizational structures, technological choices and methods to achieve competitiveness in manufacturing. Nevertheless, the report seeks to draw upon experiences in other countries, both the more economically developed and the less developed, who have already embarked upon reform of domestic telecommunication systems and enjoyed some of the fruits of success of these reform programs. This international experience suggests certain fundamental actions and reform principles that are needed to underpin any reform agenda, for beneficial change to ensue. The reform agenda outlined in Chapter 8 is guided by these fundamental principles although it is recognized that certain country specific characteristics may require the adoption of interim "second best solutions" in the short term, to ensure the viability of a more comprehensive, medium to long term reform agenda.

2.12 A final caveat concerning the study's coverage is necessary. Clearly for a network and organizational structure as large as India's telecommunications system, a thorough analysis of all aspects of the system is a prodigious undertaking. This is not attempted in this report. A detailed analysis of billing and tariff systems, maintenance procedures or demand for services is not undertaken for example. Rather, the study focuses upon the broader policy issues attendant upon DOT's ability to deliver services and the key elements of the regulatory environment.

System Performance

2.13 **Access to Service** As of March 31, 1990, total installed telephone capacity was 5.26 million lines, of which 4.6 million were used for access to service (DELs). The utilization of exchange capacity is about 89.5%, with the exchange fill in the four major metropolitan areas somewhat lower at about 86.5%. This exchange fill is slightly better than the average in most developing countries.5, 6

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5 Examples of exchange fill in other developing countries in 1988 are Argentina (84%), Brazil (93%), Chile (92%), Hungary (75%), Indonesia (83%), Malaysia (52%), Morocco (87%), Tunisia (65%) and Turkey (84%).

6 One of the factors inhibiting a fuller use of exchange capacity is the lack of capacity in the local cables. The planning, project sanction and project implementation process is very time consuming (see para 2 in Chapter 3), resulting in delays in installing local cables and wires between the exchange and new subscribers. Furthermore, insufficient cable and wire record systems also contribute to lack of capacity in the local cable network. Often, new connections are not released, even though cable pairs are available, due to lack of information. Computerization of the cable record would go a long way to remediying such a situation. In other cases, the local telephone administration holds back spare capacity to enable certain customers to bypass the waiting list. It should be noted however, that an increase in exchange fill, given the present traffic capacity in the network, would cause the call completion rates to worsen.
2.14 The average telephone density of 0.54 direct exchange lines per 100 of population (assuming a population of 850 million) is amongst the lowest in Asia. There is a strong concentration of lines in the four metropolitan centers with 1.512 million lines, giving a density of 4.06 lines per 100 people. Large areas of the country are very poorly served however, with nearly 25,000 villages with populations over 2000, that have no access to any telephone service. Despite a considerable expansion of the network during the Seventh Plan period (1985 to 1990) of nearly 1.7 million lines, there is still a considerable gap between the estimated demand for service and service availability. The official, registered waiting list is about 1.7 million lines. and the gap between supply and demand has been continually widening throughout the eighties. In 1980 the estimated demand satisfaction (based upon waiting lists which understated the true demand) was 85.8%. This had fallen to 72.8% by 1990. This decline occurred during a period when India experienced a decade of historically strong growth in national product, per capita incomes and international trade. Given that there

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7 Equivalent figures for Malaysia, Thailand, Philippines and Indonesia are 6.5, 1.7, 1.0 and 0.78, respectively.
are well over 100 million middle class, urban dwellers, it should be apparent that massive scope exists for an expansion of the network.

<table>
<thead>
<tr>
<th>Fiscal Year Ending March</th>
<th>DELS (000's)</th>
<th>Waiting List (000's)</th>
<th>Expressed Demand (000's)</th>
<th>Satisfied %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>2016</td>
<td>-</td>
<td>336</td>
<td>235</td>
</tr>
<tr>
<td>1981</td>
<td>2149</td>
<td>6.60</td>
<td>446</td>
<td>3535</td>
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<tr>
<td>1982</td>
<td>2296</td>
<td>8.84</td>
<td>594</td>
<td>2900</td>
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<tr>
<td>1983</td>
<td>2645</td>
<td>7.36</td>
<td>659</td>
<td>3124</td>
</tr>
<tr>
<td>1984</td>
<td>2668</td>
<td>8.24</td>
<td>738</td>
<td>3606</td>
</tr>
<tr>
<td>1985</td>
<td>2898</td>
<td>8.62</td>
<td>843</td>
<td>3727</td>
</tr>
<tr>
<td>1986</td>
<td>3166</td>
<td>9.25</td>
<td>1028</td>
<td>4194</td>
</tr>
<tr>
<td>1987</td>
<td>3487</td>
<td>10.14</td>
<td>1126</td>
<td>4613</td>
</tr>
<tr>
<td>1988</td>
<td>3799</td>
<td>8.95</td>
<td>1287</td>
<td>5066</td>
</tr>
<tr>
<td>1989</td>
<td>4176</td>
<td>9.92</td>
<td>1420</td>
<td>5596</td>
</tr>
<tr>
<td>1990</td>
<td>4592</td>
<td>9.96</td>
<td>1714</td>
<td>6306</td>
</tr>
</tbody>
</table>

Source: Department of Telecommunications

1 Waiting lists drawn up by the Department of Telecommunications understated actual demand for telephones for a number of reasons. First, those areas (mostly rural) with no service whatsoever, have no recorded waiting lists. Second, upon registration a deposit is levied ranging from Rs.100 to Rs.5000 depending upon the type of exchange and an "own your telephone" scheme. Given the perceived long waiting period, many potential users are reluctant to pay the registration deposit.

2.15 **Technology** Much of India's telecommunications network is characterized by obsolete equipment. The main transmission systems are analog coaxial cables and microwave radio. In a large part of the local networks there are paper insulated dry core cables. The network also contains a large proportion of electromechanical switching exchanges based on the crossbar (Pentaconta) and the old step-by-step (Strowger) systems. In addition, satellite transmission, using domestic satellites, is used as a primary medium to remote areas, and a secondary medium between the main cities. From the mid eighties, the DOT has started to introduce digital switching and transmission systems. DOT has introduced the E-10B series digital switching of CIT-Alcatel of France, and the digital telex switching of Siemens of Germany. An indigenous digital switching system has been developed by the Center for the Development of Telematics (C-DOT) (this development is discussed further in Chapter 5, together with some discussion of the E-10B larger digital exchanges). The first digital telex and telephone exchanges were introduced in 1986. Also, new transmission technology was introduced in the late eighties, using pulse code modulation (PCM) equipment, optical fiber and digital coaxial and microwave systems.
2.16 By 1990, 95% of local lines were automatic, compared to 83% in early 1986. Subscriber Trunk Dialing (STD) has been extended to about 850 cities and towns. This means that about 89% of subscribers, served by automatic systems, have access to STD. Use of STD is low however, as most subscribers request their STD service barred, and use the manual trunk service. The reason being subscribers feel metering is unreliable and that there are prevalent illegal connections to subscriber lines. To overcome this resistance, DOT is introducing detailed billing and access codes in the electronic and digital switches.

2.17 Quality of Service While showing considerable improvements over the past decade, the quality of service is still poor, in common with many developing countries. In 1990 there were 19.3 faults per hundred stations per month (compared to 40.0 in 1980). Within the four main metropolitan centers, Madras shows the highest fault problem (with 27.2 faults/100 stations/month) with a consequent higher complaint rate of 44.3 complaints/100 stations/month. The expansion of the network during the last few years has led to an improvement in the local loop networks, which has been one of the major reasons for the lowering of fault rates. Notwithstanding the progress made, fault rates are still very high, particularly against a benchmark for well operated networks of 1 or 2 faults/100 stations/month.

2.18 The reasons for the high number of faults are various. The prevalence of old and obsolete plant and equipment in the network, together with the supply of substandard equipment from some domestic manufacturers is a major contributory factor. Other factors include insufficient skilled staff, spare parts and tools (resulting in inadequate maintenance), inadequate cable records and the generally poor quality of the local cable networks.

2.19 On an all-India basis, fault rectification is quite good, with about 70% of all faults being cleared in the same day. However, in the main metro centers this performance declines considerably, ranging from a high of 57% in Madras to an abysmal 23% in Calcutta. In the latter case, the long delays reflect excessive cable flooding during the monsoon and the prevalence of cable theft.

2.20 The shortage of subscriber lines and exchange and interexchange equipment, and the fact that the long distance network has not kept pace with developments in the local networks, coupled with inadequate traffic management, means that the network is heavily congested, particularly during busy hour periods. This, in conjunction with high equipment fault rates, accounts for very high call attempt failures. Call completion rates have improved considerably, particularly in the local network, with the exception of Calcutta where the percentage completion of calls is still only 77%. STD performance has also improved, however the national average of about 82% still reflects considerable scope for improvement. In Bombay however, the STD call completion rate is a very low 61.2% in 1990. Given that STD performance is poor (together with the billing problems cited in paragraph 1.17 above), the manually operated trunk service is heavily congested, with long delays. Failure rates for manual trunk calls in 1990 were about 55% in Bombay, 27% in Delhi and 24% in Madras.
| Table 2.3 | India: Telecommunications System  
| DUALITY OF SERVICE |
| All India | 56.0 | 47.1 | 44.3 | 40.5 | 36.8 | 29.9 | 27.7 | 25.0 |
| Bombay | 30.0 | 34.9 | 36.9 | 32.5 | 28.1 | 20.7 | 19.1 | 19.2 |
| Delhi | 66.0 | 60.2 | 42.4 | 39.3 | 33.7 | 27.8 | 28.1 | 26.9 |
| Madras | 31.0 | 43.2 | 40.2 | 38.7 | 33.8 | 32.9 | 43.4 | 44.3 |
| Calcutta | 61.0 | 35.7 | 42.7 | 37.7 | 36.0 | 28.4 | 28.1 | 27.6 |
| Faults/100/Stations/Month | 40.0 | 36.2 | 33.2 | 31.9 | 28.5 | 23.4 | 21.2 | 19.3 |
| Bombay | 21.0 | 24.5 | 26.0 | 26.1 | 22.8 | 19.8 | 17.8 | 18.6 |
| Delhi | 38.0 | 41.8 | 34.1 | 33.3 | 26.8 | 22.3 | 23.3 | 22.8 |
| Madras | 25.0 | 28.7 | 25.0 | 25.1 | 23.3 | 21.3 | 25.1 | 27.2 |
| Calcutta | 25.0 | 29.9 | 22.6 | 20.1 | 19.6 | 18.6 | 19.1 | 18.8 |
| Average Duration of Faults (Hours)/Month | 5.4 | 9.0 | 9.5 | 9.2 | 8.8 |
| Bombay | 14.0 | 20.8 | 28.9 | 27.7 | 26.6 |
| Delhi | 5.7 | 4.7 | 7.8 | 8.7 | 8.3 |
| Madras | 3.9 | 6.6 | 10.3 | 12.7 | 12.0 |
| Calcutta | 16.9 | 54.5 | 41.2 | 33.9 | 32.2 |
| Percentage of Faults Cleared the Same Day | 70.5 | 72.2 | 69.9 |
| Bombay | 55.9 | 45.7 | 48.8 |
| Delhi | 69.5 | 54.4 | 55.8 |
| Madras | 59.2 | 61.7 | 57.3 |
| Calcutta | 21.7 | 22.3 | 22.6 |
| % Failure of Local Network Calls/Month | 6.7 | 5.3 | 7.3 | 8.8 | 8.4 |
| Bombay | 2.6 | 2.3 | 1.6 | 1.7 | 1.4 |
| Delhi | 4.8 | 8.1 | 7.7 | 8.2 | 7.8 |
| Madras | 5.0 | 1.6 | 1.7 | 1.2 | 1.1 |
| Calcutta | 14.7 | 13.7 | 23.3 | 23.0 | 21.5 |
| % Completion of Calls - Local Network | 87.7 | 90.8 | 93.3 | 91.1 | 91.0 |
| Bombay | 76.8 | 87.6 | 93.8 | 95.9 | 96.3 |
| Delhi | 76.6 | 85.6 | 86.5 | 89.1 | 91.2 |
| Madras | 63.7 | 67.5 | 75.6 | 74.3 | 77.4 |
| Calcutta | 57.0 | 73.9 | 75.5 | 69.7 | 62.4 |
| % Failure STD Calls (Level 0, Hour/Month) | 51.1 | 48.7 | 38.8 |
| Bombay | 70.0 | 75.0 | 55.3 | 48.3 | 43.2 |
| Delhi | 54.0 | 56.7 | 50.5 | 45.4 | 39.8 |
| Madras | 94.0 | 91.8 | 91.6 | 92.0 | 85.7 |
| Calcutta | 94.0 | 91.8 | 91.6 | 92.0 | 85.7 |
| % Failure Manual Trunk Calls/Month | 32.6 | 30.9 | 56.8 | 54.7 |
| Bombay | 38.0 | 33.0 | 33.5 | 32.6 |
| Delhi | 34.0 | 46.7 | 41.4 | 38.5 |
| Madras | 28.0 | 31.4 | 33.5 | 33.3 |
| Calcutta | 43.0 | 44.3 | 45.7 | 46.3 |
| % Failure Telex Calls/Month | 40.0 | 44.3 | 45.7 | 46.3 |
| Bombay | 50.0 | 26.6 | 25.9 | 49.7 |
| Delhi | 30.0 | 39.3 | 44.0 | 33.5 |
| Madras | 56.0 | 58.0 | 52.0 | 43.9 |
| Calcutta | 22.0 | 45.1 | 62.5 | 67.7 |

Source: Department of Telecommunications
2.21 All call completion rate figures understate the problem to some extent. Figures are averaged over the whole day, and based upon manually generated call sampling. In Bombay, new equipment to measure automatically free phone to free phone has been installed and initial results suggest call completion rates of less than 30%. Furthermore, in addition to lost calls (and of course lost revenue) due to network congestion and equipment malfunction, a large number of calls encounter busy subscribers because of the very high usage of each terminal. DOT's inability to provide sufficient DEJs, particularly for frequent callers such as business subscribers, lead to repeated unsuccessful call attempts, which, of course, worsens the congestion. Again using Bombay as an example, it was found that STD call completion rates measured on line traffic was only 21% in 1990.

2.22 The DOT is aware of these problems, and beyond the drive to expand the network, they have been implementing programs to improve the quality of service. These actions include replacement of faulty subscriber equipment; improvements in maintenance, especially in older exchanges; rewiring of exchange and interexchange facilities and the introduction of digital equipment to replace old analog equipment. While these actions have had some positive results, it is still readily apparent that much remains to be done to improve the quality of service.

Conclusions

2.23 From the brief overview given above, it is evident that massive scope exists not only for expansion of the network, but also for improvements in the quality and range of services. Despite the record achievements during the Seventh Plan period (1986-1990), excess demand for telephone services has increased. While the negative influences this might have on social and economic development cannot be precisely quantified, it undoubtedly adds to the transaction costs of doing business. This, together with other infrastructural deficiencies, retards potential growth in both domestic and external markets, and, because of the need for reliable communications, inhibits the spread of industrial and commercial activity to less congested areas.

2.24 Undoubtedly, one of the major causes for this present state has been the relatively low priority given to the development of the sector and hence the inadequate level of resources directed to its expansion. But this has not been the only factor. Policies adopted, and the organizational structures that have emerged from these policies, have not proven to be sufficiently flexible to optimize the use of those resources that have been available. Policy objectives have become merged, with the result that clarity has suffered and goals have become confused. The fundamental objective, and need, to deliver good quality telecommunication services at reasonable prices, has often been subverted by the desire to protect, and nurture, an uncompetitive telecommunication manufacturing base or safeguard a workforce anxious to preserve existing job descriptions and work practices. A good example of this may be found in the introduction of outdated electromechanical switching exchanges into the network right up to the late eighties simply to maintain employment and production in plants of the public sector enterprise, Indian Telephone Industries (ITI). These issues are taken up in more detail in the following chapters.
Chapter 3

Organizational Structures and Institutional Weaknesses

Introduction

3.1 The provision of public telecommunication services is a monopoly of the Central Government. Prior to 1985, management of these services was the responsibility of the Posts and Telegraph Department within the Ministry of Communications. This was adjusted in this year however, with the formation of a separate Department of Telecommunications (DOT), still within the Ministry of Communications, and establishment of a Telecommunications Board, to oversee operations and development of services in the country.

3.2 At the start of the Seventh Five Year Plan (1985) it was felt that a further bifurcation of the organizational structure was necessary, with the result that two further entities were created. Videsh Sanchar Nigam Limited (VSNL) was formed to operate the international gateways and telecommunication access to the rest of the world. Mahanagar Telephone Nigam Limited (MTNL) was established (April 1, 1986) to generate the networks in the main metropolitan centers of Delhi and Bombay. Both of these public corporations are subject to the provisions of the Indian Companies Act, with regard to financial reporting requirements etc. They still fall under the oversight of the Ministry of Communications, and while they may not suffer from the same degree of bureaucratic day to day routines that may be found in DOT, they do not have autonomy to operate entirely according to commercial principles. Staff conditions of service, salary structures, technology choices and tariff schedules are all in conformity with those prevailing within DOT.

3.3 This is not to deny however that the formation of MTNL and VSNL has brought about some beneficial changes in operational performance. Management have introduced commercial accounting systems, management information systems that are more sharply focussed and some staff incentive programs. Furthermore, they are able to raise investment funds directly from the market. Of equal importance, in terms of operational performance, a modest element of competition has been introduced between DOT and MTNL. The pace at which MTNL has implemented improvements in coverage and service quality, has provided a benchmark by which DOT's performance may be judged, and stimulated DOT to launch measures to improve its own performance.

3.4 A further significant organizational change occurred in May 1989, with the formation of the Telecommunications Commission (TC), which replaced the earlier Telecommunications Board. The TC was established with a view to promote rapid development of all aspects of the telecommunication sector in India, including technology, production and services. The TC controls all the operating telecommunication units, the manufacture of telecommunications equipment in public enterprises (with the exception of cables) and research and development in entities such as the Center for the Development of Telematics (C-DOT). The TC is a powerful body, and the Chairman and the four full time members (Members

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8 The first such bond issue by MTNL was made in 1986.
Technology, Production, Services and Finance) exercise considerable control over all aspects of telecommunication policy and services. This control is reinforced by the presence of four part time members - the Secretary Planning Commission, the Secretary Department of Electronics, the Secretary Department of Industries and the Secretary of Finance.

**Chart 3.1**

Organizational Structure of Telecommunication Services

MINISTER OF COMMUNICATIONS

TELECOM COMMISSION

Chairman
Member - Services
Member - Technology
Member - Production
Member - Finance

BOARD

C-DOT

ITI TCIL HTL

BOARD

DOT

MTNL

BOARD

VSNL

DOT - Department of Telecommunications
C-DOT - Center to the Development of Telematics
HTL - Hindustan Teleprinters Limited
ITI - India Telephone Industries
MTNL - Operating Company for Bombay and Delhi
TCIL - Telecom Consultants India Limited
VSNL - Operating company for international gateways

Note HCL (Hindustan Cable Limited) reports through its Board to the Ministry of Industry.
Organizational Structure

3.5 As noted, DOT (and MTNL and VSNL) holds a complete monopoly on the provision of services. These services cover telephone, telex, leased lines, VSAT and an international packet switched data service. There is one modest, satellite based data system outside DOT, operated by the National Informatics Center, and some public and private firms do own and operate their own, internal telecommunications networks. Most notable of these are the Railways and the Steel Authority of India Limited. Maintenance of this monopoly has been a strong aspect of government policy, and attempts by other public or private entities to develop networks (particularly for non voice transmission of data and other value added services) has been strongly resisted. Very recently, (December 1991) the Minister of Communications announced that franchises for the provision of mobile cellular telephones in major metropolitan areas was to be opened for tender by private sector operators. While it is too early to judge whether this liberalization will bring forth the necessary investments for mobile telephone services, it does represent a positive step. It is also not clear whether this step represents a precursor of further liberalization measures for other types of telecommunication services; particularly value added services.

3.6 Basically the governmental telephone system has three broad groups of organizational units, in which the various components report to the various full time members of the TC. These three groupings are as follows:

**Headquarters**

The DOT Directorate, with its functional units, under the TC, coordinates the activities of the field units in planning, construction, maintenance and operation of telecommunication installations and services.

**Field units**

Eighteen telecommunication field circles, covering mostly one state each, for development, operation and management of telecommunication services in different parts of the country. The circles are divided into 331 Secondary Switching Areas (SSA), corresponding mostly to the administrative districts of the country.

Four regional maintenance circles and five project circles for maintenance of interstate and intra-state long distance telecommunication networks and installation of new projects and facilities respectively.

Various functional circles for Quality Assurance, Training, Acceptance Testing etc. A stores organization with five Telecommunication Stores Depots and a HQ located in Calcutta. In addition every circle has a store depot which draws materials from one of these five.

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9 Also in mid 1991, DOT adjusted its policies with regard to phone installation and wiring within subscriber premises. This can now legally be undertaken by non DOT firms and organizations.
Independent units

MTNL, a public sector undertaking under the Companies Act for development, operation and management of telecommunication services in the metropolitan areas of Bombay and Delhi.

VSNL operates the telecommunication services with rest of the world.

C-DOT - an autonomous technology unit, established to develop advanced telecommunication systems and equipment, with the objective to transfer the manufacturing technology to independent and privately owned manufacturers.

Telecommunication equipment factories such as ITI and HTL (Hindustan Teleprinters Limited).

3.7 The organizational structure is characterized by a high degree of centralized decision making and a fragmented, functional organizational style. The corporate ethos is characterized by a civil service orientation, which affects operating practices, personnel and promotion policies, salary and incentive structures, and organizational flexibility. Within this framework there is little scope for initiative, accountability and responsibility by both management and staff (a more detailed analysis of the staff and human resource development issues is provided in Chapter 4). Furthermore, the present organizational structure has a number of serious conflicts of interest which has a negative impact on network development. For example given the role of the Member Production of the TC in overseeing switching and transmission production, the interests of the user and supplier become blurred. In particular, the corporate difficulties of ITI impinge upon the technology choices and network planning decisions of DOT and MTNL forcing the use of obsolete or sub-standard equipment.

3.8 While day to day operational responsibility is decentralized to the field units, planning, finance, procurement, technology and service development are totally concentrated within the DOT directorate in Delhi. Furthermore the functional organizational structure does not seem to promote adequate coordination even within the centralized administration. MTNL, which has the authority to raise financial resources for developments in its service area, lacks autonomy and control on the purchase of equipment, as well as on staff and other administrative matters. Allocation of switching and other telecommunications equipment and stores are controlled by DOT, and allotted to

10 A few examples will illustrate this point

a) the regional project circles report to the Member (Production), whereas the maintenance circles report to the Member (Services). As both functions often require installation of equipment, similar technical staff skills, and procurement of supplies the different reporting requirements are not conducive to appropriate coordination.

b) A decision was taken by the Member (Technology) not to use 565 Mbit/second systems in the long haul network. The Long Term Planning Unit under the Member (Production) was not aware of this for quite some time.
the different field units, including Delhi and Bombay which are under MTNL's operational control.

Procurement and Materials Management

3.9 The overwhelming majority of telecommunication equipment, stores and spares are procured centrally by DOT. Up until quite recently the bulk of cabling, switching and terminal equipment was obtained from three public enterprise producers. Pricing of equipment was governed by three year agreements with the public enterprise producers, and was basically a cost plus pricing system, which offered no incentives for the producer to be efficient or seek to reduce costs. Since the mid-eighties this situation has changed significantly particularly for cables and terminal equipment, where new private and joint sector capacity has emerged. As a result, for this type of equipment (cables and terminal equipment) a system of commercial tenders is followed by DOT. And, subject to technical approval and acceptability by the Quality Assurance Circle, procurement awards are made on the basis of competitive prices submitted by the domestic producers. Nevertheless there is not international competition, and there are indications that DOT seeks to "spread" its orders across all producers in order to ensure that a minimum level of orders are obtained by each manufacturer. With regard to ITI, the "cost plus" pricing method has been amended somewhat over the last two years. ITI has given an undertaking to maintain prices at their 1990 levels, for a period of three years, with adjustments being made only in the event there are changes in excise tax or import duty rates or due to devaluation of the rupee vis-a-vis other currencies which would increase the rupee price of imported components.

3.10 The start of production of the small G-DOT switches (RAX) by nine manufacturers has brought about an improvement in the domestic competitive environment, which in turn has made the DOT tender process for switching equipment more meaningful. Furthermore, the medium sized G-DOT switches (MAX-M and MAX-L) will provide a competitive alternative to ITI's IIT range of switches improving the possibility for price competition. Despite this improved environment however the tender process still contains some anomalies. For example, in the tender process for the RAX 128 rural switch, tenders were received and following review by DOT, a single price was agreed with all the potential suppliers (reputedly based upon the lowest price tendered) and allocations made across all of them. While this seems to have resulted in a competitive price, this system may not be sustainable over time as it will encourage collusion between producers and inhibit the growth of the more efficient firms.

3.11 The main sections of DOT involved in the placement of orders and procurement of stores are the Planning Branch, the Material Management Cell and the Centralized Stores Purchase Organization. Actual order placement is undertaken by the Material Management Cell which accounts for about 70% of the equipment needs of approved projects. The remaining 30%, mainly line material and equipment for outside plant, is ordered by the stores headquarters based in Calcutta. The distribution of materials is undertaken through five major "wholesale" store depots. In addition there are "retail" stores in each of the circles. For many items, consignments are routed directly to the stores in the circles.
3.12 In general, stores management is deficient. Storage facilities are often inadequate, overcrowded and with inadequate equipment for material handling. As a result equipment deteriorates, or is damaged, aggravating fault problems when installed into the network. There is a total lack of a computer based inventory management system. With the result that stores in one part of the country may have an excess of a certain item, while another may be without. Data management is manual, which, given the range and complexity of items held, is totally inadequate as a means of inventory control. Certain major items, such as automatic exchanges and transmission equipment, are sent directly from the manufacturer to the work site. This in and of itself does not eliminate many of the material problems encountered. Transportation systems are ponderous, often requiring transfer from one vehicle to another (because of a variety of trucking regulations), with the result that damage to sensitive equipment is high. Equipment delivery to a work site is poorly coordinated, with the result that installation is disrupted by the lack of appropriate parts and components.

3.13 A major problem in the procurement process is the annual budget cycle under which DOT is constrained to operate. The process will start at the beginning of the fiscal year (April) with discussions with ITI (or other manufacturers) and letters of intent issued. Orders are often only placed by November or December, at which time a major part of the component procurement process starts. If imported components are involved, then appropriate import licenses have to be obtained (this requirement should be eased somewhat as the recently initiated trade liberalization reforms continue). Following delivery of components production commences, with the main effort being made in the final quarter of the fiscal year (January to March). It is estimated that over 60% of all equipment and plant commissioning takes place in this final quarter.

3.14 This procurement cycle process has a number of negative side effects. The frenetic production pace in the last quarter creates quality control problems and increases the likelihood of equipment failure. Quality assurance and acceptance testing by DOT bears this out. Furthermore, factory plant is often kept unutilized for major periods of the year. Obviously this represents a highly inefficient utilization of productive assets, and adds to costs in other ways. For example, inventory levels tend to be too high, adding to working capital and storage costs; optimal production flow patterns are impossible, and capital investment is often higher than would be warranted by a more even production flow. The simple solution to these difficulties would be for DOT to award multi-year order contracts, with agreed quarterly delivery schedules spaced throughout the contract period. This would also have the advantage of reducing DOT's own inventory holding levels for new plant and equipment, as well as for spare parts and maintenance items. While it is recognized that seasonal factors such as monsoon rains and high summer temperatures can inhibit equipment installation, the present annual distribution of the work cycle could be much improved.

Operations and Management Information

3.15 A manual Management Information System (MIS) is in operation in DOT, with information on service and network performance, financial results and network development progress. The compilation of the data from the operating units is somewhat laborious and error prone. Compiled reports are less effective as a management tool because of the long time delays encountered during compilation.
Furthermore, the manual MIS process inhibits management requests for additional and ad hoc information.

3.16 Clearly a computerized MIS, structured in layers throughout the organization, is a vital priority for a network as large as India's, and an organization as complex and diverse as DOT. This need has been recognized, and as part of the Eighth Five Year Plan, a computerization exercise is to be undertaken in two phases. Phase I will focus upon hardware for DOT headquarters, the telecommunication circles, specific functional units within headquarters and elsewhere, and at least two secondary switching areas in each circle. Customer systems such as billing and accounting, fault repair services and directory enquiries have been given priority and thereafter management systems such as personnel, finance and materials management.

3.17 Within the Indian network, there is little or no data generation from the old analogue switching systems. As a result, there is a paucity of the traffic data necessary to monitor network performance or to act as an input into traffic planning. For the more modern computer controlled systems such as E10B, some preprocessing of data is undertaken, but no communication systems are installed. As a result hard copy of alarms and other traffic information is routed directly to terminals, and have to be managed manually at the switch sites. This is obviously a very time consuming process, gives little network overview and seriously inhibits traffic management. For example, in Bombay, 93% of all calls in an exchange are directed to other exchanges (this is also a function of deficiencies in network planning and the use of exchanges with inadequate capacity).

3.18 The need for an effective network management system is recognized by DOT and the TC. In this context they have proposed the establishment of one National Network Management Center in Delhi and four Regional Network Management Centers (Delhi, Bombay, Calcutta and Madras) for monitoring the performance of SPC/Digital Trunk Automatic Exchanges and the various transmission centers. An invitation to tender for the first part of such a system has been distributed to some potential foreign suppliers. However it is uncertain whether the necessary funding for this will be available within the Eighth Plan period.

Network Planning and Project Implementation

3.19 Given the capital intensive and high technology nature of telecommunications, network growth and expansion requires a capacity to evaluate cost effectiveness on the basis of available alternative engineering solutions. Moreover, the ambitious goals set for the expansion of the Indian network require a short cycle time in the planning and decision process, which in turn demands an effective information system on network status and performance. Unfortunately this is highly deficient in DOT. For example, when the need for circuit expansion between two circles is noted, the planning for circuit routing in the transmission network is undertaken by the planning committee composed of managers of the involved circles, a manager from the appropriate Maintenance Region and a manager from the appropriate Project Region. If there is no capacity in the transmission system, then a recommendation for expansion is sent to the appropriate Project Region. This process is not only very time consuming and unwieldy, but it does not allow for a broad enough view of network expansion and
often leads to ad hoc network arrangements. This in turn leads to difficulties in implementing a national network management system, and jeopardizes a balance between the plans for circuit expansion and the plans for expansion of the transmission network (these issues are discussed more fully in chapter 6).

3.20 Network planning and development of the system has also been constrained by the reliance upon an inadequate and inefficient domestic telecommunication equipment manufacturing base. Actual project implementation is sanctioned on a year by year basis, and is closely aligned to the annual procurement cycle. Production planning and allotment of equipment is undertaken by DOT headquarters based on anticipated equipment availability from the factories. Until recently, this sanctioning process was based upon a very broad five year plan, drawn up by the operating circles. The production planning process and the allotment of equipment is handled by separate divisions of DOT, and coordination of these different elements is weak.

3.21 Past experience has shown that the supply plan seldom works out, and allotments have to be changed frequently. Adjustments in this allotment plan, often mean late delivery of equipment and changes in type. Both seriously upset the delicate balance of project implementation, which is compounded by the fact that DOT does not have a systematic and effective mechanism for project monitoring. The result has been annual expansion plans that are carried out in relative isolation, and because of the lack of proper synchronization and coordination, project completion times are drawn out. 11

Financial Performance

3.22 Over the past five years there has been a continual and significant improvement in the financial performance of DOT and MTNL. Operating revenue per DEL has increased by about 120% from FY86 to FY90, while operating costs per DEL grew by only 38% over the same period. This represents a very commendable effort, and is a reflection of efficiency gains resulting from the increase in connected lines during this period (nearly 1.5 m lines), tariff increases in April 1989 and an increase in the levy charged to VSNL. Staff per DEL has declined from 114 in FY86 to 84 in FY90, reflecting an increase in lines rather than a decline in the absolute size of the work force. The average monthly wage has increased by 4.1% per annum (in real terms) over the past five years.

3.23 As a result of the improved financial performance, the rate of return on assets has improved significantly (from 7.63% on the basis of revalued assets in 1986 to 17.9% in 1990) creating a more viable financial structure. A further positive development has been the modest growth in GOI budgetary support as a source of investment funding. Over the five years of the Seventh Five Year Plan (1986-1990), the contribution of internal cash generation to network expansion has risen from 47% to 72%. Furthermore, the last five years have witnessed a significant increase in the use of bond issues (most notably by MTNL) as a means of raising investment resources. The improved internal cash generation of the

11 It has often occurred that equipment is installed but not made functional because of the lack of other necessary equipment. New digital switches have been installed, without connection to the network, and remained idle for long periods. An optical fibre link between Pune-Bombay-Dhule which was laid over a year remains idle. As it was not buried at a 5ft depth the operational group is unwilling to commission the cable.
telecommunication system, as well as its demonstrated bond issuing ability, augurs well for the mobilization of financial resources necessary to implement the very ambitious expansion and modernization plans over the next decade.
### Table 3.1
**Telecommunications System**
#### Income Statement
(billions of Indian Rupees)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>13.932</td>
<td>18.274</td>
<td>23.389</td>
<td>32.173</td>
<td>36.512</td>
</tr>
<tr>
<td>Telephone</td>
<td>11.035</td>
<td>13.648</td>
<td>18.754</td>
<td>27.085</td>
<td>30.906</td>
</tr>
<tr>
<td>Trunk</td>
<td>(2.902)</td>
<td>(2.956)</td>
<td>(3.715)</td>
<td>(4.435)</td>
<td>(4.775)</td>
</tr>
<tr>
<td>Install/Rent</td>
<td>(3.308)</td>
<td>(4.290)</td>
<td>(4.75)</td>
<td>(7.12)</td>
<td>(7.36)</td>
</tr>
<tr>
<td>Telex/Telegraph</td>
<td>2.091</td>
<td>2.594</td>
<td>2.658</td>
<td>2.853</td>
<td>2.921</td>
</tr>
<tr>
<td>Operations/Maint</td>
<td>(1.572)</td>
<td>(2.231)</td>
<td>(2.607)</td>
<td>(3.133)</td>
<td>(3.413)</td>
</tr>
<tr>
<td>Interest</td>
<td>1.701</td>
<td>2.172</td>
<td>2.152</td>
<td>2.659</td>
<td>3.421</td>
</tr>
<tr>
<td>Income Taxes</td>
<td>-</td>
<td>-</td>
<td>0.250</td>
<td>0.560</td>
<td>0.770</td>
</tr>
<tr>
<td>Net Profit (after tax)</td>
<td>2.765</td>
<td>3.522</td>
<td>5.083</td>
<td>12.056</td>
<td>13.304</td>
</tr>
</tbody>
</table>

1 Amounts are consolidated for DOT and MTNL.

### Table 3.2
**Telecommunications System**
#### Balance Sheet
(billions of Indian Rupees)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Total Assets</td>
<td>61.796</td>
<td>87.822</td>
<td>93.203</td>
<td>115.935</td>
<td>144.653</td>
</tr>
<tr>
<td>Fixed Assets</td>
<td>55.713</td>
<td>78.926</td>
<td>83.663</td>
<td>104.435</td>
<td>130.251</td>
</tr>
<tr>
<td>Plant in Operation</td>
<td>(33.943)</td>
<td>(40.320)</td>
<td>(47.562)</td>
<td>(58.191)</td>
<td>(76.891)</td>
</tr>
<tr>
<td>Other</td>
<td>(11.560)</td>
<td>(27.611)</td>
<td>(22.097)</td>
<td>(26.392)</td>
<td>(31.681)</td>
</tr>
<tr>
<td>O/W Accounts Receivable</td>
<td>(2.991)</td>
<td>(4.000)</td>
<td>(4.630)</td>
<td>(6.268)</td>
<td>(7.484)</td>
</tr>
<tr>
<td>Inventory</td>
<td>(3.060)</td>
<td>(3.200)</td>
<td>(3.374)</td>
<td>(3.649)</td>
<td>(3.118)</td>
</tr>
<tr>
<td>Total Equity &amp; Liabilities</td>
<td>61.796</td>
<td>87.822</td>
<td>93.203</td>
<td>115.935</td>
<td>144.653</td>
</tr>
<tr>
<td>Equity</td>
<td>60.292</td>
<td>74.506</td>
<td>70.805</td>
<td>83.371</td>
<td>98.859</td>
</tr>
<tr>
<td>O/W Budgetary Support</td>
<td>(24.000)</td>
<td>(29.168)</td>
<td>(29.168)</td>
<td>(29.553)</td>
<td>(32.147)</td>
</tr>
<tr>
<td>Liabilities</td>
<td>1.504</td>
<td>13.318</td>
<td>22.399</td>
<td>32.568</td>
<td>45.805</td>
</tr>
<tr>
<td>Accounts Payable</td>
<td>(0.445)</td>
<td>(4.437)</td>
<td>(5.983)</td>
<td>(7.251)</td>
<td>(7.936)</td>
</tr>
</tbody>
</table>

1 Amounts are consolidated for DOT and MTNL.
2 After cumulative depreciation.
### Table 3.3
**Telecommunications System**
**Financial Performance Indicators**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Local/STD</td>
<td>41.20</td>
<td>48.80</td>
<td>53.83</td>
<td>56.22</td>
<td>60.72</td>
</tr>
<tr>
<td>Trunk</td>
<td>26.30</td>
<td>21.66</td>
<td>19.81</td>
<td>16.37</td>
<td>15.44</td>
</tr>
<tr>
<td>Install/Kent</td>
<td>32.31</td>
<td>31.43</td>
<td>25.33</td>
<td>26.30</td>
<td>23.82</td>
</tr>
<tr>
<td>Telex/telegraph</td>
<td>15.99</td>
<td>15.76</td>
<td>12.59</td>
<td>9.20</td>
<td>8.28</td>
</tr>
<tr>
<td>Operating Revenue per DEL (Rs.)</td>
<td>3640</td>
<td>4947</td>
<td>5803</td>
<td>7779</td>
<td>8055</td>
</tr>
<tr>
<td>Operating Cost per DEL (Rs.)</td>
<td>3124</td>
<td>3782</td>
<td>4064</td>
<td>4213</td>
<td>4326</td>
</tr>
<tr>
<td>Cost Operating Cost/DEL (Rs.)</td>
<td>2592</td>
<td>3007</td>
<td>3177</td>
<td>3214</td>
<td>3197</td>
</tr>
<tr>
<td>Average Staff/1000 DEL</td>
<td>114</td>
<td>105</td>
<td>96</td>
<td>89</td>
<td>84</td>
</tr>
<tr>
<td>Average Monthly Salary (Rs.)</td>
<td>1517</td>
<td>1861</td>
<td>2135</td>
<td>2265</td>
<td>2411</td>
</tr>
<tr>
<td>Current Ratio</td>
<td>4.05</td>
<td>0.67</td>
<td>0.43</td>
<td>0.35</td>
<td>0.32</td>
</tr>
<tr>
<td>Debt Equity Ratio</td>
<td>-</td>
<td>1.11</td>
<td>1.17</td>
<td>1.00</td>
<td>0.84</td>
</tr>
<tr>
<td>Rate of Return (%)</td>
<td>11.91</td>
<td>9.61</td>
<td>14.44</td>
<td>26.89</td>
<td>24.23</td>
</tr>
<tr>
<td>Historical prices</td>
<td>7.63</td>
<td>7.96</td>
<td>11.51</td>
<td>20.29</td>
<td>17.90</td>
</tr>
<tr>
<td>Revalued prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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1. Amounts are consolidated for DOT and MTNL.
2. Exceeds 100% due to transfers between DOT and MTNL.

### Table 3.4
**Telecommunications System**
**Investment and Financing**
(Billions of Indian Rupees)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Investment in Operating Assets</td>
<td>8.51</td>
<td>9.77</td>
<td>13.45</td>
<td>20.48</td>
<td>25.52</td>
</tr>
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</table>

**Financed by:**

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Cash Generation</td>
<td>4.04(47)</td>
<td>3.76(38)</td>
<td>10.09(75)</td>
<td>16.15(79)</td>
<td>18.65(72)</td>
</tr>
<tr>
<td>Board Issues</td>
<td>4.47(53)</td>
<td>0.84(9)</td>
<td>4.40(33)</td>
<td>4.0(20)</td>
<td>7.25(28)</td>
</tr>
<tr>
<td>GDI Equity Contribution</td>
<td>-(-)</td>
<td>5.17(53)</td>
<td>-(-)</td>
<td>-(-)</td>
<td>0.17(1)</td>
</tr>
<tr>
<td>Other GDI transfers (net)</td>
<td>-(-)</td>
<td>-(-)</td>
<td>-1.04(8)</td>
<td>0.33(1)</td>
<td>-0.35(1)</td>
</tr>
</tbody>
</table>

1. Amounts are consolidated for DOT and MTNL.
2. Figures in parentheses are percentage share.
Government Reform Efforts

3.24 The GOI and the TC are aware of some of the institutional shortcomings discussed above, particularly as it pertains to network planning and the capacity of the institutional structures to undertake the planned large expansion of the system. They recognize that there is need for greater integration of various facets of network development. To bring improvement the TC has introduced a system of Strategic Business Plans (SBP) and Annual Operating Plans (AOP), which is expected to be fully operational in the next fiscal year, although the procedures were introduced in 1991/92. The basic objective of this approach is to give improved management direction to the entire organizational structure.

3.25 Within the context of the Five Year Plans of the GOI, a three year time slice is taken which becomes the SBP. The first year of the SBP is the AOP. Rather than planning in a desegregated way based upon small projects, the SBP encompasses the entire network at the Secondary Switching Area (SSA) level and looks at parameters such as profitability, growth, manpower development, budgets and financial constraints. Ultimately, these SSA perspectives are combined at the Circle level, and finally at the national level. Advantages seen in this approach include a greater participation of individual units in the plan process, which improves the capacity for accountability and responsibility, and a greater clarity in the implications of plans drawn up by the SSAs, on their financial performance and equipment requirements. The three year perspective given by the SBP, is also seen as bringing a greater capacity to monitor and evaluate service improvements and network expansion targets, and flexibly make adjustments in the event of implementation problems.

3.26 The "bottom up" planning process implied by the SBP and AOP should lead to a more disciplined and commercially oriented investment process. The individual plans will be driven by objectives and financial parameters, and each will be integrated with the whole to ensure consistency with technical requirements and likely equipment availability. However, there are some weaknesses and omissions. In the past a limitation on the development of the network has been the timely supply of equipment. This is a function of industry policies with regard to the indigenous production of equipment, import licensing procedures and the budgetary process of DOT with respect to annual investment allocations. The capacity of individual Circles, or SSAs to purchase equipment is constrained, and the proposed SBP will not really address this issue.

3.27 Not addressed in the SBP is the problem of the division of responsibilities within the national network planning process. There are separate groups responsible for technology selection, the planning of trunk transmission, trunk switching, the metro, urban and rural local networks, the non-voice services and the international services. It may not be practical that one group should plan all networks and services but they should be thoroughly coordinated. In particular the trunk network, being the most valuable asset, must be planned with total consistency whereby the PSTN (Public Switched Telephone Network), non PSTN and international capacity needs are attended to by one group; the trunk planners. Further the planning process is driven by policy and technology selection decisions which can lead to a sub-optimal, inefficient and complex network. The processes enshrined in the SBP tend to perpetuate this planning process and should be reviewed to ensure that optimum cost solutions are not
inhibited by subjective policy decisions or inflexible technology selection choices.

**Conclusions**

3.28 It should be apparent from the discussions in this chapter, that the organizational structure that exists in India to deliver telecommunication services has not evolved at a pace, or in a manner, suitable for an essential infrastructure with rapidly changing technology. The sheer size of the entity, together with its highly centralized decision making hierarchy, has been a constraint and an inhibitant to change. While it is true that the lack of investment in the network is a major cause of the poor quality of service and its limited coverage, it is also true that the organizational systems adopted have aggravated these problems. The overly centralized management system, coupled with a civil service oriented, bureaucratic structure, have reduced the capacity for monitoring unit and individual performance, which in turn has reduced accountability and responsibility. Furthermore, this structure has proven to be both resilient and resistant to change, despite a variety of initiatives over the past decade.

3.29 The formation of the TC in mid 1989 did improve the policy making environment and imparted a greater sense of urgency to the need to expand the network and improve the quality of service. Furthermore, the system of Strategic Business Plans introduced by the TC is a genuine attempt to improve the efficiency and implementation of network growth and develop unit accountability. However, the fundamental over centralization of many aspects of day to day operations has been little changed. In fact the creation of the TC may represent a counterproductive move insofar that controls have become more binding with inappropriate overlapping of policy, manufacturing and operations responsibilities. The TC not only sets general policy, but oversees research, production in public enterprise telecommunication equipment producers, staff and training issues and service provision. Furthermore, there is little flexibility in managing personnel issues given the present DOT structure. Wages are set globally, promotions are based more on seniority than performance, and the capacity for the organization to adjust work practices is very limited. (The constraints on change in the telecommunications system caused by labor relations and personnel policies is discussed more fully in the following chapter).
3.30 Technology in telecommunications, particularly in transmission and other subscriber services, has changed radically in the last two decades. This in turn has changed the types of organizational structures that are best suited to provide telecommunications services. Many aspects of the so-called natural monopoly inherent in the provision of an infrastructural service have proven to be not so binding as previously thought. It is now widely recognized that large parts of service provision can be provided to subscribers on a competitive basis, with significant improvements in service quality and cost. Furthermore, whatever institutional structures are adopted, they need to be highly flexible in order to take advantage of technological developments, and have the incentive to do so. Telecommunication organizations must be driven by the needs of the subscriber and

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**Box 3.1**

**Telecommunication Tariffs in India**

The structure of telephone tariffs in India have certain specific features. Telephone rentals and local call charges are divided into measured rate and flat rate categories. In the measured rate category, charges consist of rentals, an allowed number of free calls and local call charges. In the flat rate category, a single rate tariff is charged and is basically applicable to very small exchanges (predominantly found in rural areas and villages). The DOT has also introduced an "own your telephone" scheme, where a lump sum deposit is made, graded according to exchange size, which entitles participants quicker access to a telephone connection.

Trunk calls are determined by three factors -- specified category of call (ordinary, urgent, lightning), time of use and distance blocks. Unit fee zones of between 800-2000 sq. kms are identified and merged to form Long Distance Charges Areas (LDCA). Calls terminating and originating within a LDCA are categorized as short distance calls. Calls between contiguous LDCA's are charged on a point to point basis depending on the radial distance between trunk exchanges. Calls between non-contiguous LDCA's are charged rates on an area to area basis using the radial distance between long distance charging areas. Time of use has been split into three main categories, with differentiated pulse rates.

**Telephone Price Indices**

<table>
<thead>
<tr>
<th>Year</th>
<th>Wholesale Price Indices Weighted Price Index for DELs in Metro Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>100.0</td>
</tr>
<tr>
<td>1985</td>
<td>125.4</td>
</tr>
<tr>
<td>1986</td>
<td>132.7</td>
</tr>
<tr>
<td>1989</td>
<td>166.3</td>
</tr>
<tr>
<td>1990</td>
<td>185.3</td>
</tr>
</tbody>
</table>

The bulk of total revenues accrue from long distance calls (about 89%), the metro cities (the four main cities account for 47% of all metered calls), and from a small proportion of subscribers, (9.94% of subscribers account for 62.3% of all calls).

There are many anomalies in the existing telephone tariff structure in India. At present for local calls, there is no metering of calls with respect to duration. A call costs 80 paise to Rs.1.10 irrespective of duration. This could lead to excessive use by subscribers and adds to congestion in the local networks. Furthermore, the value of free calls allowed exceeds the rental charges for all exchange sizes up to 50,000 lines, which increases the demand for new DELs at a single subscriber rather than use existing DEL capacity. Contrary to worldwide practice, there is no tariff differentiation between different classes of subscribers (e.g., commercial/residential).
be highly customer oriented, and not driven by the needs of the service provider (or the supplier of its equipment).

3.31 The need for greater autonomy in the field units is recognized by the TC. The proposed SBP system could lead to an improvement in this autonomy, and as a result create a greater degree of accountability than presently exists. However, it is far from clear that this sort of fine tuning within the existing organizational structure will be sufficient, particularly as the fundamental incentive/reward and sanction system remains unchanged. If work practices, promotions, and career development and financial rewards are unrelated to objectives and goal achievement by either individuals or sub-units, then a more integrated planning system will soon founder. This is not to deny that ad hoc efficiency enhancing measures cannot be undertaken in the present structure and prove marginally successful. There are numerous measures (lengthening the budgetary/procurement cycle, introducing computerized project monitoring or materials management systems are good examples) that would improve the present operating performance, and should be undertaken. However they do not address the fundamental institutional structure and the incentives that drive it, with the result that the sustainability of these ad hoc measures is undermined.

3.32 To overcome some of the institutional weaknesses in the service provision structure, the very form of the structure needs to be addressed. This issue, together with some optional reform strategies is taken up in Chapter 8, however there are some broad principles that are fundamental for effective institutional reform:

a) there must be a greater decentralization of activity and decision making, and there is a strong need to allow entry of non-public sector providers of services and facilities to improve the competitive environment under which these services are provided.

b) the relationship between operating companies and service providers and governmental policy and regulatory authorities need to be sufficiently distanced to allow the operator considerable autonomy. The operator must be given discretion in equipment choice, fund raising, price setting, personnel policies, maintenance procedures and subscriber service enhancements. The issue of financial autonomy is crucial and does not imply that the operator is not accountable to its shareholders (whether it be government or private).
Chapter 4

Human Resources and the Telecommunication Network

Introduction

4.1. Institutional reform within the telecommunications sector in India has been impeded by the sometimes difficult labor relations that exist within DOT. Rapid advances in technology, which have changed manpower composition and skill requirements, together with increasing public demands for improved telecommunication services, has placed human resource management as a key element that needs to be addressed. Whatever organizational structures are adopted for the provision of telecommunication services in the foreseeable future, the public sector will continue to be a major provider, with the result that manpower issues will arise. Furthermore, the ambitious network expansion plans to the year 2000 will face implementation problems unless there is a radical change in human resource management and development. As such, this chapter explores, a little more deeply, the nature of the human resource element within India's telecommunication system and thereby provide a context for some of the reform suggestions put forward in Chapter 8.

4.2. As noted in the previous chapter, DOT's organizational culture, with excessive centralization, regulation and procedures is not suited for a high technology sector. This culture also adversely affects labor relations and improvements in labor productivity. Staff motivation is inhibited by the lack of appropriate performance incentives, salary scales which do not compete with those available outside central government for like skills and internal procedures (for promotion policies for example) which are overly rigid and regulated. The government has been aware of these difficulties for a considerable time, and a host of specialized task forces and committees have been constituted over the past twenty years to deal with pay issues, job classifications, training, organizational structures and general personnel policies. Little has been accomplished and it is useful to quote from one of these committee reports completed in 1981:

"One of the major problems is the implementation of decisions at the ground level. One General Manager has reported to us: 'Any pragmatic attempt at achieving significant improvement in the telecommunication services in India has to take serious note of the fact that almost all the problems are known, practically all the solutions are also known, but none of the solutions has been implemented effectively'". 12

Opposition to change has been a consistent norm over the last two decades and suggests that a significant transformation in the organizational culture may only occur if bold and radical policy reforms are undertaken.

12 Sarin Committee Report.
little accountability at each level and labor use is characterized by rigid work standard norms and regimented procedures.

4.18 Within the present organizational structure there are beneficial initiatives that could be undertaken to improve the use of labor and human resource development (HRD). The pace with which these initiatives are introduced, and beneficial impacts that could follow will not be speedily realized. Past experience has shown that HRD requires particular sensitivity if industrial action and disruptive labor unrest is to be avoided. Nevertheless, initiatives in HRD will not be sufficient in and of themselves. Changes in organizational structures and the very framework of delivery of telecommunications services will be necessary. In the short term, these organizational changes may increase tensions in labor relations and, as a result, be somewhat disruptive. But in the medium term the environment for productive HRD will improve significantly, with consequent improvements in all aspects of labor productivity.

4.19 It is a moot point of administrative theory whether organizational changes should precede any initiatives in HRD. Past experience in other countries suggests that for large public monopolies, a fundamental change in institutional structure which creates competitive forces, improves responsiveness to consumer needs and penalizes the lack of such responses, and inculcates a greater sense of accountability at all staff levels, needs to be undertaken at an early stage in any reform agenda. A change in the institutional structure can act as a catalyst for changes in work norms and personnel policies. To seek to bring about sequential change within the present organizational structure will encounter the full array of opposition and featherbedding, from a variety of vested interests, that has forestalled progress in the past.
Chapter 5

Indigenous Telecommunications Research and Development

Introduction

5.1 It has long been the GOI's and DOT's intent to develop a strong indigenous capability in research and development of all types of telecommunications equipment and create a strong domestic production base. Up until the early eighties little progress was made in this research effort, with few resources being devoted to any research undertaking, either by the public enterprise equipment producers or by DOT. Technologies were acquired from foreign manufacturers, under license agreements, and most of what development occurred focussed upon adaptation of the product to locally available components or to specific Indian climatic or working conditions. Domestic manufacturing was both highly protected from international competition (through non tariff barriers and quantitative restrictions) and concentrated in a few public sector enterprises. As a result there was little incentive for product or process innovation, and technology absorption into the network lagged worldwide developments by considerable margins. For example, digital switching was only introduced into the network in 1986, utilizing a switch based upon early 1970s technology. In sum, the system of foreign technology licensing, coupled with monopolistic production, meant that technology developments proceeded in fits and starts, rather than as a continual and progressive flow.

5.2 Administratively, research in telecommunications was concentrated in the Telecommunications Research Center (TRC) of DOT. In the TRC, most modern developments in telecommunications were followed, however few reached actual production. The lack of urgency to market new products often meant that recent developments were superseded by other innovations before they reached a state when production would be possible.

5.3 From the early eighties, greater impetus was given to indigenous technology development with the formation of C-DOT in 1984. The mandate given to C-DOT was to develop a family of digital switches suitable for all applications in the Indian network, together with attendant research and development of compatible transmission equipment. Not only was C-DOT tasked with development of hardware and software for the new product, but particular attention was to be directed toward production design and engineering, taking into account local production systems and indigenous component and equipment availability.

5.4 As experience has shown in other countries, development of a digital switching system is a prodigious undertaking, particularly for the necessary software development. To create a working system with the basic telephone functions is only a small part of the total development, and the software developments present the major challenge. A large part of the software consists of diagnostic, maintenance and operation programs and facilities. Furthermore this development effort should be continuous, and the system sufficiently flexible, in order to accommodate new features of traffic handling, operational needs and subscriber services.
5.5 A variety of reasons are put forward by the government for embarking on this development effort:

a) The Indian traffic conditions are stated as an important reason for seeking to create an indigenous switch. DOT claims that the call capacity of foreign systems is not sufficient for Indian circumstances. The Telecommunication Engineering Center (TEC), responsible for equipment specification within DOT, has stated that a capacity of the system is required which could sustain 25 BHCA (Busy Hour Call Attempts) on subscriber lines and 60 BHCA on trunk circuits. These indeed are high figures in comparison with most other countries. In countries with a high number of lines per 1000 inhabitants, these figures are 3 to 10 for subscriber lines and 20 to 30 on trunks. The poor quality of the telephone network, with call success rates of each attempt in the region of 10 to 20% (see Chapter 2), accounts for the high BHCA figure in India. It should be noted however that India is not unique in this regard. Many developing countries, with inadequate networks, have success rates as low as 10 to 30% and other switching systems have been accommodated to sustain relatively high BHCA. 13

b) A second reason given for the indigenous development of switching equipment is the climatic conditions encountered in India. Large heat and cold variations, together with high dust levels, do pose considerable strains on digital switching systems. These conditions are not unique to India, of course, and existing digital switching systems are built to withstand such conditions. Even in the case where power availability is unreliable, special cooling systems and/or housings are available to provide solutions to high heat conditions. But these solutions can be expensive, particularly in the case of small rural exchanges... In this latter case, a rural exchange which can operate at an average temperature of 45°C, with a low power consumption, would bring savings in investment costs. However maintenance costs may also be higher in such circumstances. As only a few countries have this requirement, for only a small percentage of their total number of lines required, the main multinational switching manufacturers are disinclined to develop a system solely to comply with this requirement. For larger systems however, there are many examples in existence with environmental specifications suitable for the conditions encountered in India.

13 Oftentimes, there is some confusion as to the precise definition of success rates and BHCA, which can result in large differences in the figures given. Box 5.1 contains a description of the definitions used.
c) One advantage put forward for an indigenous development of switching is that it will enable the use of readily available components in the international market, thus freeing India from price and/or supply constraints for proprietary components from foreign manufacturers. This rationale may have some dangerous implications however. Often technology improvement in switching is based upon improved components with an emphasis on high speed, low power and miniaturization. Hence if components used are outdated then so too will be the final product.

d) A final rationale put forward relates to the costs of development. Given an abundant engineer workforce, at relatively low costs, it is argued that considerable savings can be realized in the indigenous development of switching systems, with specific user performance requirements, rather than paying a foreign producer for previously incurred development costs. Furthermore, it is argued that development of an indigenous system that is more attuned to local production conditions, utilizing a more labor intensive method, as well as optimizing local equipment content, will be more cost effective.

5.6 Whatever the merits of the above arguments, it is clear that the policy desire to standardize on switching systems introduced into the network, and to develop an indigenous switch as part of this standardization process, has important implications for future network efficiency and the pace of expansion. Delays in the development process; inability to develop systems with sufficient flexibility to accommodate technology changes (in an area where technology is changing very rapidly), or inability to be able to introduce into the network systems of sufficient size and capacity to enhance network performance and improve network management, could all be detrimental to the goal of broadening the coverage of the network and optimizing the use of resources. Furthermore, given the long service life of capital plant, decisions as to technology and type of equipment, once made, cannot be readily or speedily adjusted.

5.7 The focus of this chapter therefore is to evaluate and examine more fully the implications of the indigenous technology development policy. The emphasis will be upon switching systems, most notably that being developed by C-DOT, however, some attention is directed toward the research efforts of ITI. Also there is documentation of indigenous research and development in transmission equipment. Of particular importance is an assessment of the capabilities of the achievements to date, and place this assessment in the context of the TC's strategy of relying on C-DOT switching for small and medium exchanges and their integration with much larger trunk and local urban exchanges.
Box 5.1

Call Definitions and Failure Reasons

Definitions:

- Call attempt is defined as any closed loop situation which is detected by the local exchange as the start of a call. Normally, when the loop is closed longer than 100-200 microseconds, the exchange will detect this as a call attempt and will provide dial tone if the subscriber is not blocked because of technical or administrative reasons. There will always be attempts detected which will be aborted before any digit is dialed. This is caused by subscriber behavior, telephone instrument malfunctions and by short circuits in the outside cable plant. It is observed that the amount of these so called "hits" in the Indian network is very high (20% - 40% of the total call attempts). The normal subscriber behavior should give figures between 5% - 10%. This means that in Indian circumstances, the required BHCA of the module handling the subscriber calls (e.g. the Base Module of the C-DOT switch) needs to be 50% higher because of the poor quality of the outside plant and subscriber instruments. A successful call is a call which is answered by the called subscriber. Only these calls will bring in revenue. From a network point of view, many of the call failure reasons are the result of the subscriber behavior and are thought to be outside the control of the administration. Because of the low success rate in India, the number of attempts made for a given number of successful calls is 3 to 5 times higher than necessary. Applying more processing power instead of attacking the cause of the low success rate, will only lower the success rate and not raise the number of successful calls.

Call failure reasons:

- After the call attempt is started because of the detection of a closed loop a number of reasons can cause the call not to end in a successful call. The main reasons are:
  - false call attempts. Through improving the outside plant this can be minimized.
  - no dialing, mainly caused by bad subscriber behavior. By providing proper instructions some improvement can be realized.
  - partial dialing, can be caused by a poor transmission quality introducing noise and tones when subscribers do not expect them but mainly this is caused by bad subscriber behavior.
  - congestion in the switch. This is minimal in modern digital exchanges.
  - congestion in the network. When trunk groups have insufficient capacity and congestion occurs, this will lead to repeated attempts causing more congestion. In many countries, because of the shortage in subscriber lines, the trunk network is neglected. However, the world wide trend is that the long distance and international traffic have a far higher growth rate than the local traffic. Insufficient trunk lines will lead to high congestion situations. Because of the high revenues of long distance traffic, the network should be planned with low congestion probability even if demand rises faster than expected. India suffers from considerable congestion in the trunk network which has not kept pace with growth in the local networks. In the Indian network, congestion in the trunk network is high mainly because the actual extension of local exchanges, trunk exchanges and transmission are not well synchronized. Planning for the long distance network based on the additional traffic resulting from the extensions in the network is different (see chapter 5).
  - called subscriber busy. This should be low for business subscribers but for residential subscribers who will have normally only one line, this is normally 5% - 10% of the calls reaching this stage in the call setup. In India this is 20% - 40%. As the waiting list is long, and buying connections from existing subscribers is expensive, the number of lines of PABX's is often insufficient. As busy subscribers cause repeated attempts and because of the high BHCA rate, the number of subscriber lines has to be limited. A solution would be to give free subscriber lines for terminating traffic only to PABX's. Normally a PABX owner requires originating and terminating traffic. As the traffic generated by PABX lines is much higher than on residential lines, the chance of all lines busy is high when not sufficient lines are available or when the owner does not want to invest in sufficient lines. By providing sufficient lines for terminating traffic only, the DOT could ensure that calls destined for this PABX will be successful. As the amount of call attempts will be lower, because no repeated attempts occur, the additional lines do not lower the number of lines which can be sold. The cost is only the hardware of the subscriber line but this will be paid by the higher number of successful calls.
  - no answer from subscriber. This can be a real no answer or a fault in the exchange, cable plant or telephone set. The number of not answered calls is higher than expected for the social circumstances in India. This can be caused by the poor quality of the telephone network. By introducing digital exchanges on a large scale the technical faults should be lowered considerably. The measurements available indicate a high number of signalling faults which indicates insufficient maintenance. The outside plant and telephone set should be checked regularly by an outside plant test performed by test equipment inside or connected to the exchange.
The Role of C-DOT

5.8 C-DOT was formed in 1984 with the primary goal of developing a family of digital switches covering all applications of switches in the Indian network and adapted to its particular needs. The broad specification of this system was agreed between C-DOT and DOT in early 1985. Following initial staffing of about 200 engineers, including about 30 from the original DOT switching research department, some rather ambitious goals were set. The initial goal was to develop a family of digital telephone switching systems in the capacity range from 100 to 40000 lines in about 3 to 4 years. This has proven to be infeasible.

5.9 **Research Progress** The C-DOT approach has been to develop the system in a number of phases, based on the modularity of the system design. Subscribers are connected to Terminal Units (TU); a number of TUs are connected to a time switch and form a Base Module (BM). Up to 16 BMs can be connected to a space switch to form a Main Automatic Exchange (MAX). The first phase focussed on the development of the terminal unit, as a complete independent switch on which 80 to 96 subscribers could be served. This small switch was developed as a rural exchange as well as a PABX. The first trial PABX was available in August 1985, and commercial production commenced in 1988. The first RAX rural exchange went into field trial in July 1986. This 128 port system is not able to interface with digital connections to the rest of the network, nor is it able to work in a synchronous mode as required in the digital network. Theoretically, the C-DOT design should allow for the connection of two digital trunk circuits, however, this would cut the subscriber capacity to 64 lines. This would not be very cost effective. Developments are underway (with a target of completion in 1992) to double the capacity of the RAX to 256 ports. In this configuration, digital connections become more feasible.

5.10 The first trial single Base Module (MAX-M) exchange was put into service in August 1989 in Delhi. Field trials were undertaken while the development of the BM program package was completed. The acceptance test of DOT of the MAX-M with up to 1400 subscriber lines was successfully completed in September 1991. The MAX-M, suitable for small local systems, has a capacity that ranges from 384 (at 0.4 Erlangs/subscriber) to 1536 (at 0.1 Erlangs/subscriber) subscriber lines. Control units limit the system's capacity to these values, when a normal average holding of 90 seconds is used (in the current traffic conditions in India, the average holding time is 45 seconds). In rural applications, in small towns with a mixture of residential and business subscribers and in residential areas of larger towns, the maximum of 0.1 Erlang will, in most cases be sufficient. The limit in most cases will be the BHCA capacity, and at the existing network quality levels, an average traffic of 0.1 Erlang would limit the MAX-M switch capacity to a maximum of 900 subscribers. As BHCA levels improve, the full capacity could be installed.

14 Present employment is about 200 engineers working on switching and about 150 on transmission equipment.
5.11 A medium sized local switching system is in an advanced stage of development. This is the MAX-L with a maximum capacity of 16,000 subscribers (at 0.1 Erlangs/subscriber). The first 10,000 line MAX-L (with 4,600 subscriber lines) was commissioned in December 1991. All the BMs in this exchange are of the 512 port version without additional line units. The capacity of the BM control unit and of the Administrative Processor, limit the subscriber line capacity to about 9,000 to 10,000 lines in present Indian traffic conditions. However, if TEC's specifications are used, the maximum size of this switch should be 5000 subscribers in the business parts of metropolitan areas and 10,000 subscribers in residential areas. If the highest figures given by CCITT Recommendation A.543 are used, the maximum size should be 7500 subscribers in business areas and 15,000 subscribers in residential areas.

5.12 **System Architecture** The basic architecture of this system resembles the design of the 5ESS system of AT&T with base modules which are small complete switching units. The base modules are then connected to a central module which performs the switching function for traffic between the base modules and provides the connection to an administrative module responsible for global routing, resource allocation and other centrally provided functions. This type of partly distributed design combines the advantages of a centrally controlled design (such as easy resource management and configuration control) with the survivability and economy offered by a distributed design. The BMs are in a size comparable with the 5ESS system (both can connect 512 trunks). In the 5ESS a maximum concentration of 1:8 is provided, but in the MAX the concentration is 1:4 because of the higher traffic figures prevalent in India. In the 5ESS, a much more powerful processor is used with a memory that is eight times larger. The central module of 5ESS has a larger capacity (192 BM's versus 16 BMs at present, and 32 BMs in the planned C-DOT MAX-XL). Further development of a central module for larger than 32BM's capacity is possible, however the existing central message switch in the central module represents a capacity bottleneck. The MAX has a small 16-bit processor in the administrative module compared to the 5ESS, which has a 32 bit processor, with a cache memory and other measures to gain processor speed. The memory space in the processor and on the hard disk is one tenth of the size of the 5ESS system.

5.13 There is a desire to expand the switch size, however there are some bottlenecks in the design. The capacity of the base module control complex is presently only 6,000 BHCA, and the capacity of the message switch of the Central Module complex is presently 200,000 BHCA. Attempts are presently underway to expand the BM capacity to 10,000 BHCA. Furthermore, if the configuration can be increased to 32 BMs, then the control complex (CM and AP) should be able to handle 300,000 BHCA. In this configuration, depending upon the traffic per subscriber and average call duration, a local exchange of 16,000 to 30,000 subscriber lines or a trunk exchange of 10,000 to 16,000 trunks could be realized.
5.14 The present C-DOT MAX-L switch cannot be used as a large local switch due to the call handling capacity required.\textsuperscript{15} The maximum for the MAX-L is 200,000 BHCA. The proposed MAX-XL should improve this capacity to about 300,000 BHCA, nevertheless this will still not be sufficient for large local switches in Indian traffic conditions. As a result, capacity would be limited to about 15,000 lines. It should be noted that if the quality of the existing exchanges and transmission networks could be improved, the number of call attempts generated would drop. In turn, this would allow for the MAX-XL to function economically, as large local switches of 20,000 to 30,000 lines in metropolitan business areas.

5.15 **System Performance** While the development of the MAX-L is still in an early phase, all necessary functions for standard telephone service in the Indian network seem to be available. A major function, not yet realized however, is the synchronization of the switch to the digital network. At present, the central clock unit cannot be synchronized on incoming digital bitstreams and outgoing digital bitstreams are slaved to the exchange clock which has a low stability. A national synchronization plan is under study, but it will take some years before it will be realized in the smaller towns where most of the C-DOT switches are applied.

5.16 The C-DOT system provides most of the subscriber services used in SPC systems (although C-DOT does not follow known subscriber service standards such as CEPT which will enhance the products export potential). There is a lack of standardization of these services in the Indian network as no sufficiently detailed specifications are given by DOT. In particular, the use of Direct Inward Dialling and the subscriber procedures for activation and deactivation are not supported by specifications. The system has the ability for the development of other required subscriber services. But the limited memory space available in the BM may cause restrictions in the use of the services, as each service requires data storage of subscriber related data.

5.17 The flexibility of the software in the system could be better, partly as some of the peculiarities of the Indian network are coded in the program. As the number of C-DOT switches in the network increases, this software rigidity becomes more ominous as it makes implementation of innovations such as new numbering plans or network structures more difficult.

5.18 The system provides an extensive set of maintenance facilities and the built in processing of traffic measurement data is very good. The traffic data collection is based on the use of detailed records of each call which are sent, after each call, to the Input/Output Processor (IOP). At the end of each measurement interval, these records are processed into measurement data which can be a powerful tool for analyzing the flow of traffic through the exchange. At the time of field analysis, this function

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\textsuperscript{15} It should be noted that the present EIOB version 8 system produced under license from Alcatel by ITI also faces a similar problem with 180,000 BHCA. The improved EIOB version P11 would increase this to 300,000 BHCA.
was still suffering from a number of faults that will need to be remedied. This could require some redesign, which in turn might cause a higher BM loading.

5.19 All signalling systems required in the Indian network are available in the C-DOT system (loop disconnect, 1 E&M and digital Indian R2). All three signalling systems can use either decadic or R2 register signalling. CCITT Signalling System No. 7 (SS7) is planned for the next software release, with testing planned for 1992, and first fully operational SS7 links by 1994. There are some doubts about this target. Comparing the chosen structure with other switching system designs, there are serious doubts over the stated capacity of the exchange for connecting SS7 signalling links. Systems which have SS7 in operation either use much more powerful processors in the Protocol Handlers to process SS7 signalling traffic or spend more central processor capacity on the SS7 signalling. Furthermore, in the present design, the SS7 messages are sent unprocessed to the BM of the incoming trunk. As the processor loading of SS7 calls is much higher than of calls via the Channel Associated Signalling (CAS), this would mean that the number of trunks that could be connected to one BM would be lowered considerably unless there is a redesign of the Base Processor. It is estimated therefore that the capacity of the present design, with SS7, will be insufficient for more than a 10,000 trunk exchange.

5.20 Development of ISDN has not commenced beyond some studies on the impact on the system and possible technical solutions. Development of this has a low priority, which is probably appropriate in the present development phase of the C-DOT system. Nevertheless some observations are pertinent at this point. The additional signalling and call handling of ISDN calls will require a higher processing capacity. Given the limited capacity of the control elements of modules and other units in the present design of the C-DOT system, implementation of ISDN will require some redesign and increases in processing power. This could delay progress considerably.

5.21 Evaluation Over the past seven years C-DOT has made progress in the development of an indigenous digital switching system. A small rural switch (RAX) with a maximum of 88 lines is now in volume production, and a medium sized switch (MAX-M) for 400-1400 lines is now approved by DOT and production orders have been given. A larger switch (MAX-L) has been developed and the first exchange has been commissioned with about 5000 lines. Development of a larger switch (the MAX-XL as a 40,000 line switch) is proceeding. The cost of this switching development from 1985 to 1991 has been about US $55.0 million. This is relatively low by international experience, although it is comparable to the resources spent by the smaller switching manufacturers for the development of a digital switching system equivalent to the present stage of development of the C-DOT system.

5.22 The design of the switching system is comparable with other modern digital switching systems designed and manufactured elsewhere, and it has sufficient flexibility to introduce the new features that will be required
in the future. The development to date includes most of the basic features required for the public switched telephone network (PSTN). C-DOT is continuing work to finalize the basic switch, and to carry on with the further developments that will be required in the future. At this stage in the production of the family of switches, the royalties received (4%) from manufacturers will not cover the costs of the switching development department of C-DOT and continued direct subventions from the Government and DOT will be necessary.

5.23 It is apparent that the time taken to realize the present achievements is longer than originally foreseen. This should not be construed as a reflection of the quality of the engineering and scientific staff at C-DOT, but rather as a function of the earlier unrealistic expectations of the efforts needed to develop a digital switching system. To a large extent, this problem of the underestimation of the time needed to develop the system is still prevalent. This is particularly apparent in the development of software. In most cases, C-DOT estimate half the time normally used by well known manufacturers, with much larger development groups. Past experience suggests that the design of a specific function in a faultless situation is 20% of the effort and 80% of the effort is spent on addressing all possible fault situations.

5.24 Continued developments are necessary on the MAX switch design to provide, digital interface including synchronization capability; extended operation and maintenance functions; improved traffic monitoring and management functions for trunk facilities; higher control unit capacity; CCITT No.7 signalling functions and ultimately ISDN functions. It is probably a moot point at this stage, as to whether it would have been more cost effective to have relied upon switching developments that had already occurred in other countries, with suitable software and hardware adjustments necessitated by Indian network and climatic conditions. Costs and benefits are complicated by a host of positive and negative externalities, many of which may only become apparent over a very lengthy time period. Past sunk costs are not relevant. What is relevant, is an assessment of the likely future benefits and the costs that will be incurred to achieve them. In this framework it would probably be beneficial to continue development of the C-DOT system to improve its operational flexibility and introduce some of the capabilities cited in the earlier part of this paragraph. But, the switching requirements of the Indian network should not be constrained by or predicated upon the switching development efforts of C-DOT. The achievements to date, and the developments planned, should result in a medium sized switch in about two to five years, with sufficient capacity to handle the needs of much of the network. However the present C-DOT MAX-XL switch capacity objective (300,000 BHCA), would not be sufficient for large local, transit and trunk switches (this is also true of the EIOB version 8 switch produced by ITI).
For example, for large local switches in Indian traffic conditions, the MAX-XL capacity would be limited to around 15,000 lines. 16

5.25 The capacity limitations of the switches presently being produced in India has implications for network planning and traffic management (this issue is taken up more fully in the following chapter). The network plans of the metropolitan networks use a large number of local and transit exchanges, which adds to capital costs and overly complicates the network. This in turn inhibits traffic management, maintenance systems and future operational flexibility. The same issue applies to the higher order trunk exchanges, where the multiplicity of trunk exchanges makes the planning and management of the trunk network much more complicated and less efficient.

The Role of ITI

5.26 India Telephone Industries (ITI) was formed in 1948 as the sole public enterprise supplier for much of the equipment required by DOT. The strategy of DOT was to utilize designs from other telecommunication equipment manufacturers in ITI's production. As a result, the development activity within the firm has been mainly involved in adaptation of foreign designs to local environmental conditions and to local sourcing of components. Little or no innovation or updating of the original design took place. In the last decade however, ITI has accelerated its own development efforts, oftentimes based upon specific projects for defense, broadcasting, banking and sometimes DOT.

5.27 Research Progress The main production activity of ITI is the production of the Alcatel EIOB version 8 digital switch. Discussions have been ongoing with Alcatel to upgrade or move to a newer, more powerful version of this switch. Other than outsourcing of indigenous component development, little product specific innovation has been undertaken. There has been research into the test equipment used, which has resulted in the development of automatic board test equipment which replaced proprietary Alcatel test equipment. On switching however, the main development effort has been in developing (since the early eighties) the ILT family of digital small local exchanges. This has resulted in the ILT 512 and ILT 2048 with a maximum capacity of 384 and 1536 subscriber lines (at a maximum of 0.4 Erlangs/subscriber). A smaller version for rural applications, the MILT-64, was also developed with a capacity of 56 lines. Finally, the organization developed an electronic rural exchange, the ESAX 200, for up to 192 subscriber lines.

5.28 System Architecture and System Performance The ILT family of digital switching systems lacks many of the properties common in modern digital systems. Because the memory capacity is very limited, the program is written in assembly language, as was common in SPC systems in the early seventies. The ILT switches are able to provide the basic PSTN telephone

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16 It should be noted that if the quality of the existing exchanges and transmission networks could be improved, the number of call attempts generated would drop. This would lead to a significant increase in capacity to about 20,000 to 30,000 lines for application in metropolitan business areas.
service in a digital network, on a par with the normal service level in India. The design would require a considerable development effort if it was to maintain a service level comparable or competitive with the capabilities of the C-DOT switching family. The system was originally designed for military purposes, which resulted in the use of non-volatile memory (EPROM). Consequently, to save memory space, the programming was in machine language (I.S.O.). This in turn has meant that program modification is cumbersome and the capacity for new functions is limited. Also, the maintenance features are, as a result, much less extensive and user friendly. On the other hand, because of the less complicated software (and more years in service) the stability of the software is high, and downtime because of software problems, was found to be very low compared to other digital systems.

5.29 The ESAX 200 is not a digital switch, but a Pulse Amplitude Modulation system which is a switched analogue transmission of the speech signal. Such a system would require special converters to connect to a digital line. It is a low cost switch for present rural applications, however the lack of redundant switching and control elements results in poor reliability. In the case of the MILT-64 system, the connection of digital trunk circuits will take up too much capacity to be practical. Although the ILT systems have a non-blocking switching network, as with the C-DOT systems, the control units limit the capacity of the switches. In the ILT switches, no concentration of subscriber lines is used above 384 lines, and in all configurations the traffic per subscriber line could be higher with improved processor capacity. Also, as with the C-DOT system, the ILT switches do not presently have the capability to synchronize to the digital network.

5.30 The ILT switches are used for small transit exchanges. The ILT 2048 can theoretically be used as a transit exchange, with a maximum capacity of 1984 trunks. In the Indian traffic circumstances however, the capacity of the control elements will limit the capacity to about 1000 trunks. The limited capabilities of the switch for traffic monitoring and measurement also reduces the application possibilities of the switch. ITI is working on a new design, the XD-90, for a large capacity local/transit switch (about 16,000 lines) for military applications. Considerable further development will be necessary however before this switch could be considered for wider application in the public network.

5.31 Evaluation ITI's research and development efforts on switching have been intermittent and resources devoted to all research have been quite modest as a percent of sales (3%). The total manpower involved in all R&D is about 1900, however this includes a large number of engineering staff and individuals involved in the production of prototypes. In particular, the number of staff involved in software development, compared to other manufacturers outside India, is very small. The development effort required for digital switches is mainly the development of a proper software package. The development group for the ILT system consists of only 15 graduate engineers. It is not surprising therefore that the software package of the ILT system has very limited facilities.
Furthermore, the time frame to realize the present achievement has been overly long, and one might question the efficacy of embarking upon an endeavor to develop such smaller exchanges, with such limited development potential, when "off the shelf" solutions were available from abroad in 1980. As the manpower available at ITI for further development of the ILT switch is so limited, the effort to maintain the existing software and hardware package will leave no room for the development of additional features, such as CCITT #7 Signalling or ISDN. Development priorities for the ILT switch at present are DTMF signalling on subscriber lines, PCM trunks, digital MFC equipment, detailed billing and recorded announcements.

5.32 ITI is developing a network management system for a non-DOT customer, with a view also that should DOT request a network management or a centralized maintenance and operation system (both needed), an example would be available. However, given the proposed computer systems, the full concept of such a system is not possibly fully understood. For both applications, large data streams have to be processed in real time, which the present system, mainly developed for a static presentation of a data network, would not be able to perform. While a start has been made, much development work remains to be done on the interfaces with the exchanges and transmission equipment (the CCITT specified Q3 interface), the development of functions in the switches and transmission equipment, the data transfer network and the computer systems.

Conclusions

5.33 India is endowed with a large pool of technical and scientific manpower, and with the broadening of the switching production base, this pool should continue to be enhanced. The achievements of C-DOT to date are significant, and this has been done over the past seven years with a relatively small budget. This is a reflection of the good quality of the engineering and scientific staff, and their low costs relative to international standards. What is also apparent however, is that the time taken for developments to reach a stage of volume production has been consistently underestimated. The C-DOT switching system can provide a part of what the network needs, but the likelihood that this system will evolve into a switch with sufficient capacity for large local and trunk switching applications, in a time frame that does not negatively affect network planning and development, is very slim. This problem also relates to the E1OB version 8 switch in license production at ITI, and is taken up in more detail in the following chapter. Suffice it to note at this stage, there is urgent need to optimize network planning on the basis of worldwide technology availability, and not on the basis of present local manufacturing and indigenous research and development. To do otherwise, could lead to serious longer term negative repercussions for India's telecommunications system, which, because of the massive capital investments incurred, could not be readily rectified.

5.34 A variety of reasons have been put forward to justify the indigenous development of switching and telecommunications equipment (see paragraph 5.5 below). On purely technical or economic grounds, these rationales do not stand up under close scrutiny, and undoubtedly the desire for
indigenous capabilities is part of a wider, ephemeral desire for national "self sufficiency" and independence. While the C-DOT switches have some unique characteristics (the lack of the need for air conditioning in the RAX switch for example), which might find ready applicability in other developing country environments, it is hard to believe that existing foreign manufacturers could not have provided the technology for a range of small to medium switches, with suitable software to integrate with the existing network, for a cost considerably less than the US $55 million spent thus far. And more importantly, this could have been available, and domestic production commenced in a broad spectrum of plants, significantly sooner.

5.37 This is not to imply that research and development efforts should cease, however. A certain critical mass of effort has been expended, and considerable successes enjoyed. Further development efforts are needed to expand the capabilities of the MAX switch design (see paragraph 5.24) and these should continue. Furthermore, it is readily accepted that there are a variety of positive externalities that could ensue, only part of which would be a broadening of the domestic skill base. These may not be readily quantifiable and benefits could accrue from presently unforeseen areas. However, the type of equipment, and its capability that is introduced into the network, should not be determined by the pace of the indigenous research effort. If C-DOT is able to develop a large capacity, 40,000 to 50,000 line digital switch by 1995, then nothing precludes this being introduced into the network. But the use of such switches in the system should not await this development. It is quite conceivable to import the latest technology to manufacture under license and thereby ensure that the telecommunication system is not burdened by out of date equipment.

5.38 A final observation concerns the coordination and cooperation between ongoing research efforts in the country. Given that this effort is in its relative infancy, it is imperative to optimize the use of resources that are devoted to this effort. In this context, it may be useful to improve cooperation between the research departments of C-DOT and ITI. At present, cooperation in design and development is negligible, and much could be gained from the common usage of a variety of facilities (such as environmental chambers), as well as a free exchange of knowledge. While competition in R&D can be healthy, in some areas (certain transmission equipment for example) duplication of efforts to develop equipment where the technology is already established elsewhere, may represent a wasteful use of scarce developmental resources.
Chapter 6

Network Development and Planning

Introduction

6.1 It is readily apparent from the discussions and analysis in Chapters 2 and 3, that a major expansion and policy reform effort is needed if India's telecommunications system is not to fall further behind. Considerable attention is being directed by DOT and the TC to bring about both a rapid expansion in the network, and a considerable improvement in the efficiency and delivery of telecommunications services. This objective is to be achieved within the framework of some broad policy goals. In this chapter we set out these broad policy goals, together with a documentation of the physical objectives for the next decade and the organizational methods that are envisaged to realize these goals. We provide an evaluation of the proposed network planning process and an assessment of the capacity of DOT to implement the ambitious targets set. Furthermore, we shall focus on the broad policy objectives, the proposed institutional framework in which these policies are to be pursued, and the implications that this might have for network planning and the future efficiency of the telecommunications system.

Policy Objectives

6.2 The drive to improve telecommunications in India is framed in the context of certain broad policy goals and objectives. These are as follows:

- To improve the quality of service of existing subscribers, thereby raising business and general public confidence in the system.
- To narrow the gap between supply and demand for basic telephone services by accelerating network expansion.
- To extend telecommunications in rural areas to meet a variety of social and economic needs, with the objective that no person will be further than 5 km. from a telephone or PCO.
- To extend the range of telecommunications services, particularly for business users, including data and video transmission, as well as providing improved capacity for a range of value added services.
- To standardize on the type of equipment and technology that is introduced into the network, and to encourage the development of indigenous capacity in both research and development and manufacturing.
- To improve the productivity, efficiency and profitability of the various operating agencies and existing institutional structures. Related to this broad objective is a goal to raise the necessary financial resources for the expansion and modernization of the network from internal sources or the financial markets.
6.3 These broad objectives involve certain strategies and complementary initiatives:

- To use only digital electronic equipment for switching and transmission, with eventual introduction of CCITT #7 Signalling and voice/data ISDN. In this context, there is to be an accelerated program to replace obsolete and life expired exchanges.
- To use only jelly filled cables for high reliability (as opposed to paper wrapped dry core cables) and to provide ducting on a much larger scale to avoid repeated digging and to reduce construction periods.
- To move toward increasing use of PCM and optical fibre systems for junction routes to improve network performance.
- To upgrade the quality and reliability of cabinets, pillars, DPS, subscriber loops and house wiring.
- To increase the use of push button electronic telephone instruments, both decadic and DTMF type.
- To provide direct dialing to all major cities, and international dialing and to introduce an STD lock facility in all electronic exchanges.
- To introduce automatic message accounting for detailed billing, and to offer enhanced voice and data services nationwide (call waiting, automatic ring back, voice mail, conferencing, data communications, electronic mail/facsimile, videotex and mobile telephones).
- To automate overall network management to increase efficiency and reliability, coupled with decentralization of decision making and establishment of small organizational cells and working groups with a "mission oriented approach".
- To improve the production capacity of the indigenous telecommunication manufacturing industry through appropriate retraining, retooling and encouragement of establishment of new firms.

6.4 A detailed breakdown of the specific targets to realize the above aims for the Eighth Plan Period (1991-95), together with some broader perspectives for the Ninth Plan Period (1996-2000) are retained on file and are available on request. Box 6.1 below provides an example of specific physical and service targets. The objectives and targets of the 8th Plan represents a significant undertaking, and, if implemented, will certainly be consistent with Government and community expectations. There are serious questions however, whether given past achievements, the desired policy framework and the institutional weaknesses identified in Chapter 3, this ambitious effort is feasible.

6.5 Specifically, a number of key issues could cause serious deviations from the proposed targets, as well as affecting future network performance and service quality. First, no organizational or institutional reforms are contemplated to improve implementation capacity or ongoing operational
performance and service quality. The new planning concept of the Strategic Business Plans (SBPs) and Annual Operating Plans (AOPs) is certainly an improvement over previous planning and implementation systems, but the lack of reform of basic institutional structures will undermine the effectiveness of the proposed new planning concepts. Secondly, a constraint on past network expansion efforts has been the lack of equipment and delays in the delivery of materials from domestic suppliers. Unless there is significant restructuring of ITI; a broadening of the base of competing equipment manufacturers (which is occurring with the production of the C-DOT switches), greater international competition from equipment suppliers, more ready access to production inputs (both domestic and foreign), and changes in procurement policies and procedures, then the ambitious expansion plans will not be realized. A final source of constraint on growth and improvements in service quality concerns the technology standardization policy, and its related goal of fostering both a local switching research and production base. If the system is constrained to utilize only the E10B and C-DOT switching technology, then network planning could be sub-optimal with higher investment costs than would be warranted.

Box 6.1
Telecommunications Network Expansion

**Telephones**

To provide gross (new) local switching capacity of 7.3 million lines, of which 6.9 million is to be electronic and 0.4 million is to be electromechanical. This is to result in a net addition to switching capacity of 5.9 million lines, following replacement of 1.4 million lines of life expired exchanges. The target is to have 5.2 million new telephone connections, resulting in telephone density being increased from 5.5 per 1000 population in all India, to 10.9 and from 0.96 to 2.29 per 1000 for the rural areas. In the latter case, it is planned to have a net increase in rural switching capacity of 1.0 million lines, giving an increase from 12% to 15% of all services. A massive effort is planned to provide 0.4 million Public Call Offices (PCOs), with one PCO in each of 200,000 Gram Panchayats including one highway PCO every 10 km. It is also planned to have at least one long distance public telephone in every inhabited 5 km hexagon. Finally, there is a goal to have at least one transit switch in each Secondary Switching Area (SSA), and to improve connectivity by dynamic network management and digital connectivity to the 21 "level 1" TACS.

**Telex**

To provide gross additional lines of 50,060 resulting in a net addition of 37,360.

**Long Distance**

To introduce 21,750 route kilometers (Rkm) of optical fibre cable, digital coaxial cable (utilizing existing spare tubes) of 6705 Rkm, and to expand digital microwave links by 17,700 Rkm and UHF/VHF by 35,000 Rkm.

**Services**

Beyond a general desire to improve service quality, with increased STD availability and replace all manual telephone services with automatic services, there are some specific goals. In particular there is a desire to introduce CCITT #7 Signalling, introduce ISDN based upon the C-DOT switching systems, provide new services, particularly in the metropolitan centers, including non-voice services of data on a packet switched network and introduce Automatic Call Distributions for various special services.
6.6 Achievements during the 7th Plan period (1986-1990) were variable. Of a switching capacity target increase of 2.1 million lines, 94%, or 1.967 million were achieved. However, only 66% of TAX capacity (53,000 lines as opposed to a plan of 88,000) and 72% of coaxial targets (5935 Rkm as opposed to a plan of 8212 Rkm) were achieved. Good progress was made in expanding microwave and optic fibre links, but total expenditures were 36% higher than expected at Rs.84.17 billion over the five year period. To put the effort required during the 8th Plan into perspective it is useful to compare with immediate past performance. This is shown in Table 6.1 below. The percentage increases are massive, and in some cases (such as optical fibre and rural radio) may be overly ambitious. Equipment availability may not only post a constraint, but the availability of sufficient skilled construction and operations staff may also be a serious problem. We now turn to aspects of the planning process itself.

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<tr>
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<tbody>
<tr>
<td>Switching Capacity (000's)</td>
<td>1967</td>
<td>5000</td>
<td>200</td>
</tr>
<tr>
<td>Direct Exchange Lines (000's)</td>
<td>1694</td>
<td>5150</td>
<td>204</td>
</tr>
<tr>
<td>TAX lines (000's)</td>
<td>53</td>
<td>300</td>
<td>66%</td>
</tr>
<tr>
<td>Coaxial (Rkm)</td>
<td>5935</td>
<td>6783</td>
<td>14%</td>
</tr>
<tr>
<td>Microwave (Rkm)</td>
<td>10290</td>
<td>17700</td>
<td>72%</td>
</tr>
<tr>
<td>UHF/VHF (Rkm)</td>
<td>7760</td>
<td>35018</td>
<td>351%</td>
</tr>
<tr>
<td>Optical Fibre (Rkm)</td>
<td>2294</td>
<td>21750</td>
<td>848%</td>
</tr>
</tbody>
</table>

The Planning Process

6.7 Network development planning is project orientated, very centralized, essentially top down yet at the same time is somewhat divided. It is driven mainly by policy and the availability of technology, rather than by customer demand, sound economics and good engineering practice. The ability of the planners within DOT to plan using sound network economics and good engineering practice is of world standard. But in an environment of strong central policies on technology selection and supply limitations, this expertise is under-utilized. Within DOT and the TC, the policy is for maximum indigenous production and the technology to be used is decided by the Telecom Engineering Center (TEC) in conjunction with the Long Term Plans group. TEC determines specifications for equipment, type approvals, technology approvals and customer premises interface approvals, and checks for suitability in the context of operational compatibility and serviceability. TEC also negotiates with local and overseas suppliers to select technology types, timing of availability and for indigenous or
foreign manufacture. The outcome of these negotiations is then offered to the planners for their use in network development.

6.8 Trunk transmission and switching planning is centralized but separate. Planning information is gathered via the Regional Trunk Planning Committee process whereby representatives of transmission, switching, Regional and Circle planners meet quarterly to co-ordinate network development. This Committee is the means for collecting Regional and Circle needs for local transmission and switching. These needs are aggregated with traffic forecasts, known trunk switching development plans, terrain constraints, and CCITT and the Long Term Plans group recommendations to form the basis for the main trunk planning. Non PSTN needs do not have a high priority and are largely ignored, although leased 64 kilobit/second link demand is becoming significant within India. Also, if the policy limiting interconnection of PABX's were to be relaxed the transmission capacity demand impact could be quite large.

6.9 With the above source data, and advice from TEC upon the technology types to be available in each given year, the trunk transmission and switching groups plan accordingly but separately. Advice of planning proposals and developments is exchanged between the two groups but their efforts are not well co-ordinated. Similarly the Circles and Regions are advised of the proposals and developments by documentation and at the quarterly meetings. With respect to the metro/urban areas the networks are planned in accordance with established guidelines, using the standard technology. Both the rate of development and the mix of equipment technologies are dependent on the equipment allotted and subsequently delivered. This process has the potential to encourage a less than ideal mixture of small and large switches and the use of PCM on copper or optical fiber systems according to availability.

6.10 Upon receipt of the national trunk planning proposals, the Circle and Regional planners develop complementary local plans. These constitute terminal exchange project proposals from the Circles which are assessed by the Regions then co-ordinated and aggregated with Secondary Switching Area (SSA) transmission and switching project proposals from within the Regions themselves. At the national level, the Long Term Plans, Transmission and Switching groups aggregate and assess for consistency with policy, all of these project proposals. After further negotiations with local manufacturers, and if need be with foreign suppliers, the approval of projects is made and material is allotted. Again, both the rate of development and the mix of equipment technologies are greatly dependent on the equipment allotted and subsequently delivered.

Planning Process Constraints

6.11 The present policies and processes create several significant constraints and limitations. The structure of the TC oftentimes leads to poor internal communication with Member responsibilities being divided along the lines of different disciplines rather than with a customer, service or geographic focus. Even within one Member's area there is often little communication (e.g. Switching and Transmission planners claim to not
meet frequently, only to (formally) advise each other of their plans and progress.) The TC and Government policy is for local development and production of the major telecommunication components, with little regard for the impact on network development costs. The policy and process of indigenous production (of transmission and switching material in particular) causes planning to be constrained by the types of equipment which are made available and limited to the allotted quantity.

6.12 Network development plans are on a project basis which may include external plant, switching and transmission. With the present process of top-down allotments of material and inadequate deliveries of this material, the components of each project can and do get out of step or proportion (eg. switching and transmission needs may not be balanced). Material needs are well planned and documented, quantities are negotiated and allotted one year ahead of planned construction. Deliveries are generally less than allotted, may be mis-matched (eg. switching without transmission) and are too concentrated towards the end of each financial year. This latter problem appears to be a consequence of the annual funding, ordering and manufacturing cycle imposed by Government and DOT practices. This in turn limits the manufacturing output, lowers quality and creates very uneven and inefficient construction profiles.

6.13 Whilst present practices appears to perform cost/benefit studies before a project is approved, there is no compulsion to conduct a review during or after implementation. Further, there are no mechanisms to effect any changes to a project if the review was to show adverse trends.

Planning Analysis

6.14 The constraints cited above inhibit network development or encourage sub-optimal development and their impacts are discussed below.

6.15 Transmission The planning process of the main trunk network is heavily dependent upon technology selection by TEC and is centrally controlled yet divided between the central office transmission and switching groups. This division causes co-ordination difficulties needing rectification. However, a centralized control of the main trunk network development is best retained, because as well as being in the national interest to have an effective trunk network, one of the best rates of return on investment in telecommunications is from the trunk network; from both telephony and non-telephony traffic. Given this high value and the relatively low cost of bulk transmission, the development of the switched and non-switched telecommunications network, especially the main trunk and junction transmission, should never be inhibited by inadequate processes. The cable network plan is good, linking all four major cities in a ring hierarchy with cross links, i.e. the ability to cross patch for restoration is good and prepares the way to take advantage of the capabilities of synchronous transmission systems (also known as Synchronous Digital Hierarchy (SDH) and Synchronous Optical Network (SONET). Similarly, the
microwave program appears balanced, although parallel routing of optical fiber cables already having alternate routing capacity is an anomaly.

6.16 MTNL foresees a lack of metro bearer capacity, especially if switch supplies improve. They have ordered 565MB/S systems to alleviate the need but delivery dates are unknown, and there are doubts that the systems will be received before all fibers have to be placed into service. This is an example of the lack of communication between TEC and the field groups, as TEC has planned for a 1995/96 availability of 565/622MB/S metro transmission and MTNL appears to be unaware of that date. As a direct consequence of the policy of using both optical fiber and PCM in the junction network, coupled with the shortage of optical fiber terminal equipment, MTNL plans large scale use of PCM. This is poor planning (to use obsolete, expensive, unreliable equipment) forced by the inadequacies of supply, and should be discontinued.

6.17 Switching One policy which has adversely influenced the planning process has been the drive to develop and supply the small C-DOT switch. The availability of this small, relatively cheap switch, and the non-availability of larger switches, has caused the proliferation of small local switches (sometimes even co-located clusters of switches acting as one) in situations where a larger switch with distributed access would be cheaper. As local connectivity of stand alone exchanges is unlikely to be required by customers, as switching is expensive to provide relative to transmission and as the multiplicity of switches will lead to network inefficiencies and future operational difficulties, the cheaper alternative of using fewer, larger, centrally located local and trunk (TAX) switches and greater use of transmission should be considered. These economies would be derived from the trade-off between transmission and switching costs. This will lead to fewer, larger exchanges which are easier and cheaper to dimension and increment, and which can be operated with lower overheads.

6.18 The TAX and local tandem hierarchy is predicated upon the use of available switches. These have an effective port capacity of only ten thousand approximately, being traffic limited with high processor loads. An example of the adverse network planning consequence is that in Bombay two E10B switches are operating as one switch of 14,000 port capacity. Traffic levels have caused plans to be developed to duplicate this situation. Larger port and traffic capacity switches are needed to improve network efficiency and to simplify the network to make it more manageable (i.e. fewer TAX levels and numbers and fewer local tandems to simplify the network and to avoid the necessity of having co-located switches acting as one switch).

6.19 Management policy is for distributed small exchanges to minimize external plant costs. This distribution of switches to be close to customers may result in external plant savings in many circumstances but each situation needs to be individually studied to assess costs. Analysis by the DOT's own planning staff indicates the use of large metro exchanges in a minimum number of exchange sites and the use of distributed RLU's and
RSU's. Planning needs to be based upon properly conducted studies of the alternative solutions using least cost combinations of switching, transmission, network and external plant capital costs and operating expenses and not upon inflexible rules. The E10B is capable of serving up to 30 thousand residential customers, but it is traffic limited to only 8-10 thousand customers in high calling rate business areas. This is a major limitation which may only be solved by selecting a further switch technology having greater traffic handling capabilities. With regard to the more populous Circles, they have planned for the use of switches in the range of 5 to 10 thousand lines. Due to the lack of supply of these (the allotment appears to be focussed on the metro needs) the development has either not progressed or has been implemented with multiple small switches, contributing to network inefficiencies and operational overheads.

6.20 Trunk Network The Trunk/Long Distance PSTN network hierarchy is based upon having a single level of local switch (with a local tandem in the large metro networks) and three levels of trunk exchanges (TAX's). Only the upper level of the TAX's will be fully meshed and will ultimately have network management facilities. The lower levels will mostly be star connected. The numbers of TAX's are determined by the Commission policy of having one TAX per Secondary Switching Area (SSA) which in turn were chosen to cover geographical areas representing areas of community interest, (i.e. a policy of installing a TAX in each SSA (321) regardless of ideal network development needs). The trunk hierarchy was then determined by computer modelling to minimize costs of provision of these TAX's using the available types of equipment.

6.21 The artificial constraint of having a TAX per SSA may cause sub-optimal planning and needs to be reviewed. The present TAX capacity of 141 thousand ports services 4.6 million DEL's (i.e. 31 ports per 1000 DEL's). The 8th Plan proposes a new total of 441 thousand ports for 9.8 million DEL's or 45 ports per 1000 DEL's. The modelling process employed in the planning does not consider international equipment cost norms, nor does it consider the operational implications of having a proliferation of TAX's in a complex three level hierarchy. The network management being proposed to operate only at the upper level will offer inadequate service to users of the lower levels. The lower levels being mainly star connected could suffer reduced availability due to non-redundancy of bearers.

6.22 It has been decided by TEC to limit availability of 565MB/S systems to the metro short haul variety. This is in recognition of the need for capacity in the metro areas pending the availability of 622MB/S via synchronous transmission. After having assessed the trunk network traffic, and determined that congestion is not in the trunk network, but in the access networks, TEC decided not to pursue long haul 565MB/S systems as they would become orphaned by synchronous transmission in about 1 to 2 years. This could be optimistic. CCITT guidelines on synchronous transmission are available but manufacturers and operators have not yet settled on an agreed "mix" option within these guidelines. TEC acknowledges that if the trunk access networks were cleared of congestion
then the trunk network probably could not cope with the demand and the higher capacity systems would be needed.

6.23 In the metro/urban areas it is a policy to use RLU’s/RSU’s, small stand alone switches and line concentrators to reduce the external plant costs. The savings are in the copper pairs (numbers) between the remote units and the exchange and in the conductor gauge from the remote units to the sites. The costs are the remote units and their associated transmission, housing and power. Net savings of up to 20% are estimated to be achievable if the policy is carefully implemented. These are worthwhile savings and should be pursued although (as above) proliferation of small switches should be avoided. The electronic exchanges are directly meshed, with the E10B switches also being used as tandems for the star connected analog exchanges. As the E10B tandem load decreases (with electronic replacement of analog exchanges) lines will be added to the switch. This is sound engineering.

6.24 External Plant Generally, external plant construction can be commenced when lines are allotted. However, as the lines don’t always arrive on time or at all, external plant effort can be wasted, even lost due to theft. All digging is slow and manpower intensive. Repetitive digging and the length of time for which excavations are left open is causing resident resistance to excavation approvals. The solution appears to lie in better co-ordination with other public utilities, the use of larger capacity cables to avoid re-work, the more general use of inter-exchange ducts to enable additional cables to be installed quickly as growth demands and the increased use of mechanical aids to speed the process.

6.25 Rural and Remote It is a strong policy objective to improve telecommunications availability and accessibility in the rural and remote areas. The methods proposed to achieve this is to use satellite systems, single and multi-channel radio systems, multi access rural radio (MARR) systems, small automatic terminal exchanges and small combined local and trunk exchanges. The cost per line for these rural services is high, in part due to the remoteness of the customers and in part due to the methods adopted. As stated elsewhere, the use of numerous small exchanges is expensive, inefficient and leads to extremes of network complexity and of operational overheads. It is strongly recommended that the methods of implementation be revised with the view to cost minimization by the optimum use of traditional transmission or other emerging technologies to connect the distant telephones to centralized, larger exchanges.

Finance for Expansion

6.26 On the basis of estimates and projections made by the TC and DOT, the financing of the proposed expansion plans over the next decade can be realized without resorting to central government budgetary support. The proposed outlay for the 8th Plan period if Rs.197.0 billion, of which Rs.183.34 billion is projected to come from internal resource generation and Rs.13.42 billion from market borrowings. The projections for the 9th
Plan period are less detailed, but investment expenditures are estimated at about Rs.300.0 billion, all of which is expected to come from internal resource generation.

6.27 The financial revenue and expenditure projections are based on a variety of assumptions. Telephone revenue per DEL assumes a 5% annual growth rate which may be somewhat conservative (given the planned improvements in the network). However, given that a major drive is to expand coverage in the rural areas, where revenue per DEL may be lower than in urban areas, the assumption correctly errs on the side of caution. Staff expenditure and maintenance expenditure are projected to grow at 11% and 15% per annum respectively. Both assumptions are disappointing insofar as it implies quite modest attempts to constrain staff costs, and improve productivity and efficiency, given that telephone growth is projected at about 17.5 to 18% per annum. With respect to demand projections, given the excess demand that is already understated, the lack of a sophisticated demand survey for basic PSTN may not be serious. The present demand-supply imbalance suggests there is little risk of underutilization of the proposed expansion of facilities.

6.28 There is one major problem with the planned network increase, and its financial implications. A serious constraint in the past has been the lack of adequate equipment, in a timely manner to install into the network. The best example of which is switching. Over half of the planned increase in switching capacity is for switches with over 10,000 line capacity (about 3.0 million lines or about 0.6 million per annum). As the present TC policy stands, this will be provided by the E10B version 8 switch supplied by ITI. As noted above, this switch lacks the BHCA capacity with the result that more exchanges are necessary in high traffic areas which is both cost ineffective and operationally unsound. Furthermore, the capacity of ITI to supply this quantity of switching has yet to be demonstrated. A recent agreement has been reached between ITI and Alcatel to produce their more efficacious OCB 283 switch, which has a BHCA capacity of 800,000, compared to about 300,000 BHCA for the present E10B version being produced. This represents a significant improvement and could allow for exchanges with up to 200,000 lines in local networks and 60,000 for trunks, which would radically transform the present network planning deficiencies.

6.29 ITI has plans to produce this switch in its various plants around the country, and thereby utilize its surplus manpower displaced by the closure of its electromechanical switching plants (this is discussed further in Chapter 7). Ignoring for the present the merits of this proposed reorientation of ITI's production mix, it is clear that this restructuring could take a considerable time given the retraining and retooling requirements, (ITI's own estimates suggest about three years). This in turn, could disrupt the ongoing production of the E10B switch, which is undertaken in ITI's Mankapur plant.

6.30 Two serious difficulties emerge therefore. First, unless there is a change in procurement and sourcing policies with regard to switching, the present E10B version 8 switch will continue to be installed in the high traffic parts of the network for at least the next three to four years.
Second, it is highly likely, that the availability of even this switch will not be sufficient to meet the needs projected in DOT's 8th Plan network expansion. This implies that not only will the plan targets not be realized, but the revenue projections, based upon the number of projected DELs, could be significantly lower than forecast. This in turn, will negatively affect internal resource generation and funding patterns for other aspects of the expansion program.

6.31 On technical and financial grounds, and network growth needs, the obvious solution is to source the larger switch requirements from abroad on the basis of competitively priced tenders. This in turn might lead to investment by foreign switching manufacturers, in conjunction with local partners, to establish domestic production bases, and thereby provide DOT with competitive alternatives to procurement solely from ITI for the larger switches (i.e. when the OCB 283 switch is available from ITI). This has indeed occurred with at least two foreign firms in the process of establishing switching production facilities in the country.

**Service Competition and Private Sector Investment in Network Expansion**

6.32 It is apparent that even if the ambitious 8th Plan expansion targets are realized, there will remain considerable excess demand for all forms of telecommunication services in India. Herein lies a fundamental problem with the network expansion plans of the TC and the policy framework surrounding these plans. The monopoly powers granted to DOT (and MTNL) as a service provider inhibits the mobilization of private sector resources, both local and foreign, and the potential to improve service, lower costs and accelerate the introduction of new services and facilities.

6.33 Changes in telecommunication technology over the last decade have brought about dramatic changes in the range of services that can be offered and the cost of the provision of these services. Traditional arguments of the strong economies of scale in service provision have been increasingly made redundant. There is now strong empirical evidence to suggest that the minimum network size needed for an individual service provider to be economically viable has declined substantively over time. As was discussed in Chapter 1, networks can now grow in a more modular fashion, with each of the modules being economically efficient from the perspective of the new provider. This has important implications for developing countries as the economics of dispersed communications (i.e. rural or low traffic areas) has become increasingly more viable.

6.34 The technological advances in microwave transmission and Pulse Code Modulation (PCM) has provided a means for bypassing local loops, which in the more industrialized countries has resulted in a significant increase in private network capacity. Furthermore, developments in digital switching have advanced sufficiently to allow exchanges to analyze and route calls selectively through networks owned by different generators while at the same time providing appropriate billing information. These and other advances have been accompanied by similar advances in flexible interconnection standards which ensure ready compatibility between switches and transmission products from a wide range of different equipment.
manufacturers. Advances in computer technology are enabling higher capacity exchanges from which electronic interfaces can be split off and placed close to subscriber groups, thereby allowing the economic use of fibre cable as a substitute for copper. Standards for open network telecommunications interconnection are being developed which will readily permit the whole array of "s" facilities to interwork smoothly. These will include personal communications, mobile services, intelligent networks, X400 messaging, and X500 directory services. Furthermore, these technologies will continue to evolve, resulting in ever increasing opportunities for efficient competition in the provision of value added, local loop and long distance services.

6.35 These advances provide a special opportunity for economically developing countries with underdeveloped telecommunication networks to "leap frog" a variety of stages of telecommunication system development both in the equipment used and the methods of service delivery. This is an opportunity available to India, which would greatly facilitate and expedite the expansion of the system and the quality of the services provided. This is not to deny the role of the public sector as a dominant provider of service, at least in the medium term, but creating a policy environment conducive to greater competition in the provision of facilities and service, and private investment in this, would be strongly complementary to the overall effort to improve India's telecommunication system.

Conclusions

6.36 With continued economic and social development over the next decade, the demand for telecommunications services of all types will accelerate. If these demands are not met, not only will system congestion become worse, but the growth of key productive sub sectors will be retarded. The ambitious expansion plans proposed by the TC and DOT are therefore warranted and in urgent need of implementation. While the more modest achievements in earlier plan periods were a function of low national plan priorities and limited investment resources, the policy framework and organizational structures employed, further retarded an improvement in the system's performance. There is a serious danger that this same policy framework and organizational structure has not been sufficiently adjusted to cater to the needs of the now more demanding objectives.

6.37 Network planning, and the form which the network expansion will take, should be divorced from other policy objectives within the telecommunications sector. The most notable of these is the desire to nurture a domestic telecommunication equipment research infrastructure and maximize domestic production capabilities, utilizing excessive protection and preferential procurement policies. There is nothing inappropriate in the desire to improve domestic capabilities in both areas. However, if this occurs at the expense of the development of a sound telecommunications network that is serving an already apparent need, then this will have serious negative ramifications for the economic and social development of the entire country. Whatever organizational deficiencies that might have been apparent in the past, which have impeded network growth and
improvements in service quality, the lack of appropriate equipment (and even the lack of mandated equipment which is not technically appropriate) has seriously constrained an expansion of the system. This should not be allowed to continue. Greater flexibility in switching technology choices is needed, as well as in procurement practices. Only in this manner can the main beneficiary, the telecommunication service consumer, be assured of a service that is technologically capable at a price and resource cost that is competitively efficient.

6.38 It is far from certain that the internal adjustments, undertaken within the present organizational structure, will be sufficient to overcome the many institutional weaknesses that plague DOT/MTNL. These weaknesses will inhibit the envisaged pace of network expansion, as well as the desired improvement in service quality. Serious consideration must, therefore, be given to a change in the organizational structure that allows for more institutional flexibility in response to consumer needs, for competitive demonstration effects and for a greater degree of staff and management accountability. The present corporate ethos of a civil service bureaucracy is unsuited to the urgent need to improve telecommunications in India. Furthermore, there is need to allow for a greater degree of private sector involvement in the provision of services and facilities, not only as a source of needed financial resources, but also to act as a stimulus to the organizational reforms needed within DOT and the necessary improvement in the quality of services. A possible reform agenda to achieve this is put forward in Chapter 8.

6.39 Extant from the two policy reforms discussed above, there are a number of specific actions that will have a positive effect on the rate of network development in an optimum, cost effective manner. These are shown below:

- There is need to review the material ordering procedures (as well as component import procedures) with a view to smooth out the delivery flow.
- There is need to establish a mechanism to review the viability of projects during and after implementation. Such a mechanism must enforce, or at least allow, an informed decision on the continuation of the project and ensure revision of the initial assessment processes.
- Traffic forecasts on the trunk network need an early review, taking into account the likely impact of the planned doubling of the rate of growth of the local switching capacity and planned improvements in customer access to the trunk network. In the light of this review, the decision to defer the purchase of higher capacity optical fiber systems may need to be reconsidered. If this shows that the higher capacity systems are needed to avoid network congestion or to avoid expensive alternative solutions then they should be purchased.
- There is need to review the division of responsibility for planning the development of the trunk transmission
and switching components. This will ensure consistency and balance in the development of the network and will ensure that the necessary transmission and switching capacity is available when needed, at least cost.

- There is need to revise policies which inhibit planners from developing the network in an optimum manner. For example, the policy of having a TAX per SSA and of having switches near to the metro and rural customers. The least cost solution must be allowable to the network developers.

- Very few enhanced, value added and data services are presently available, so business demand is not satisfied. These services should be made available at the earliest. Private enterprise involvement should be considered so that demand is satisfied early with the DOT/MTNL gaining revenue from leased lines and traffic carriage for minimal investment.

- Common channel signalling and a network management system should be implemented at the earliest to more readily enable the provision of enhanced services and appropriate monitoring and control of the network.

- Introduce ISDN to enable deployment of new services quickly and extensively throughout the network and to give business customers the advantages of the single integrated access to the various network services.

- Equipment deliveries must be in accordance with orders to avoid unbalanced or sub-optimal network development, e.g. switching without adequate transmission or the use of switching instead of transmission.

- There is urgent need to review the policy of using only E10B and C-DOT switches in the large metro networks. A switch with a higher traffic handling capability and greater line capacity is necessary to reduce capital and operational costs. In similar vein there is need to review the policy of using only E10B switches as large metro tandems and TAX's. A switch with a higher traffic handling capability and greater port capacity is necessary to enhance network efficiency and to reduce capital and operational costs.

- External plant practices need to be reviewed to achieve better co-ordination with other public utilities, to allow the use of larger capacity cables to avoid rework, to consider the more general use of inter-exchange ducts to enable additional cables to be installed quickly as growth demands and the increased use of mechanical aids to speed the process.

- Revise the methods of implementation of rural and remote services with the view to cost minimization by the optimum use of traditional transmission or other emerging technologies to connect the distant telephones to centralized, larger exchanges.
The microwave and UHF/VHF radio network is extensive and developing rapidly. Such a network requires a comprehensive frequency plan. Whilst a plan does exist, it is being outstripped by the rate of network development. A further study is recommended to determine the need for the introduction of frequency planning software and expertise.

Ensure that the necessary test instruments are available in adequate quantities to avoid placing the construction program at risk.

Carefully monitor the demand for telex and telegraph services to avoid over investment. As telephony accessibility improves India will follow the world trend of declining demand for telex and telegraph.

Discourage and phase out the use of PCM-on-copper technology in favor of optical fiber systems to achieve economies of provision and reduction in operational costs.
Chapter 7

Domestic Manufacturing Capabilities

Introduction

7.1 Under the Industrial Policy Resolution of 1956 (Schedule A), the manufacture of telephone equipment, instruments and cables was exclusively reserved for the public sector. Under this policy regime, three public enterprises, Indian Telephone Industries (ITI - formed in 1948), Hindustan Cables (HCL - formed in 1952) and Hindustan Teleprinters Ltd. (HTL - formed in 1960), had monopoly production rights for the bulk of the material and equipment procured by DOT/MTNL (or posts and telegraph department as it earlier was). Also, within DOT itself there are four factories producing open wire line hardware, including foundry items, telegraph instruments and manual switchboards for local and trunk exchanges.

7.2 This policy of self-reliance, behind an international barrier of import licensing and quantitative restrictions, has seen the manufacturing sub-sector grow in size and scope, with the result that over 90% of DOT's final equipment needs are procured domestically. This has not necessarily proven to be useful or beneficial for the telecommunications system however. Output quality has often been poor, with significant lags in the delivery of equipment and spare parts. Moreover, in most cases the delivered prices of locally produced equipment has been much higher than that prevailing on the world market. Finally, there has been a strong, symbiotic relationship between producer and purchaser, with the result the deficiencies of policy and management have severe negative consequences in the other. This is particularly apparent in the area of technology choice, although it is not often clear which side is leading the other. For example, ITI was still producing obsolete Strowger electro-mechanical switching equipment in 1990, and this was still being installed in the network. It is not clear whether this was to preserve, for as long as possible, employment in ITI, or whether it continued to be produced because of deficient technology policy and network planning in DOT. Whatever the reason, however, the result has been detrimental for the network and the quality of telecommunications in India.

7.3 From the early eighties it became apparent that with rapid advances in technology (with greater interface standardization) and the inability of the public enterprise producers to provide high quality equipment at reasonable prices, the reform of telecommunication equipment investment licensing policies was long overdue. The first round of liberalization occurred in March 1984, with the private sector (and the joint sector) being allowed to produce subscriber terminal equipment. This was followed shortly by liberalization in the production of copper cables, which brought forth new investment in both areas. The results of this liberalization have been beneficial, particularly in terminal equipment, with a fall in prices of over 50% in nominal terms. There was also some liberalization in switching and transmission equipment. Initially, private Indian companies were allowed to manufacture switching equipment up to 2000 lines capacity and line transmission equipment with a capacity of up to 120 voice/data channels. For larger capacity switching a minimum equity stake
of 51% by Central or State Governments was mandated. The per unit capacity limitation on private sector production was subsequently revised to 10000 lines in 1990. In the most recent industrial policy announcement (July 1991), all restrictions on the production of telecommunication equipment were removed, including participation by foreign manufacturers.

7.4 The progress made in the delicensing of production of telecommunication equipment is good, and has brought further benefits in terms of prices and an improvement in quality. Production of switching, and to a lesser extent cables, is still dominated by public enterprises which suffer from a range of inefficiencies. As noted in Chapter 6, procurement policies for DOT, while showing some improvement, still result in a degree of artificial allocations across firms, which may not penalize the least efficient. With organizational and institutional changes in India's telecommunications system, this should alleviate some of these difficulties, and create a more competitive and responsive manufacturing sub-sector, to the ultimate benefit of the service user. It is still too early to judge the effects of the full delicensing (investment in big switch production capacity utilizing alternative technologies has started, but production has yet to start) of domestic manufacturing, but clearly the sub-sector is in a phase of transition and will be facing considerable challenges in the near future. Hopefully, this will ultimately create a sector that is competitive by world standards17.

7.5 In this chapter we assess the capabilities and competitiveness of the domestic production of telecommunication cables and switching equipment. Given the significant increase in domestic competition of terminal equipment and the relatively small share that this equipment constitutes in overall expansion capital costs, this component of manufacturing has been omitted. In similar vein, limited attention has been directed at the production of transmission equipment. And given the importance of rural radio and other transmission media, further analysis of domestic production of this equipment would be warranted.

Cables

7.6 Industry Structure: There are presently thirteen copper cable companies in India of which twelve were in production in 1991. Two basic types of telecommunication cables are produced - the obsolete paper insulated dry core type known in India as "paper covered unit twin" (PCUT) and the more modern "polythene insulated jelly-filled cables" (PIJF) which reflect current technology and have higher standards of reliability18.

17 Significant import duties are levied on import equipment. The sum of Basic, Auxiliary and Counter Vetting import duties is about 105% for digital switching equipment, over 150% for cables, 126.5% for optical fibre and over 105% for subscriber terminal equipment. These need to be progressively reduced in line with the continuing reform of the trade regime.

18 About 70% of the cables installed in DOT's local networks are of PCUT type. These cables are prone to water penetration and are a major factor in the high failure rates in the network, particularly during the monsoon season. DOT decided, as of March 1990, to discontinue the use of PCUT cables, except for local repair and maintenance, and to progressively replace all dry core cables in the local networks by PIJF cables.
All production involves a variety of foreign collaborations and the production technology employed in the more modern facilities is in keeping with facilities found in other parts of the world. The full range of cable sizes are produced up to 2400 pair cables (solid and foam skin). The sector is dominated by the government owned Hindustan Cables Ltd. (HCL) which has an existing production capacity of about 5.1 million conductor kilometers (ckm) of PIJF in two factory complexes in West Bengal and Andra Pradesh. It is in the process of converting a further 2.1 million ckm of PCUT capacity to the production of PIJF cables. Total domestic production capacity is about 16.5 million ckm, however many firms do not run a full sequence of 3 daily shifts, with the result that the country's capacity may be somewhat larger.

### Table 7.1

**Domestic Production Capacity of PIJF Cables**

<table>
<thead>
<tr>
<th>Firm</th>
<th>Ownership</th>
<th>Capacity (million ckm)</th>
<th>DOT (1.4.90-31.3.91)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hindustan Cables</td>
<td>CG</td>
<td>1.6</td>
<td>0.225</td>
<td>UK</td>
</tr>
<tr>
<td>Rupnarsipur (under conversion)</td>
<td></td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyderabad (under conversion)</td>
<td></td>
<td>3.9</td>
<td>1.264</td>
<td></td>
</tr>
<tr>
<td>Vindhya Telelink</td>
<td>JS</td>
<td>1.0</td>
<td>0.387</td>
<td>Zambia</td>
</tr>
<tr>
<td>Karnataka Cables</td>
<td>JS</td>
<td>0.625</td>
<td>0.599</td>
<td>USA</td>
</tr>
<tr>
<td>Upcon Cables</td>
<td>JS</td>
<td>0.625</td>
<td>0.599</td>
<td>Italy</td>
</tr>
<tr>
<td>Micco Telelink</td>
<td>JS</td>
<td>0.625</td>
<td>0.391</td>
<td>USA</td>
</tr>
<tr>
<td>Telephone Cables</td>
<td>JS</td>
<td>1.0</td>
<td>0.271</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traco</td>
<td>S</td>
<td>0.625</td>
<td>0.029</td>
<td>USA</td>
</tr>
<tr>
<td>Ushe Beltron</td>
<td>JS</td>
<td>0.625</td>
<td>0.360</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gujarat Cables</td>
<td>P</td>
<td>0.625</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starlite Cables</td>
<td></td>
<td>0.625</td>
<td>0.545</td>
<td>USA</td>
</tr>
<tr>
<td>Finolex Cables</td>
<td>P</td>
<td>1.25</td>
<td>0.624</td>
<td>USA</td>
</tr>
<tr>
<td>Tamil Nadu Cables</td>
<td>JS</td>
<td>0.625</td>
<td></td>
<td>USA</td>
</tr>
<tr>
<td>Beltron</td>
<td></td>
<td>0.625</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Capacity (including that under conversion) 16.5 million ckm, Total DOT procurement (1.4.90 to 31.3.91) 4.696 million ckm.

1/ CG = Central Government, JS = Joint Sector, S = State Government, P = Private
2/ For most of the firms other than HCL, licensed capacity authority was granted for .5 million ckm. However, actual capacity is closer to 0.625 million ckm and hence this number is used.

7.7 The conversion of the PCUT production lines to PIJF production in HCL's West Bengal plant is very seriously behind schedule, and it is
unclear when this capacity will come on stream. With regard to PIJF cable production, HCL in its Hyderabad facility, was technologically the most advanced, insofar as it can produce the large size cables. This situation has changed significantly over the past two years, and nearly all the producers are able to produce the large sizes. Employment varies across firms, however with the exception of HCL, the number of workers per plant is not excessive. Four joint sector and one private sector firms surveyed, showed one employee per ckm of capacity ranging from 6097 ckm to 2857 ckm. HCL on the other hand has about 800 ckm of capacity per employee. In part this is a reflection of the large workforce made redundant with the curtailment of the PCUT production.

7.8 Procurement by DOT is undertaken on a local tender basis, however, once the lowest price has been obtained, then production orders are allocated across all firms willing to supply at this price. HCL is allowed a 10% surcharge to cover "social overheads". The ordering process is such that the bulk of production and delivery is undertaken in the last quarter of the fiscal year, with factories often not producing at all from April to September. Obviously this does not represent the most efficient use of the capital plant installed in the factory.

7.9 Orders outstanding as at April 1991 totalled 7.134 million ckm. This represents about 50% of the present installed capacity in the country, with the result that there is considerable overcapacity. Breakeven levels for non HCL plants are slated to range from 45% to 52% capacity utilization. Given the present procurement by DOT, many plants are not recovering full long run costs. This situation is not expected to change speedily as DOT stores are reported to hold between 7 to 9 million ckm of cable. The main bottleneck in the use of this cable has been the lack of suitable switching equipment; most notably the large size switches from ITI's Mankapur plant.

7.10 For the Eighth Plan period it is estimated that about 87 million ckm of PIJF cable will be necessary over the five year period, rising from 12.8 million ckm in FY90/91 to 22.05 million ckm in FY94/95. Given the delays already experienced, it would appear unlikely that this target will be realized. As such, the existing production capacity in the country is sufficient to meet the demands of network expansion. The target in the Ninth Plan period is 125 million ckm. If this is realized, then additional local capacity will be necessary if all the cable requirements are to come from domestic sources.

7.11 Competitiveness: Table 7.2 provides an assessment of the competitiveness of the local telecommunication cable industry. On the basis of the calculated effective protection coefficients, the industry is competitive by world standards. This calculation assumes of course, that firms are able to access all of their necessary inputs at world market prices. About 70% of the total production cost is composed of raw material (copper, HDPE, MDRE, LDPE, jelly compound are the major items). Local copper prices for 8 mm rod are about twice the world market price, as a result of the price setting of the sole import agency, the Minerals and Metals Trading Company (MMTC), which blends a price of the local copper
producer with the imported prices. Even with these higher prices for inputs however, the nominal protection coefficients for the small sizes are very modest, and for the larger sizes, the local ex-factory prices are only about 30% higher than world prices. This indicates that the present import duty for completed cables of over 150% is totally redundant.

7.12 It should be noted however, that the domestic prices utilized for this assessment reflect the highly competitive local production situation presently prevailing. These prices may not be construed as long run prices, given that many firms may not be fully providing for capital equipment replacement at these prices. Nevertheless, there is sufficient evidence to suggest that the local industry has an export potential provided that raw material inputs are made available at close to world market prices. Furthermore, the quality of production is, by and large, good. One test DOT applies is a water penetration test requirement of 14 days, which is the most stringent in the world. While some firms have encountered difficulty with this (most notably HCL), the proportion of failures has declined significantly over the past three years. 19

7.13 Assessment: The changing market structure for telecommunications cables in India has improved its competitiveness. Nevertheless, because of the high domestic costs of inputs, and a 21% excise and 4% sales tax on ex-factory prices, DOT and the network are paying considerably more than world market prices for its copper cables. For example, for the large

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19 In a study undertaken in June 1984, "A Study of the Telecommunication Equipment Manufacturing Industry", World Bank, an effective protection coefficient for the firm of HCL was calculated as 1.45. This is higher than the present calculation but reflects the production of the entire Hyderabad unit which was producing PCUT cables as well. Secondly, this was before the new joint sector and private sector capacity came on stream. Finally, it also reflected the cost plus pricing regime prevailing for HCL at the time. Given the changes that have occurred in the industry over the past five years, it is not surprising that effective protection rates have come down.
cable sizes (800 pair and above) DOT is paying about 62% more than that prevailing on the world market. This is clearly a heavy tax on the telecommunication consumer, given the already existing deficiencies in the network and its negative implications for the country's development. Consideration should therefore be given to a reduction in the excise tax charge, as well as allowing firms a greater freedom to source their key raw material inputs from abroad, without a heavy import duty penalty.

7.14 Within the sector, HCL is the dominant producer, but is clearly not the most efficient one. Increased domestic competition has put considerable pressure on the company (sales declined by 18.5% in FY89/90 over FY88/89). The firm is overstaffed, and given the present overcapacity in the country, the conversion of PCUT production to PIJF is proceeding at an inauspicious moment. The company needs to continue to find means to improve conversion efficiency and rationalize the range of activities in which it is presently engaged.

Switching Equipment

7.15 Industry Structure: Up until very recently the production of switching equipment for the telephone network in India has been the sole preserve of Indian Telephone Industries Ltd. (ITI). This is a large public sector undertaking (32000 employees) established in 1948, and manufactures a full range of terminal equipment, transmission equipment and switching equipment. In this latter category, the firm has recently discontinued production of the electro-mechanical Strowger switching system and cross bar equipment production has been frozen at 60000 lines. Following agreement with CIT-Alcatel, a digital electronic switching system, the EI0B version 8, is produced, together with its associated digital trunk exchanges (DTAX). ITI presently has the monopoly in the country for the production of this larger capacity digital switch, however this sub sector has been delicensed, and there is now investment by two foreign companies in conjunction with local partners, to establish factories producing larger size switches incorporating the latest technology.

7.16 For small switches based upon C-DOT technology, 23 licenses had been issued to allow manufacture of the C-DOT RAX 128 port rural switch and 9 licenses for 512 port C-DOT base module. In the past two years 10 producers have commenced production of the C-DOT switches, including the ITI "model plant" in Bangalore. Initially there was a capacity limit on these newly licensed domestic producers such that they were not permitted to produce an exchange of greater than 10000 line size. Since the new industrial policy announcement of July 1991, this constraint is now redundant and all producers are eligible to produce exchanges of any size. Sales to DOT will still require type approval and validation however, and the investment liberalization will have no impact on these existing C-DOT switch producers as the present C-DOT switch cannot go above 10000 lines. To produce larger exchanges these firms would be obliged to produce a different technology switch. ITI also produces a small switch (developed within ITI), the ILT range of switches with a 512 port capacity.
7.17 In FY91/92 nine manufacturers received orders for 20 MAX-M switches, with capacity up to about 1400 subscriber lines. For the larger size C-DOT switches (the MAX-L-2000 to 10,000 lines and the MAX-XL-10000 to 20000 lines) volume production of the MAX-L is not expected before 1993, and for the MAX-XL by 1995.

7.18 Techniques of production for all switching equipment in India tends to be considerably more labor intensive than might be found in the more industrially developed countries. In some cases semi-automatic machines are used for the assembly of printed circuit boards (PCBs). In many firms however completely manual mounting of PCBs is undertaken, often in non-dust free, controlled environments. As a result, component failures tend to be high\textsuperscript{20}. Traceability systems are used in all firms, but to varying degrees, and there is considerable scope for improvements in quality standards. Oftentimes, domestic switching producers are constrained to source their electronic components only from indigenous sources. This in turn often causes problems in component failure rates, particularly for ICs, resistors and diodes. This in turn obliges firms to undertake 100\% component testing (rather than on a sampling basis) for many components prior to assembly.

7.19 The estimated requirements of switching equipment during the Eighth Plan (1990-95) is about 7.5 million lines (6.0 million for expansion and 1.5 million for replacement) and 0.56 million for tandem and trunk automatic exchanges. Of the 7.5 million, 6.0 million lines are needed in the medium to larger size switches, and 1.5 million for the smaller rural switches (RAX). It will be apparent from Table 7.3, that a serious deficiency exists in the capacity of the local industry to supply the larger switch sizes (notwithstanding the need identified in Chapter 6 to utilize larger size switches than are presently made in the country). Of the smaller size switches, there appears to be adequate capacity, and in fact there may be considerable overcapacity, which could cause some difficulty for local producers.

\textsuperscript{20} A member of the DOT Quality Assurance Circle noted, "On delivery, we expect 5 defects per 100 systems. At present, we have 3 defects per system."
7.20 The recent industrial policy which liberalized the production of telecommunications equipment, most notably large switches, could remedy the perceived shortfall in large switch capacity, but this may not come on stream for another two years. III has reached agreement with CIT-Alcatel to produce the new OCB 283 switch, and has plans to produce this switch in four of its plants. But again the likelihood that this will emerge within two years is slim. Three foreign collaborations with Indian private and joint sector firms are reported, of which each is expected to produce about 0.5 million per annum (the foreign firms involved are CIT-Alcatel, Siemens and Fujitsu). If these collaborations do in fact emerge, it will represent a highly positive step, but in the absence of direct imports, it is unlikely that the switching targets for the Eighth Plan will be met.

7.21 **Competitiveness:** Assessment of the competitiveness of switching production is complicated by a host of variables which affect the price\(^2\).

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\(^2\) Variables include redundant common equipment, type and amount of I/O equipment, WDF requirements, power supply requirements, signalling used, distribution of parts between subscriber lines and trunks, and the range of subscriber services offered. Also the traffic capacity per line varies considerably amongst switches dependent upon the power and capacity of the processor part of the switch.
With the result, that cross comparability between switches is not straightforward. For the RAX 128 switch, the present ex factory price is between US $130 to US $180 per subscriber line. This compares favorably with what might be available internationally. The large international manufacturers might not be as competitive with the C-DOT or ILT small switches in the area of small stand alone exchanges (below 1000 lines)\textsuperscript{22}. For the MAX-M (1000-1400 lines), with subscriber line concentration, the cost per line is about US $175 to US $225 per subscriber line, whereas the larger ILT switch (1632 lines) without subscriber line concentration is about US $200 to US $230 per line. All of these prices are comparable to international prices. The Harris 2020 switch sells in the United States for about US $150 to US $200 per line for exchange sizes above 500 subscriber lines. It should be borne in mind that Indian prices include the import duty on imported components (ranging from 45% to 85%) and higher prices for some domestically processed items. If the producers could obtain their inputs at closer to world prices, costs per line would decline by about 20 to 30%.

<table>
<thead>
<tr>
<th>Type</th>
<th>Nominal Protection Coefficient\textsuperscript{1}</th>
<th>Effective Protection Coefficient\textsuperscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-DOT RAX (128 Ports)\textsuperscript{3}</td>
<td>1.05</td>
<td>0.90</td>
</tr>
<tr>
<td>C-DOT MAX-M (up to 1,000 lines)</td>
<td>1.10</td>
<td>1.04</td>
</tr>
<tr>
<td>ILT 512 512 Ports</td>
<td>1.10</td>
<td>1.05</td>
</tr>
<tr>
<td>E10B (Up to 20,000 lines)\textsuperscript{4}</td>
<td>1.65-1.80</td>
<td>1.35-1.45</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Ratio of domestic prices to world prices.
\textsuperscript{2} Ratio of value added in domestic prices to value added in world prices.
\textsuperscript{3} Based on averaged information from four producers.
\textsuperscript{4} The range is based upon varying exchange specifications.

7.22 For the larger sized switches of the E10B system produced in ITI's plant at Mankapur, the ex factory price per subscriber line varies from about US $280 to US $380 depending upon the size of the exchange \textsuperscript{23}. This is significantly higher than world market prices (US $200 to US $225).

\textsuperscript{22} In this range the larger manufacturers offer the use of remote modules resulting in a higher price per line for smaller exchanges compared to larger exchanges.

\textsuperscript{23} These prices relate to late 1991, hence an average exchange rate of Rs.28.00 per US $1.00 was used.
250), and even if allowance is made for higher priced inputs, the effective rate of protection coefficient would still be significantly high in the range of 1.2 to 1.3, that is about 20 to 30 percent higher than world market prices even if tradeable inputs were available at world prices. It is notable that indigenous equipment suppliers in China (in collaboration with foreign producers) are providing switching equipment for as low as US $150 per line. Clearly this suggests considerable inefficiency and adds significantly to the cost of expanding the network.

7.23 Over the past forty years, ITI has grown into an organization with twelve factories, located in six areas throughout the country. The company faces serious problems. It has been estimated that about 13,500 personnel (out of a total of 32,000) have become surplus as a result of the phasing out of the electromechanical switching production in Raebareli and Bangalore. It is hoped that this workforce can be absorbed by the introduction of new digital switching production in both places (line cards are presently being produced for the E10B system). An ambitious corporate plan has been developed to improve efficiency and expand output from 1990 to 1995 costing about US $700 million. It is not clear that this should be undertaken in the absence of a fundamental review of the corporate structure, its various cost centers and product range, and management system. The reliance by DOT on a single manufacturing source for switching has not served the network well, nor has the lack of competition helped ITI insofar that productivity and efficiency suffered. Now that domestic competition has emerged in terminal equipment and some areas of switching, prices have declined and the financial performance of ITI has been significantly eroded (the rate of return (net profit) on sales in 1990/91 was 1.7%).

Conclusions

7.24 The environment for domestic manufacture of telecommunication equipment has improved considerably over the past five years. Prices for much of this equipment have declined in real terms (and in many cases in nominal terms), and quality and technological capabilities have improved. The major difficulties concern the two large public enterprises, and most notably ITI. With regard to the production of the larger switches, the company is not efficient by world standards. Continued reliance on this company for the larger switches will inhibit network expansion and add to its cost. There are good elements in various parts of the corporate structure, and the firm is endowed with some highly skilled staff. In this lie the possibilities for change and an improvement in productivity and efficiency. In many respects, it would be better if the entity was restructured into three or four autonomous firms. This would ensure that the more viable parts were not constrained by the grossly inefficient. In any event, it is recommended that a very detailed corporate restructuring study be undertaken that focussed upon all aspects of the firms'
operations. This study would hopefully devise a viable corporate structure for the various components, together with appropriate programs for dealing with the overstaffing and estimates of the viability of capital restructuring and modernization.

7.25 A further major policy thrust should be directed at the tax and local cost structure of components that are supplied to the sector. Import duties on imported components should be progressively reduced, and firms given greater freedom to access these components and raw materials at close to world market prices. Furthermore, even where domestically produced components are available, firms should be given discretion to source their needs wherever they deem appropriate. Finally, serious consideration should be given to a reduction in the excise duties levied on the ex-factory prices of domestic production, and the import duties of finished products. Both factors add significantly to the cost of network expansion, and reduce the potential pace of this expansion.
Chapter 8

Strategic Reform Agenda

Introduction

8.1 The telecommunications network in India is highly inadequate both in terms of coverage and the quality of service. This inadequacy is in part a function of low levels of investment, but it is also due to an inappropriate policy environment and organizational structure for a sector that has been experiencing massive technological change over the past two decades. The approach of a single public sector provider of all services, coupled with largely inefficient public sector suppliers of equipment, has resulted in technological obsolescence, high cost and poor response to consumer needs. This infrastructural inadequacy represents a considerable constraint on all aspects of the country's economic and social development. Poor telecommunications adds significantly to transaction costs which undermines the country's competitiveness in the international arena and inhibits business development and investment.

8.2 The government is aware of the need to improve the quality and coverage of telecommunication services in India, and since the mid eighties, has sought to improve performance in a variety of components of the sector. In some areas, progress has been achieved. Domestic deregulation of manufacturing of terminal equipment and copper cables has brought forth new investment, and most importantly, led to significant improvements in the quality of equipment available and a lowering of prices. This has occurred in a relatively short space of time. The removal of investment licensing for switching equipment production of all exchange sizes, could also have a similar effect. To some extent this has already been witnessed in the growth of the production base for small switches. Furthermore, the foundations for an indigenous research and development capability have been laid and progress achieved in the development of materials and equipment and a broadening of the technical skill base.

8.3 Progress and policy reform in the delivery of telecommunication services however has been much more limited. A plethora of studies and committee reports, as well as numerous attempts at organizational fine tuning over the past two decades, has done little to cure inherent policy and institutional weaknesses. Throughout this period there have been massive generic changes in telecommunications technology that have not only transformed the range of services that could be made available, but also the methods of service delivery. Developments in transmission in particular, have brought about a lowering of infrastructure costs and a lowering of per unit service costs. This in turn, has transformed many of the natural monopoly elements inherent in earlier telecommunications networks, and made redundant or unnecessary, earlier organizational forms. This technological revolution both demands and allows, more flexible organizational arrangements that can more readily respond to consumer needs, in more cost efficient ways. The economically developing countries cannot avoid this trend, and indeed should welcome it, as it offers scope for innovative mobilization of investment resources, a more rapid
broadening of the network's coverage and a significant lowering of basic user costs.

8.4 Any policy reform agenda for telecommunications in India should, therefore, start from the basic premise that the present organizational framework is unsound and needs to be altered. This can be accomplished in a variety of ways, but it should be recognized that scope for service based and facilities based competition is possible and the policy framework should allow this. The basic model of service delivery by a monopoly supplier must be changed. Experience in a host of other countries, both the economically developed and less developed, has shown that this is technically feasible and administratively possible. Furthermore, liberalization in the provision of specialist services, or of basic services, is not inimical to the development of telecommunications in areas where the social need is high but the economic and financial viability may be relatively low in the early stages of development.

8.5 Beyond the acceptance of the possibilities for service based competition, it should also be recognized that for a network structure as large as India's, there is need for decentralization of management and decision making. Smaller operating entities, with a greater degree of operational and financial autonomy will reduce bureaucratic constraints, increase internal flexibility and ease difficulties of personnel management and human resource development. These smaller operating units would be more responsible to specific consumer needs and would have a greater capacity to be innovative in the development and marketing of new subscriber services. Furthermore, even though these smaller units may be confined to specific, geographic operating regions, with initial monopoly of PSTN within these specified areas, it would provide for demonstration effects across regions. If efficiency and coverage improves more rapidly in one region, as opposed to another, then State Governments, municipalities and consumers in the less efficient region would have more readily apparent benchmarks for comparison. This might make these subscriber groups more proactive and purposeful in pursuit of improvements in the quality of service. As it presently stands, potential users and existing subscribers accept the existing quality of service with the same fatalistic resignation that is accorded to the hot, monsoonal summers. Fortunately, the means and capacity to change the former is more readily to hand.

Policy Framework and Institutional Structure

8.6 A fundamental objective is to have a telecommunication development policy that is driven by consumer needs and not burdened by other policy objectives. The priority policy framework must be one that addresses a rapid expansion of investment in the network and an improvement in its quality of service, and provides appropriate "ground rules" for this to occur. This policy framework will be an evolving one but from a very early stage should allow for facilities and service based competition. Hence there is need of a mechanism that allows this policy frame to respond to the changing technology and subscriber needs. This in turn will require an independent policymaking body, supported by a modest secretariat, and
reporting to the cabinet and Parliament of the Central Government. The membership of this "Policy Board", in terms of size and composition, can be somewhat flexible, however certain fundamentals are necessary. Firstly, the majority of the members should be outside of government, and be representative of industrial/commercial and residential consumers, with possibly some representation from the academic community. Governmental representation could include the Minister of Communications (possibly as chairman) and senior members of Finance, the Planning Commission and other economic ministries.

8.7 Box 8.1 provides a possible structural option for the telecommunications sector in India, but it is readily recognized that other structural forms are possible. What is important however is that there is a delinking of the policy making function, from the regulatory and operating functions. The proposed "Policy Board" should be independent, with its own budget and with no line authority over the regulatory authority or the operating units. It's sole mandate should be to develop a policy framework and a strategic reform agenda with an implementation schedule. The policy entity should monitor this reform agenda, and adjust its content and timetable according to changing circumstances, technology and perceived developmental priorities. It should be noted however that the proposed "Policy Board" would not set investment levels, as this would be the prerogative of the operating entities.

8.8 The proposed "Regulatory Authority" would be guided by the broad policy agenda in ensuring that the goals set are not being thwarted or undermined by anti competitive behavior on the part of the operating units. This Authority should be independent from the operating units, but would have to have the capacity to monitor performance and have access to the necessary financial and operating data, in order to do so. Dependent upon the functional forms of the operating units (i.e. either regionally and/or service based; public, private or joint sector shareholding), the proposed "Regulatory Authority" would administer franchising and operating agreements, oversee interconnection practices, and where monopoly service elements exist, provide a price regulation function.

8.9 The "Regulatory Authority" would need to be staffed by highly competent technical staff, with a strong capacity to undertake price, cost and financial analysis, as well as assessments of service quality and contemporary technology developments worldwide and its implications for the country's telecommunications network. This Authority would need to liaise regularly with the policy making body, but should not be beholden to this entity for day to day operations. And, provided the basic framework of the policy is being adhered to, should have independent discretion in its administrative and oversight functions. Obviously, given its licensing functions, there would need to be complete transparency and clarity of decisions made, the procedures followed in reaching these decisions, and the guidelines and administrative rules utilized.

8.10 With respect to the operating units these would be discrete entities, with a corporate structure that allows for financial autonomy and accountability to the shareholder, whomsoever they might be. They could
be regionally based, service based or a mixture of both but it should be recognized from the outset that new entry and competition in the provision of services should be allowed. They would operate under a licensed regime granted by the "Regulatory Authority". Within this licensed arrangement, the service provider would have discretion to provide and enhance subscriber services, make independent technology and equipment choices, raise financial resources in a manner consistent with overall economic policy and impose tariff schedules in accordance with guidelines imposed by the "Regulatory Authority". Whatever the shareholding of these entities, the board of directors should reflect a wider, non-governmental membership.
8.11 The Government has undertaken a variety of reviews of the present organization with a view to adjustment of the present DOT/MTNL/VSNL form. The most recent (the Achreya Committee) submitted its report in 1991. The main recommendation of this committee was to break up the present structure into four regional operating public sector companies, with separate trunk and international connector companies, under a separate holding company. This approach has been rejected by the government and the trade unions involved. In particular, it has been suggested that this transformation would create pension, interest, insurance and corporate tax liabilities amounting to about Rs.90.0 billion over a four year period, and thereby was not financially feasible. These financial obstacles cited do not bear close scrutiny however. Asset transfers can merely reflect a "book entry" and can be transformed into public sector equity. Pension rights for all involved can also be maintained. The Central Government already has an accrued liability for those pensions. The payment of corporate tax is a requirement of all public enterprises, including those providing so called infrastructure services (eg. power). There is absolutely no prima facie case to suggest that the payment of such a tax out of net income will raise the cost of telecommunication services.

8.12 The Government needs to transform DOT. Devolution into a number of operating entities would be one possibility which would be both beneficial and feasible. Furthermore, following this restructuring, it could be speedily followed by a dilution of the public sector's equity stake in the various operating units. This could be achieved by a sale of shares to the general public, as well as to financial institutions (eg. mutual funds, as is presently being done for over thirty public enterprises) and other financial intermediaries (eg. pension and life insurance entities) which seek a fixed return or steady dividend income stream as part of their portfolio.

8.13 In conjunction with a restructuring of DOT, there should be a liberalization of entry by others who wish to provide telecommunication services. Once an appropriate regulatory framework has been established, the capacity for private sector investment in the network and system could be significant. This could occur in the areas of specific services (digital cellular radio, mobile telephones, data transmission networks), or could occur in the form of overlay networks in specific areas or competition in trunk transmission.

8.14 The options available for greater private sector involvement in the telecommunication sector are very broad. A dominant carrier can enter into a variety of franchising schemes to provide services on both a retail and a wholesale basis. For example, operating as a wholesaler, the service operator might enter into contractual agreements with independent entities that would undertake responsibility for installing facilities to link a subscriber premises to the operator's "interface point." This franchise agreement would establish technical standards for franchisees, a revenue division formula, and other marketing and operational obligations.
Labor Relations

8.15 As was discussed in Chapter 4, the labor elements within the present organizational structure have represented a significant challenge to organizational change. Furthermore, improvements in the quality of service, and the choices made with respect to technology and modes of service delivery, have been strongly influenced by the desire to accommodate labor concerns. Work standard practices and norms have changed slowly, and attempts to reform these have often been bureaucratically tedious and only partially successful. The trade unions have voiced strong opposition to organizational or structural changes, and have spoken out in opposition to any relaxation in the public sectors' monopoly in the provision of the full gamut of telecommunications services.

8.16 This is not to deny that some of the concerns and fears of the workforce in DOT/MTNL are not real. And, furthermore, the trade unions do recognize that the pace of technological change and the levels of consumer discontent are such that the workforce cannot remain aloof from this. Job security is a major concern, and if organizational reform is to proceed with a minimum of service disruption, then these concerns need to be given due weight. Therefore, any reform agenda would need to address human resource development issues. This could be addressed in a number of ways.

8.17 Whatever decentralized organizational form is adopted for the existing monopoly provider of service which gives operating units autonomy, the existing workforce need not change, and assurances can be given that the existing baseline of benefits will not be lowered or withdrawn. In return, the trade unions should accept that future working practices and norms, and productivity bonuses should then be subject to agreement between individual operating units and their employees. At the time of the reorganization it would also be useful to enter into a "Technology Agreement" with the workforce that laid down the parameters for accommodation to technology change. In this context, those made redundant by technical changes in the network (e.g. manual operators) would be eligible for retraining in skills within the individual's capacity and inclinations and which, of course, would be useful within the various operating units.

8.18 This implies that a more intensive retraining and skill upgradation exercise would need to be instituted within the existing training infrastructure. This infrastructure could be made autonomous, and would receive a part, if not all initially, of its revenues from the various operating units on the basis of cost recovery for individual staff trained. It should also be noted at this stage, that some of the courses offered could impart skills that are not only useful to the network, but would also find use in other sectors of the economy. For example, providing good word processing and data input skills could provide opportunities to certain categories of staff in a growing software and data management industry in India.

8.19 With regard to liberalization of and competition in the provision of services, and allowing a greater private sector involvement in this, could
open up opportunities for many members of the existing DOT/MTNL workforce. Not only will an expanded array of service activities be made available, which will be job creating, but the capacity for individual employees to establish their own businesses will be enhanced. For example, the scope for terminal equipment installation, wiring and repair could spawn a host of individual firms to carry out this function. Furthermore, the subcontracting of a host of outside plant activities could fulfill a similar role.

**Technology**

8.20 Any telecommunication system would benefit from certain pooled software resources related to operational standardization, testing, network design and optimization and economic cost benefit studies. Furthermore, existing progress made in equipment development and design (most notably at C-DOT) should be continued, if only to ensure that the full range of planned capabilities is realized. There is a large pool of technical and scientific manpower in the country which represents an asset that needs to be fully utilized. Therefore in the initial phases of a transformation of the telecommunication system in India, it is suggested that C-DOT keep its present form. The funding framework however would need to be progressively adjusted. The present system of royalties for equipment developed and supplied, is not sufficient for C-DOT's present research agenda, and would need to be supplemented from government budgetary resources. However, C-DOT should reassess some of its research and development priorities (for example its efforts in digital microwave equipment and optical line terminating equipment) to align them more toward the provision of some services on a commercial basis. In particular applied research, development and pilot experimentation could be undertaken on behalf of individual operating units or manufacturing units on a contractual basis. Furthermore the software and technical base is such, that considerable scope exists for the commercial development of customer specific informatics (the need for this in banking and parts of the transportation sector is well known).

8.21 With regard to the technology that is introduced into the network, the guiding principle must be to utilize the most effective, both in terms of cost and technical efficiency. Individual operating units must be free to choose the type of technology they wish to employ, subject to interconnection compatibility with the entire network. Tying the service provider to particular producers and equipment types, irrespective of cost and technical capability, will result in sub-optimal network development and significant network management problems in the future. The recent agreement between ITI and its foreign collaborator to produce a more efficacious digital switch (the OCB 283 of Alcatel) is a very positive development, but it is far from certain when such equipment will leave the factory. Furthermore, ITI has its own restructuring and efficiency problems that will need to be dealt with, which could entail a radical transformation of its present organizational structure.

8.22 The present C-DOT switch developments, as well as the E10B presently under production at ITI, can meet part of the needs of the Indian network
expansion. But from an optimal network planning perspective, they cannot meet them all. While the domestic production base is broadened, both in terms of technical capabilities and cost efficiency, it should be recognized that importation of appropriate equipment (most notably large capacity switches) is necessary. Not only would this ensure more effective network planning, but it would also encourage direct foreign investment, in conjunction with local partners, as the market potential is more fully perceived and the riskiness of such investment significantly reduced.

**Network Planning and Expansion**

8.23 Many of the problems identified with respect to network planning and expansion (material ordering procedures, project implementation, technological specifications and planning coordination practices), would be significantly reduced if there is a fundamental change in the policy and institutional structure. An environment that creates greater autonomy, accountability and competitiveness, with broader freedom in technology choice and equipment sourcing, will bring many of the improvements suggested in the conclusions of Chapter 6. Network planning practices for the trunk and metro areas could be guided by optimal technical and cost considerations, and as equipment availability improves, avoid second best solutions in the provision of subscriber services.

8.24 At whatever pace policy and organizational reforms proceed, a variety of reforms could be instituted that would improve network planning and expansion. Procurement procedures need to proceed on a multiyear basis rather than on a year by year ordering basis. The tender process needs to be revised to ensure that lower cost producers (and those with better quality and delivery records) are favored, and higher cost producers penalized. The allocation of orders should not be undertaken by administrative discretion once a certain price has been fixed by a tender process. The price preferences given to public enterprises (10% in the case of HCL and administrative discretion in the case of ITI) should be discontinued. There is urgent need to introduce an effective management information system and improve project monitoring and review processes (the system of Strategic Business Planning, with Annual Operating Plans will help in this regard). There is need for further study to draw up a comprehensive frequency plan for the microwave and UHF/VHF radio networks. And finally, there is need for an early review of traffic forecasts on the trunk network, taking into account the likely impact of the planned doubling of the rate of growth of local switching capacity and the planned improvements in customer access to the trunk network.

**Domestic Manufacture**

8.25 There has been considerable improvement in the policy regime supporting the domestic manufacture of telecommunication equipment. As it presently stands, investment is possible in every area of equipment production. And, subject to type and technical approval, is eligible to be sold to DOT. In terminal subscriber equipment, cables and, most recently, in the production of the C-DOT switches, considerable new capacity has emerged, costs have declined and quality improved. The
increased competition in these sub sectors has been beneficial to the consumer of telecommunication services.

8.26 There is limited international competition however and nominal protection levels are high. In effective protection terms, the efficiency of cable production in the more modern plants is good, and if they could obtain their necessary inputs at international prices, then these firms should be quite competitive by international standards. The decanalization of copper rod imports would be a significant advance in this regard. The same can be said of the production of smaller switches, with an ex-factory price per line (before excise and sales taxes) which already appears to be quite competitive. How long this price level may be maintained however is uncertain, as most small switch manufacturers are not breaking even at the present price and capacity utilization levels. Terminal equipment was not studied in this report, but recent export orders for push button telephones and EPABX systems suggest that the competitiveness of this subsector has improved considerably over the past five years.

8.27 All is not well with domestic manufacture however. There is considerable over capacity in cables and in smaller switches (also in terminal equipment), and some of these firms may not survive. There is scope for cable producers to export, provided inputs are made available at international prices and a considerable marketing effort is undertaken. The scope for small switch producers is somewhat less however, given the specificity of the C-DOT software, although there may be shorter term potential for PABX and EPABX systems. If the network expansion plans for the Eighth and Ninth Plan periods are realized however, then capacity utilization in the cable and small switches sub sectors should improve significantly.

8.28 The main difficulty in domestic manufacture relates to the public enterprises. They are significantly overstaffed, with a corporate and management culture that has suffered from three decades of monopoly production rights, with cost plus pricing systems that did little to constrain production costs, and insulated them from any form of international competition. In a fully competitive environment it is very unlikely that ITI and HCL would survive in their present forms. Moreover, notwithstanding their poor productivity and high cost structures, the quality of equipment produced and supplied has been deficient. Management of HCL and ITI are endeavoring to rectify the situation in their respective enterprises.

8.29 In the case of HCL, the transformation of dry core PCUT production lines to PIJF is far behind schedule. When completed however, the outlook for the company is somewhat improved. But if the firm were to compete equally with other domestic cable producers, considerable productivity enhancing measures would still need to be introduced, including a staffing plan that allowed for a progressive rationalization of staff size.

8.30 The problems of ITI are much more acute, and require more radical reformation. The company is geographically very dispersed, and its product base very broad. It undertakes many activities in internal departments
(eg. metal working and machining) which could more productively be undertaken on a sub-contracting or outsourcing basis. It has ambitious plans to increase its output of digital switching (particularly of the latest technology OCB 283 switch in technology collaboration with Alcatel), thereby utilizing the about 8000 staff made redundant by the closure of the Strowger production lines. Considerable uncertainty surrounds the enterprises' capacity to achieve this in its present organizational form, and considerable capital investments will be necessary to effect this transformation and modernization.

8.31 There are elements of ITI which do display better productivity levels, and there is no doubt that the organization contains many excellent managerial and technical staff. Herein lies...the capacity to effect beneficial change. To achieve this change however it would be necessary to restructure the public enterprise into a number of separate and autonomous firms. In this manner, rehabilitation efforts can be focussed upon those elements most in need of transformation. In the process of this restructuring into separate entities, the shareholding and capital structure could be adjusted by broadening the share ownership base to include the domestic private sector, the state sector, workers (in the form of employee stock ownership plans), the general public and foreign investment. Not only would this enhance managerial accountability, but it could provide some of the needed capital resources for modernization.

8.32 It is therefore an urgent necessity that a highly detailed corporate restructuring study of ITI be undertaken that encompasses all departments, its productive base, its staffing component and its financial structure. This study should provide a detailed plan of rationalization, together with appropriate corporate forms and an assessment of equipment requirements. It should also address human resource development issues and suggest appropriate mechanisms for early retirement for longer serving staff or retraining where deemed to be effective and feasible.

8.33 In the restructuring of ITI, the focus must be on the firm as a manufacturing unit, and should not be related to the policies and objectives of a reorganized network structure. In this context, it would be useful to have ITI report to the Ministry of Industry (as is the case for HCL) and not the Ministry of Communications and the Member Production of the TC. This would provide an improved environment of policy separation between the policies developed for network expansion and those necessary for a healthy, domestic manufacturing sector.

8.34 Ultimately, the domestic production of telecommunication equipment must be competitive on an international scale. This will only occur when domestic manufacture faces competition from foreign suppliers. To achieve this will require a gradual and progressive decline in the import tariffs applied to foreign sourced equipment. As this occurs, then import tariffs on imported components must also decline, as well as the protection afforded to domestic component producers. Domestic final equipment producers must be able to source their inputs and components in an internationally competitive manner if they themselves are to be competitive. The ultimate beneficiaries of this reform process of course,
will be the employees in the domestic producers, as well as the Indian telecommunication service consumers.

8.35 One final area of reform of domestic manufacture relates to the departmental factories presently under the control of DOT. As the organizational structure of the telecommunication system is transformed along the lines suggested, attention must be given to a change in the corporate structure of these four factories. Not much attention was directed at these units during this study, however at the time of overall organizational reform, it would be appropriate to either divest these entities to the private sector or reorient their shareholding to include participation by their respective workers.

Reform Timetable

8.36 There is a sense of urgency of the proposed reform agenda if the targeted improvements in service quality and coverage are to be realized. The first step should be the commissioning of the proposed "Policy Board" to both initiate change and oversee its progress. This could proceed speedily as little organizational adjustment is required. Once established, an initial, broad telecommunications policy reform agenda could be drawn up, which sets the broad objectives in telecommunications sector reforms and the policy parameters that will underpin this reform. A more detailed series of internal policy documents could then be addressed that covers the formation of the proposed "Regulatory Authority", and its terms of reference, composition, funding and legal authority. In parallel, a further policy document could focus upon the devolution of the present DOT/MTNL operational structure. A fundamental requirement of this policy agenda must be the allowance of service-based and facilities-based competition, the parameters under which this will operate and the mechanisms that will process the entry of private investment into the sector.

8.37 Once these policy initiatives are completed, a detailed timetable could be drawn up that would be monitorable by the "Policy Board", and by which the GOI can gauge progress in the reform agenda. With regard to the devolution and restructuring of DOT/MTNL, it may be necessary to establish a separate Task Force/Working Group to address the necessary legal, financial and labor elements of the proposed restructuring. It should be noted that if regional services entities are adopted, it is not necessary to have all the regional units formed at the same time. And, it is not necessary for the financial structures of these units to be the same. Some may attract a greater degree of non-governmental equity involvement than others, and no prior limits should be set for this.

8.38 For some parts of the DOT structure (training for example) there may not initially be a place for the unit as part of regional operating units. But, these parts would be able to provide a service to all the operating units. Therefore, it is proposed that a separate, independent structure, similar to that proposed for the domestic research complex, be created.
8.39 Clearly, the needed reform agenda is massive in scope and implication. It could not all proceed at once and problems in the implementation of it will occur. However, the important thing is to initiate the change process and to have a clearly articulated policy intent and objective that is seen to be carried out.
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**Policy Framework**

The present framework for the development of the telecommunications sector in India is deficient. The extreme centralization of service delivery, technology choices, equipment procurement, together with a policy of indigenization of technology development and manufacture inhibits network growth and quality enhancement.

Recent policy initiatives have sought to remedy some of the shortcomings of the present system. The manufacture of switching equipment has been liberalized (July '91). DOT has announced its intention to broaden the range of technology and type of larger switches that might be introduced into the network and for certain types of specialized services (e.g., mobile telephone) where private sector involvement is to be allowed. These steps are welcome, however, they are not occurring in the context of an overall policy framework of reform in the sector. What is needed is a telecommunications sector policy reform agenda that sets out a longer term vision of reform objectives and measures. There is an immediate need to allow for competition by private sector entities in the provision of facilities and services. This policy agenda could also address proposed organizational reforms of DOT and the policy and regulatory framework under which this will occur.

The proposed telecom policy reform agenda represents a "blueprint" for change. As this reform agenda is a precursor of any reform effort, it should be completed as soon as possible.
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<td><strong>Institutional Structure</strong></td>
<td>A fundamental tenet of the reform agenda must be a structural reform agenda that creates greater competition and accountability in the provision of services. Furthermore, there needs to be a dichotomy between the formation and monitoring of policy change, the regulation of service providers and the actual operators. As such, this requires three distinct bodies or groups: 1.) An independent Policy Board needs to be formed, composed of governmental and nongovernmental members. This should be established, with a modest secretariat, and be responsible through the appropriate Minister to the cabinet and Parliament. Its task would be to draw up the overall policy frame and monitor its adjustment and implementation. 2.) A Regulatory Authority independent of operating units should be established to oversee operating/purchasing agreements, interconnection practices, and where monopoly service elements exist, provide a price regulation function. 3.) Operating Units should be discrete entities, with a corporate structure that allows for financial autonomy. These entities should have discretion in technology choices, sourcing of equipment, range of subscriber services offered, and</td>
<td>This Policy Board would be responsible for drawing up the proposed telecom policy framework. As such, this Board should be established as soon as possible.</td>
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This Regulatory Authority could be formed following announcement of the policy framework agenda. The restructuring of DOT into Operating Units would follow the establishment of the Regulatory Authority.
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<td>Procurement of telecom equipment should be based on more competitive bidding processes. Tariffs on inputs and final products should be lowered. Both HCL and ITI need to be restructured, in conjunction with a dilution of public sector shareholding.</td>
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<td>Reduction in import duties on imports and final products should proceed progressively over a period of, say, three years. Restructuring and corporate strategy studies for ITI and HCL should commence as soon as possible, with implementation of needed reforms commencing thereafter.</td>
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<td>in domestic manufacture relates to the public enterprises. Both ITI and HCL are in need of significant restructuring.</td>
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Appendix 1:

TELECOMMUNICATIONS REFORM IN INDIA:
AN INTERNATIONAL PERSPECTIVE
This discussion paper was prepared at the request of the Indian Government to outline the implications of international trends for telecommunications reforms in India and presented to the Government in January, 1992. The paper was prepared by Hugh Lantzke and Ashoka Mody (IBRD) and Robert Bruce (consultant). Given that sections of this paper were utilized in the main body of the report, for completeness the entire paper has been reproduced here.
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EXECUTIVE SUMMARY

i. The economic reform initiatives of the Indian Government and worldwide technological and organizational innovations in telecommunications form the context of this paper.

ii. The benefits of telecommunications have been shown by international experience to be extremely important in the very areas that will feel the thrust of current Indian economic reform. The new industrial policy and prospective changes in India's trade policy make access to telecommunications services a key need for Indian businesses to be competitive in domestic and export markets. India's efforts to attract foreign investment will also be greatly aided by a first-rate infrastructure.

iii. In contrast to the huge and pressing demand, the availability of telecom service in India is limited. As new telephone connections have been provided, waiting lists, rather than shrinking, have grown dramatically. This vigorous growth in waiting lists is evidence of the enormous latent demand. Apart from the huge demand backlog, service quality in India is inadequate to meet the high standards required for data and facsimile transfer. Finally, in addition to the high demand for plain "old" telephone services (POTS), there is a growing, although unmeasured, demand for many specialized and "intelligent" services.

iv. A perspective based on user needs suggests a new cluster of pragmatically-driven policy initiatives that would accelerate the pace and efficiency of investment in the telecommunications sector, leading to the provision of services on the most rapid basis.

v. Modern technological developments have made it possible for several investors to coexist fruitfully, providing specialized services, extending the vitally important basic network, and providing competition to each other. Reduced economies of scale make it possible for investors to profit from even small telecommunications investments. However, the needs of Indian businesses and households are vast. Large infrastructure investments on a national scale, harnessing the energies of private domestic and foreign investors, will be called for.

vi. At the same time, the network operations of the Department of Telecommunications (DOT) could be allowed greater flexibility in their functioning so that the core existing operations could continue to contribute to the greater provision of telecommunications services.

vii. A policy that allows substantial private investment in the telecommunications sector and allows DOT greater autonomy and flexibility would have far-reaching effects not only on the telecommunications arena but also on national capital markets, and indeed on the very conduct of business and household transactions. Besides stimulating exports and foreign investment by bringing international partners in closer contact, the policy would have a profound effect on the efficiency of other infrastructure such as railways, road transport, and ports. Knowledge-based industries, of which software is only one element, would benefit tremendously, and new services not even currently visualized could sprout up.
viii. In our judgement, the benefits of such a strategy overwhelm the risks, although, as with any innovative strategy, risks do exist. The main concern would be that regulatory practice may not be able to keep pace with the needs and demands of investors. The regulator would need to ensure that the various networks interconnect with each other, that the dominant provider (which will for long be the Department of Telecommunications) does not use its newly acquired flexibility to price in predatory ways, and hence prevent entry, and that historical telephone tariff structures are gradually changed so that new investment goes where most needed.

ix. Without in any way minimizing the challenges posed, it seems fair to say that India could draw upon the considerable regulatory experience that has been acquired in many countries over the past decade. While no regulatory regime can be tailor-made to suit another country, elements of sound regulation do exist and have been well-tried. Simple, non-discriminatory principles for technical interconnection, and price-caps and price-floors to prevent the abuse of monopoly power are accepted as the critical ingredients for successful regulation. While much work will be required in adapting these principles to the Indian context, the task is technically straightforward and could be achieved within a short period of time.

x. The major prerequisites for successful telecom reform can be seen as involving four major spheres of activities that must be addressed in a balanced and comprehensive way.

(1) De-linking Domestic Manufacturing from Service Provision

xi. Telecommunications is a service where the value is ultimately determined by the gains made by the users through their effective use of the service. While seemingly a simple point, in practice this is not always the perspective adopted in the policy-making process in India. Specifically, the objectives of telecommunications hardware producers continue to loom large in policy discussions, leading to a diversion away from the central concerns of users.

xii. The rapid international pace of technical change and the possibilities of acquiring modern telecommunications hardware in a competitive international market are strong arguments against relying solely, or even primarily, on domestic capabilities.

xiii. Investment in telecommunications infrastructure will be severely dampened if it is limited by the availability of domestically produced equipment, widening the already huge gap in service capability between India and its major competitors. In particular, if private initiative is to be attracted to make significant investments in the telecommunications sector, the urgency of delinking manufacturing from service provision is only heightened.

xiv. The objectives of job creation and saving on foreign exchange, which are the stated reasons for promoting domestic manufacturing, are ultimately better served by providing telecommunications to users who can thus expand exports and attract foreign investment. Also, India's strong advantage in telecommunications software, systems design, and service provision needs to be capitalized upon.
(2) Restructuring Policy-making and Regulatory Mechanisms

xv. New institutional and regulatory arrangements to promote sectoral restructuring and ongoing expansion would be necessary. It is of overriding importance to separate a number of markedly different functions involved in the telecommunications sector. There are at least three functionally different roles that need to be de-linked: (i) setting overall policy for the telecom sector, (ii) regulating the activities of DOT and any new entrants in the telecom market, and (iii) managing the operation of the DOT network. When these activities are melded together, policy-makers often do not focus closely enough on the differing perspectives and conflicting interests involved in carrying out effectively each separate area of activity. A single authority for dealing with all matters related to telecommunications is anachronistic in today's context.

xvi. A separate policy-making body reflecting the interests of industry, commerce, and finance is needed and could be based on available international models. A new regulatory body with complete independence from all operators is also critically important.

xvii. This separation of powers suggests the need for refocusing the mandate of India's Telecommunications Commission towards improving the operations of DOT's network. The Commission seems well suited to devoting its considerable expertise to the challenging task of revitalizing DOT's network by expanding services, introducing new network ideas and concepts, and forming innovative partnerships to attract international expertise in a cooperative mode with Indian engineers and managers.

(3) Revitalizing DOT

xviii. The existing service provider, DOT, can be expected to play a major role for the foreseeable future and hence would benefit from restructuring and more autonomy. Many such steps have already been initiated by DOT; and more far-reaching changes are recommended in the Athreya Report. Experience suggests that the network's operational autonomy of the network separated from the Government--is a necessary prerequisite to its effective functioning. This would require the network operator to develop a new arms-length relationship with the Government of India. Where possible, some decentralization of DOT's activities, as recommended in principle by the Athreya Report, would also be beneficial.

xix. Moreover, DOT cannot be expected to keep pace with demand for new services unless it increases its self-financing capability through a range of efficiency-generating measures. Like other telecommunications organizations around the world -- British Telecom, NTT, the Dutch PTT, France Telecom, Deutsche Telekom -- DOT would need to develop new cost-accounting capabilities that enhance its ability to determine the costs and revenues of different lines of business and different segments of its operations.

xx. The reorganization process can, however, become very costly and controversial. Following in the footsteps of other still publicly-owned enterprises France Telecom, Deutsche Telekom, and the Dutch PTT, DOT could usefully find ways to approach this process through the creation of new
business units. New partnerships, either through franchising or through creating joint ventures and subsidiaries, could assist in a bottom-up process of restructuring. The experience of France Telecom in creating new filiales or subsidiaries is especially interesting and instructive.

(4) Encouraging New Service Providers and New Investment

xxi. A pragmatic focus on the needs of users suggests the crucial importance of attracting large new amounts of capital through new providers.

xxii. Competitive provision of value-added services using the existing infrastructure is being widely practiced, and this principle seems well accepted in India. However, where the basic infrastructure is limited, the provision of new services on the existing network would be limited by capacity and reliability constraints and would, therefore, have only a small overall impact.

xxiii. It is, therefore, of some importance that private initiative be harnessed to invest in the expansion and enhancement of the network. Private infrastructure provision through new techniques and media such as cellular telephones, paging, VSAT or private satellite networks, is practiced in many developed and developing countries. These networks are no longer being restricted to the provision of specialized services to closed user-groups. The wide appeal of the cellular telephone is only likely to grow as the technology advances. Steps are being taken within the European Community (EC) to liberalize the provision of satellite services, including their use in providing public-switched voice services where, as in the case of the neue lander in Germany, the basic infrastructure is grossly inadequate.

xxiv. In fact, a broader consensus is emerging now among policy-makers worldwide that new entry and competition are desirable, not just where new transmission media are used but even with respect conventional technologies for the provision of the core infrastructure. Indeed, in the U.K. and in other parts of Europe and even beyond -- including countries with small populations such as New Zealand and Australia -- support for monopoly provision of infrastructure, even at the level of local networks, has eroded. Thus, the area of consensus concerning the right role for private service providers is not static but is in a rapid state of evolution. Pragmatic and not ideologically-driven considerations rule the day in current discussions about future telecommunications policy.

The Next Steps. The following next steps are suggested:

xxv. The appointment of a high-level group with a mandate for recommending and implementing the reform program.

The constitution of the group should reflect the broader goals of the current economic reform, such as export competitiveness and greater economic efficiency. The Ministries of Communication, Finance, Industry, and Commerce, along with user representatives and technical expert(s) on competition policy could constitute the group. The appointment of such a group would be a strong signal to DOT and private investors on the future direction of change so that
they would start to make long-term plans to invest and compete in a new environment.

xxvi. The group would draft a broad policy statement on the future direction of reform.

The group would also determine the specifics of key policy measures; these would include the modes of new entry, regulatory pre-requisites in the form of specific decisions or creation of agencies to take regulatory control, and pro-active measures to encourage appropriate new entry. The group would also take action to initiate the change process. This would include managing the legal and administrative processes to establish the institutional prerequisites for orderly change.

xxvii. Once the change process has been initiated, two new institutions will be needed: (a) a permanent policy-making body with a strong technical secretariat and (b) an effective and independent regulatory body.

Taking advantage of international experience, the group would be able to make recommendations on forming appropriate bodies and drafting any necessary legislation.
I. INTRODUCTION

1.01 Telecommunications infrastructure is bound to be central to the realization of economic reform objectives in India. Modern telecommunication networks are already a prerequisite for international commerce and investment and are likely to become even more critical in coming decades. The efficiency of the financial infrastructure, transportation networks, and large and small business users will depend integrally on the availability of high quality and inexpensive telecommunications.

1.02 There is strong support in the Indian government for bold and imaginative initiatives for stimulating rapid growth of telecommunication services as a means of increasing the momentum and effectiveness of the overall reform program. According to press reports, the Minister of State for Communications has moved ahead of committee deliberations to announce the opening of cellular and paging services to private firms. If the pace of economic reform in other sectors is any guide, the structure of telecommunication services in India could and should change very rapidly.

1.03 This paper responds to a request from the Indian Government to outline the implications of international trends for telecommunications reform in India. The paper is not meant to provide definitive solutions and recommendations but to identify the key (i) policy, (ii) institutional, and (iii) market structure issues that are central to creating an efficient, self-sustaining process of change. The paper takes into account the experience of other countries in restructuring their telecommunications sectors; however, it is recognized that sectoral reform initiatives in India must be responsive to the institutional context of India as well as to the critical strategic objectives of the economic reform program now being initiated by the Government.

1.04 This is a good moment for serious consideration of telecommunications reform in India. Over the past decade, a whole assortment of off-the-shelf technologies have become available for ready use. Given the small size of the current network in relation to eventual needs, a rapid increase in investment could lead to the creation of a modern and efficient network. Thus, India could well leapfrog to advanced and cost-effective technologies if the appropriate effort were made.

1.05 However, the evidence of the past decade also shows that to leapfrog in a technological sense requires commensurate organizational and institutional leapfrogging. The challenge is for the adoption of new technologies to be accompanied by a parallel array of organizational and institutional innovations. Particularly in the Indian situation, where the needs are urgent, an imaginative policy that harnesses local and foreign capital and entrepreneurial energies is a prerequisite for capitalizing on the current opportunity.

1.06 In an increasing number of countries, the trend is to encourage the development of a telecom policy regime that allows significant new entry. In these countries, as technological limitations on entry have eased over time, substantial competitive entry has, in fact, occurred. In turn, entry has been
supported by regulation that ensures reasonable terms for network interconnection and controls the possibly anti-competitive behavior of the dominant providers.

1.07 Emphasis on greater entry reflects a shift in focus away from the concerns and priorities of service providers and telecom hardware manufacturers to the needs of users. This shift in focus could be appropriate for India. Telecommunications is a service where the value is ultimately determined by the gains made by the users through their effective use of the service. While seemingly a simple point, in practice this is not always the perspective adopted in the policy-making process in India. Specifically, the objectives of hardware producers and the current limitations of dominant operator continue to loom large in policy discussions, leading to a diversion away from the central concerns of users. Focusing on indigenous hardware production as a major concern could be especially deleterious at this time, when technological change is so rapid.

1.08 While a user perspective suggests the need for attracting large amounts of capital through new providers, it is equally important to take measures that revitalize the existing, dominant provider (India's Department of Telecommunications) through restructuring and fostering new partnerships with private capital.

1.9 The next section provides the background of Indian telecommunication needs, as the telecom sector embarks upon a major economic reform process; the section also highlights current availability and gaps, and the opportunities afforded by international technological developments. Section III describes the minimum institutional prerequisites for attracting new capital to the telecom sector, stressing in particular the separation of policy-making, regulation, network operation, and manufacturing. Section IV considers measures to revitalize DOT. Competition in value-added services and entry of private capital into basic infrastructure provision for both long-distance and local services is discussed in Section V. Finally, Section VI outlines the next steps.

II. NEEDS, GAPS, AND OPPORTUNITIES

A. Needs

2.01 Why does India need a profoundly improved telecommunications network in a hurry? The simple answer is that the benefits of telecommunications have been shown by international experience to be extremely important in the very areas that will feel the thrust of current Indian economic reform.

2.02 The new industrial policy and prospective changes in India's trade policy make access to high-quality infrastructure services, and especially telecommunications services, a key need for businesses to become and remain competitive in domestic and export markets. Foreign investment is known to be heavily dependent on a first-rate, widely-available and highly reliable telecommunications infrastructure. Such infrastructure is similarly a prerequisite for any serious export effort, especially as India diversifies and upgrades product quality.
2.03 Impact on Exports and Foreign Investment. Empirical studies have shown that both the quantity (lines per 100 people) and the quality (e.g., availability of digital communications links) of telecommunications are extremely important for generating exports and for attracting foreign investment (see Boatman 1991, and Wheeler and Mody forthcoming). Developing countries are even more dependent on a telecommunications infrastructure than are developed countries. Exports of products that are characterized by variable demand, such as garments, shoes, and furniture, are particularly sensitive to the availability of a telecommunications network. In addition, the export of intermediate products, such as automobile parts, require close contact with customers who are carefully monitoring their inventory levels.

2.04 As just one example, the Southern Provinces of China boast of extremely high-quality digital telecommunications services. This region has experienced extraordinary growth of manufactured exports in the past decade and has been extremely successful in attracting foreign investment.

2.05 In the Indian context, the stimulus from excellent telecommunications could be enormous, for example, in regions exporting labor-intensive but demand- and fashion-sensitive products. Tiruppur, a semiurban location in Tamil Nadu, exports $300 million of cotton knitted garments to the United States and the European Community and is now trying to become more active in product design and higher-quality garments. The rural town of Vaniyambadi, also in Tamil Nadu, exports $100 million worth of leather goods, and the village of Badaun in Uttai Pradesu exports $200 million worth of handwoven carpets. It is not uncommon to see international buyers in these locations. Access to international-quality telecommunications could give a tremendous boost to exports from such regions.

2.06 Furthermore, exports need access to databases concerning demand and pricing conditions in overseas markets. In turn, overseas buyers of Indian products and services need direct access to information about export products, inventory conditions, and pricing. While database access is critical, there is certainly a more basic requirement for communications via telephone and facsimile. For example, multinational corporations are managed on an integrated basis; and thus, where basic operational and financial information cannot be accessed or effectively transmitted, investors are likely to be wary about creating new centers of entrepreneurial activity.

2.07 Indian air transport and financial services firms cannot compete with multinational firms or even with the expanding firms from newly industrialized economies unless basic telecom infrastructure capabilities are equivalent. With telecom modernization and restructuring becoming the hallmark of a broader process of economic development in the Asian-Pacific region, India can hardly risk falling further behind in the telecom arena without severe consequences in terms of overall competitiveness.

2.08 Impact on Key Infrastructure Sectors. Telecommunications is also integral to the supply of other infrastructure. Financial institutions are the most obviously dependent on telecommunications, but railways, ports, and trucking services need telecommunications as an integral part of their business as well. Increasingly, international logistics (movement of goods, ordering, invoicing) are being driven through modern telecommunications (see Hans Peters 1989 and 1990
for a powerful commentary on the Indian logistics system and the role of data transmission in efficient logistics systems).

2.9 Inter-bank payments as well as payments within key industry sectors depend on access to reliable telecom infrastructure and open and liberal access to of telecom services. Future payment services are likely to develop based on electronic data interchange (EDI) capabilities that today are used largely to transfer inventory and order-related data among manufacturers, distributors and retailers. Credit card verification and transaction processing systems are also a critical component for the development of India's tourism sector.

2.10 Major harbors and shipping centers around the world are developing sophisticated systems for tracking freight and integrating shipping documentation into customs clearance systems. For example, a major logistics and tracking system is being developed as a joint venture of the Dutch PTT and the Port of Rotterdam. Similar systems are emerging in Singapore and Hong Kong.

2.11 Integrating the national market. Currently, India's huge internal domestic market is economically fragmented by limited transportation and telecommunications capabilities. Modern telecommunications can have a powerful impact on integrating the domestic market by making it easier to do business within the country. Often telecommunications can also substitute for transportation, creating the additional benefit of lowering the pressure on the transportation infrastructure and reducing energy consumption and pollution.

2.12 Just over a century ago, the Indian national market became integrated through the spread of the railway network. Telecommunications today are very much in a position to play a similar role--only the role of telecommunications is much more powerful because it not only integrates the national market but also links the national economy to the world economy.

B. Gaps

2.13 In contrast to the huge and pressing demand, the availability of telecom service in India is limited. Table 1 shows the availability of telecommunication lines per 100 persons for a number of countries. India consistently shows extremely low availability. What is more striking is that current Indian availability is less than what most competing countries -- e.g., Thailand, Malaysia, Mexico -- had over a decade ago. During the past decade the other countries have dramatically added to their infrastructure while Indian infrastructure has remained at a very low level.

2.14 This is not to deny the worthiness of DOT's efforts. DOT's performance, particularly in the past few years, has been impressive, given the severe constraints under which it has been operating. The task ahead, however, is very challenging, and all energies -- both in the public and private sector -- need to be harnessed. If demand for new telecommunications services from business and residential users is to determine and drive the availability of telecom infrastructure and services -- rather than supply constraints determining demand, as has been the case in the past -- Indian telecommunications policy will be successful if based on an array of new creative, pragmatic, but far-reaching policy initiatives.
Table 1: TELEPHONE MAIN LINES PER 100 INHABITANTS

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<tbody>
<tr>
<td>United States</td>
<td>38.57</td>
<td>40.91</td>
<td>48.9</td>
<td>50.58</td>
</tr>
<tr>
<td>Japan</td>
<td>30.33</td>
<td>35.20</td>
<td>38.17</td>
<td>40.68</td>
</tr>
<tr>
<td>South Korea</td>
<td>4.22</td>
<td>10.61</td>
<td>20.75</td>
<td>28.32</td>
</tr>
<tr>
<td>Singapore</td>
<td>13.87</td>
<td>25.34</td>
<td>33.29</td>
<td>36.56</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.59</td>
<td>0.89</td>
<td>1.67</td>
<td>2.09</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1.76</td>
<td>4.27</td>
<td>6.85</td>
<td>7.34*</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.17</td>
<td>0.31</td>
<td>0.44</td>
<td>0.49</td>
</tr>
<tr>
<td>China</td>
<td>0.36</td>
<td>0.47</td>
<td>0.70</td>
<td>0.79*</td>
</tr>
<tr>
<td>India</td>
<td>0.26</td>
<td>0.33</td>
<td>0.45</td>
<td>NA</td>
</tr>
<tr>
<td>Brazil</td>
<td>2.71</td>
<td>4.47</td>
<td>5.58</td>
<td>6.01</td>
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<tr>
<td>Mexico</td>
<td>3.32</td>
<td>4.25</td>
<td>4.55</td>
<td>5.57</td>
</tr>
<tr>
<td>Turkey</td>
<td>2.00</td>
<td>3.24</td>
<td>9.01</td>
<td>10.50</td>
</tr>
</tbody>
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* indicates value for 1988.


2.15 DOT faces a dilemma in seeking to fill the gap between supply and demand for telecom services. As new telephone connections have been provided, waiting lists, rather than shrinking, have grown dramatically. This vigorous growth in waiting lists is evidence of the enormous latent demand. In 1991, despite DOT’s adding 470,000 new lines, waiting lists grew by about 500,000 applications.

2.16 In short, in the telecommunications sector, estimates of unfulfilled demand are a moving target constantly requiring readjustment as new capacity is made available and as new requirements from users of basic telephone and data services emerge. In fact, this paper is based on the premise that the demand for telecommunications service in India is so great that no time needs to be devoted to measuring demand precisely. The Telecommunications Commission has set a target for increasing the number of telephone lines from 5 million to 20 million by the year 2000. It is likely that even double this number of lines could be used in a highly productive manner.
2.17 Apart from the huge demand backlog -- which, as noted, grows with the provision of each new line--service quality in India is inadequate to meet the high standards required for data and facsimile transfer. Poor quality is likely a consequence of chronic under-investment and poor maintenance throughout the Indian network. Another major problem is the poor quality of the cable network from the exchange to the customers' premises. In 1988 the number of faults per 100 telephones per month was about 20. In comparison, fault rates for developed countries are less than 2 faults per 100 telephones per month. India's call-completion rates for international services, which would generate substantial amounts of foreign exchange revenues, are also well below international standards.

2.18 Finally, in addition to the high demand for plain "old" telephone services (POTS), there is a growing, although unmeasured demand for many specialized and "intelligent" services. The problem, therefore, is not merely the aggregate gap between normal telecom supply and demand; the problem expands to include the need for increasingly specialized telecommunications services and users' seeking increased control over the conditions for all telecom services. As telecom services become integral to the operations of financial services as well as industrial firms, it is becoming more essential to increase the responsiveness of service providers. Meanwhile, vital data-related services that form the core infrastructure of modern firms in India's manufacturing and service sectors are impeded by the high cost of leased circuits, restrictive regulations, and poor quality local access circuits. The introduction of packet-switching services in India has been hindered by overly restrictive policies on the utilization of foreign-supplied hardware and software, for example.

2.19 DOT already recognizes it will not be able to meet demand over the next decade due to personnel, organizational, equipment, and financial limitations and hence will be compelled to ration services.

2.20 Organizational and personnel constraints were recently considered by the Athreya Committee and are being further reviewed by the Telecommunications Commission. The Bank's forthcoming sector report on Indian telecommunications will also present an analysis of options for reorganizing and modernizing the operational activities of DOT. These options are briefly reviewed in Section IV, and an argument is made for including public-private partnerships in the menu of options.

2.21 Another constraint on DOT is the Government's requirement for DOT to use predominantly locally-made equipment, which generally lacks the versatility, capacity and scale economies of more modern equipment. Unless appropriate imports are sanctioned, DOT will be unable to provide, at low cost and in timely

1/ Many businesses urgently need packet-switching facilities, X.400 messaging services, EDI (electronic data interchange) facilities, and paging and mobile services. To overcome these shortages, a number of bypass networks have been, or are being, provided to enable companies with local and international needs to transfer data. These include networks belonging to the Indian Railways, SAIL, the State Bank of India, ONGC, Reliance Corporation, and other private networks.
manner, the specialized services required by businesses (e.g., mobile telephones, packet switching, and so on) or will be unable to use the latest capacity broadband equipment and provide the high-capacity switches needed for the development of the large network proposed.

2.22 Finally, financial resource constraints imposed by the Government limit DOT's capacity to expand its network at the rate needed. This is a sector that can attract new resources and generate its own resources to a substantial extent. As such, pre-specified limits on the resources the sector is allowed to use seem inappropriate.

C. Opportunities

2.23 During the past decade when India was suffering from its underdeveloped telecom network, high-quality and increasingly cheaper telecommunications equipment was becoming widely available in international markets. The pace of technological development has been more rapid than ever, driven by advances in microchips, optical technology, and software. Core switching technology continues to improve at the rapid pace of semiconductor technology. Technologies, such as satellite and radio communications, that are specially relevant for large countries like India have also advanced rapidly (see Huber 1987).

2.24 These advances not only have made telecommunications cheaper, more reliable, and more versatile, they also have made it easier for networks to grow in a modular way without significantly sacrificing cost advantages. In other words, it is increasingly becoming privately profitable to an entrepreneur to develop small efficient networks (some of which may be connected to larger networks).

2.25 The development of "modular networks" through the utilization and interconnection of private networks may not only be an effective way to develop the Indian infrastructure, but may also be an area in which Indian "systems developers" can excel in offering new models and arrangements for telecom expansion in countries trying to modernize their telecommunications infrastructure rapidly. Such software-based networking capabilities are currently being reined in by the Indian government, however, because of under-investment in telecommunications networks essential to foster informatics services.

2.26 Nevertheless, this creates both an opportunity and a challenge. The opportunity exists to tap into internationally-generated knowledge at relatively low cost to upgrade the network as it is being expanded. The challenge is to create an institutional and regulatory framework that allows and encourages adequate investment.

2.27 De-linking domestic manufacturing from services. In many countries, such as India and Brazil, telecommunications policy has been driven by the needs of local equipment producers and service providers rather than by the user community. Strong constituencies of producers have come to dominate telecommunications policy-making. Based on countries' need to preserve foreign exchange, provide jobs, and develop local technological capabilities, producers have been effective in determining the services users receive.
2.28 This is inappropriate in today's context. A policy targeted at developing specific manufacturing sectors should not be able to surreptitiously run a telecommunications policy. India's need to de-link production from service provision was always important but is now becoming critical. The pace of technological change is such that even the largest international companies can hardly keep pace. International trade in equipment and exchange of knowledge are essential for all nations (for a useful discussion see Vietor and Yoffie 1991).

2.29 International trade in telecommunications equipment has grown rapidly in the last decade. Figure 1 shows the world trade in telecommunications equipment in relation to trade in capital goods. Telecommunications equipment trade has grown consistently faster than capital goods trade, which has itself been extremely dynamic. Many developing countries (especially the East Asian newly industrializing economies) have relied extensively on imported capital goods as a source of new technology; these same countries (even while fostering domestic manufacture) have also relied heavily on imported telecommunications equipment for upgrading their telecom network.

2.30 Growth in telecom equipment trade has occurred not only for technologically-simple products, such as telephones, but also in switching equipment and other more advanced telecom products. Over the past decade, the international switching industry has consolidated into about half-a-dozen major players who spend vast amounts on research and development. Consolidation reflects the economies of scale in research and development as well as in manufacturing. At the same time these firms are intensely competitive in selling their products. The beneficiaries are consumers all over the world who are able to receive the fruits of massive research at competitive prices.

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2/ Vietor and Yoffie (1991) note that in 1987, AT&T spent $360 million on research focused on central office switches; Fujitsu, the eighth largest spender in this league, spent $100 million.

3/ World trade in telecommunications equipment grew at the rate of 15.5 percent per year between 1970 and 1988, while trade in all capital equipment grew at 13.3 percent per year during the same period.
2.31 The objectives of more jobs, saving on foreign exchange, and local technological development, which are the stated reasons for promoting domestic manufacturing, are ultimately better served by providing telecommunications to users who can thus expand exports and attract foreign investment. In addition, opportunities exist within the telecommunications sector for production and technological development that lead both to domestic benefits and export growth.

One example of untapped opportunities is the production and export of simple, but high volume, telecommunications products. The liberalization of customer premises and cable production has led to significant competition and a decrease in the prices of these products. Potentially India should be able to compete with East Asian economies in products such as telephone sets, provided some capacity building occurs in skills, such as injection molding and quality control. These skills can bring broad benefits, as the East Asian experience has shown.

2.32 More important, by focusing on manufacturing rather than on services, India has failed to capitalize on its latent software skills. Even by conservative estimates, about 20 percent of the expenditure on switching is for software updates; in addition, much software is built into the switches (Vietor and Yoffie 1991). This is only one example of the huge international telecom software market that lies untapped. In addition, network planning is almost synonymous with software development. In all such cases, Indian firms and research organizations would need to form alliances with international firms. A few examples exist of Indian consulting/software firms having formed joint ventures or informal alliances with international telephone providers.

2.33 Two measures would enhance Indian software capability. First, by allowing new entry into various segments of the telecommunication network, a large internal software demand will be generated; the sophistication of the software required will increase as the quality and diversity of these services increase. Where new entry occurs through the formation of a joint venture with an international partner, these links will provide access to technical and market trends in the international marketplace. Second, India has a number of well-established and highly regarded research centers in the general area of computers and communications. These would need to be strengthened at the same time as their orientation is made more commercial. A possible mechanism for capacity building is discussed in Section III.

III. INSTITUTIONAL AND REGULATORY PREREQUISITES FOR ATTRACTING CAPITAL

3.01 An important lesson from the past decade is that institutional and regulatory reform is required to facilitate technological leapfrogging. Reduced government control over the dominant provider and competitive entry of new providers have been the central objectives of India's telecom reform process. While the dominant provider (in its still evolving organizational form) continues to add new technology to its network, the pace of change could likely be accelerated by allowing a much broader array of participants into service provision.
The consensus is that such competitive entry (or even threat of entry) has a powerful stimulus effect on the adoption of new and innovative technologies.

3.02 Entry policy may be seen not merely as an initiative to achieve the benefits of competition but also as a pragmatic tool to attract the maximum amount of investment capital for the telecom sector. If the policy goal is to expand investment rapidly and efficiently in the Indian telecommunications network, it appears inevitable that the capital and energies of domestic and international entrepreneurs will need to be harnessed to the fullest extent.

3.03 As we discuss below in detail (Section IV), new entry does not in any way imply a diminished role for the Department of Telecommunications (DOT). Indeed, a strong case could be made for revitalizing DOT and expanding its role through new partnerships with the private sector. It should be noted, moreover, that pro-competitive policies are often beneficial to established telecom operators such as DOT, since telecom operators then face a less intrusive regulatory environment.

3.04 To attract investors who could generate a self-sustaining process of change, the Government would likely need to provide a strong indication of its commitment to institutional and organizational change. These organizational prerequisites are discussed below, followed by a discussion of key issues which should be addressed to assure open entry and stimulate competition.

A. Institutional Prerequisites

3.05 A separate policy-making body and a technically sophisticated regulatory agency, both of which are fully independent from any operator, would be needed. The principle of separating policy-making, regulation, and operation is widely accepted and is the very basic and core requirement for telecommunications reform. The continued coalescing of these functions in the Telecommunications Commission could possibly be an impediment to reform in the Indian context.

3.06 Institutional specialization is considered desirable for three reasons. First, the tasks involved in each of the different functions require different skills. Second, an independent policy-making body provides the forum for presenting user interests in a strong manner. Finally, an independent regulatory body can prevent conflicts of interests among the various actors in the telecommunications arena.

3.07 Clear international experience is that change does not come from within the established telecommunications system. In the United States, AT&T fought its dismemberment to the last; even the regulatory agency in charge of telecommunications, the Federal Communications Commission, lost control of the process. Irrevocable change was brought about by the Department of Justice, through an antitrust case. In Mexico and New Zealand the lead was taken by the Ministry of Finance. In the United Kingdom the Department of Trade and Industry has been the vehicle for telecom change.

Appendix A discusses the technological underpinnings of competitive entry and presents evidence on the impact of competition on efficiency.
3.08 In addition, any reform process designed to accelerate growth would need to take account of the demand for investment capital. In this regard, the Indian investment banking community, as well as international organizations such as the International Finance Corporation, could play a very important role.

Policy-making Process.

3.09 Two aspects of the policy-making process need to be distinguished. The first deals with initiating and managing the transition, and the second relates to governing a more permanent structure.

3.10 An inter-agency coordinating group was established in the process of the Mexican telecom restructuring. It consisted not only of representatives of the Ministry of Telecommunications; but also officials from the Ministry of Planning and Budgeting, the Ministry of Commerce and Trade, and the Ministry of Finance. In Germany and in other countries involved in restructuring, such inter-agency groups have had a crucial role in the process. During Mexico's final critical phases of introducing new investment into Telmex, the Ministry of Finance took a leading role in collaborating with a state-owned Mexican investment banking group, Banco International, which retained international financial advisers and experts to oversee the process.

3.11 In the Indian context, a similar high-level group could oversee the reform process. In addition to the Ministry of Communications, representation from user ministries (industry and commerce), the Ministry of Finance, private user groups, and competition policy experts would be desirable. Since the task is a complex one, inputs from international experts experienced in the pitfalls of the reform process would greatly facilitate the transition.

3.12 Once the process has been initiated, a permanent policy-making body with a strong technical secretariat would be needed. In recent months, the Ministry of Telecommunications has taken the lead in promoting new investment by private entrepreneurs, which is line with international trends. One question is whether the Ministry of Communications can maintain an arms-length relationship with the government-owned telephone operator. If user interests are to be given priority, policy-making must have substantial inputs from user industries and user groups through well-defined channels and not merely in an ad hoc and consultative manner.

3.13 An option that could be considered is to locate policy-making in the user ministries. There has been only limited international experience with such an arrangement, but the limited evidence suggests that user groups can have an effective influence on policy-making. Two examples of such policy-making/advisory bodies are the telecommunications group in the U.K. Department of Trade and Industry and the National Telecommunications and Information Administration, an agency of the U.S. Department of Commerce that provides policy and technical support to the Executive Branch of the U.S. Government.
Independent Regulatory Agency.

3.14 Both conceptually and in practice it is necessary to make a distinction between policy-making and regulation. Policy-makers set the broad agenda based on the needs of users. Regulators ensure that the goals set by policy-makers are not thwarted by anti-competitive and/or inefficient behavior.

3.15 At a minimum, an effective regulatory structure would need:
- a carefully-defined element of independence from the telecom policy-makers and the relevant ministries;
- independence from existing and potential service providers; and
- creation of transparent and accurate accounting systems (e.g., definition of cost centers) in existing and new telecommunications firms.

3.16 In principle the anti-trust laws and executing agency can be used to perform the regulatory task (as in New Zealand); however, most observers agree that a specialized regulatory body is needed. An effective regulator needs core competence in: (a) regulatory policy; (b) price, cost and financial analysis; (c) assessment of service quality; and (d) administrative, legal, and information systems. (See Miller 1991 for more details on the skills needed for regulation.)

3.17 In most countries regulatory efforts are complemented by other independent bodies responsible for competition policy. In the United States, the Department of Justice is a regular intervenor in proceedings before the Federal Communications Commission. The Director General IV of the European Commission has also played a very constructive and dynamic role in defining the future parameters of telecommunications policy in Europe. Likewise in the U.K., the Monopolies and Mergers Commission must be consulted in revising and amending licenses issued by the Department of Trade and Industry and enforced by OfTEL, the regulator.

3.18 In all such cases, difficult and complex issues need to be tackled regarding the size, structure, and jurisdiction of the regulatory body. These are addressed once the basic principle of independence of regulation is accepted. One important issue of jurisdiction is whether the regulatory function should be centralized or whether regional/state regulators would be necessary. This need not be an either/or choice but may be a matter of sequencing. As competition increases and spreads to the local networks, regional regulation may be required in some form. (For a discussion of these issues and a description of international experience in this regard, see Appendix B.)

3.19 Another complex issue is whether the regulatory function should be performed in a wide consultative manner, with expert testimony called in to gather evidence, as is the case in the U.S., or whether regulation should follow predetermined administrative and procedural guidelines in arriving at decisions, as in the U.K. Both have their dangers, the first of prolonging decision-making and encouraging litigious behavior, and the second of arbitrariness. Once again,
the choice for India need not be a stark one between the two models. However, careful consideration will be required to arrive at the optimal combination.

B. Ensuring Fair and Efficient Competition.

3.20 If the goal is to attract private investment to the telecommunications sector, the regulator must ensure that there are no artificial barriers to entry. Barriers can arise because of the behavior of incumbent providers but are paradoxically often the result of regulatory goals and behavior.

3.21 To attract private investment, historically inherited relative prices would need to be changed. Specifically, local rates would rise as long-distance and international rates fall. Inherited price structures are often the result of re-distributive goals. To attract investment while also meeting re-distributive goals, transparent instruments could be developed that explicitly account for transfers made. Similarly, long-term technology development requires to be addressed through transparent instruments.

3.22 The regulator also monitors the potential abuse of monopoly power, which occurs when consumers are charged excessively high prices.

3.23 Above all, clarity and simplicity of rules is essential for attracting investors.

Regulatory Barriers to Entry

3.24 Barriers to entry are often a product of the regulatory regime. One important issue is whether entry should be restricted to a predetermined level of providers. International experience with entry has been evolving. Most countries have retained some regulatory control over entry either because it is believed that certain segments of the network exhibit characteristics of a natural monopoly or because it is feared that entry may be disruptive if fly-by-night operators can take advantage of unwitting customers and even damage segments of the public network.

3.25 One method adopted in some countries has been to allow a duopoly, which is seen as a transition to more competitive entry. As experience with competitive entry has accumulated, the fear of excess or disruptive entry has declined. At least in a few countries, the move to open entry is unmistakable, although entry policy does continue to vary by segment of the telecommunication network. Section V contains more detailed discussion of economies of scale and

2/ A recent report by the National Telecommunications And Information Administration argues that this is the more important source of entry barrier rather than any technological characteristics of the telecommunications sector. See U.S. Department of Commerce (1991). Crandall (1991) and several contributions to Cole ed. (1991) discuss the deleterious effects of regulatory entry barriers.
scope in different parts of the network and the implications for entry policy.

3.26 A view held by some competition policy experts (e.g., Greenwald and Sharkey 1989) is that even if a natural monopoly exists in a certain network segment, open entry is desirable to encourage innovation and prevent high prices for consumers. New Zealand has adopted the most open entry policy so far, but recent developments in the U.K. are potentially more important. After experimenting with a duopoly set-up, the U.K. has recently adopted a very liberal entry policy, for both its long-distance (trunk) and local markets. The following statement is illustrative:

"The Government is inclined to consider favorably applications for new licenses in all or part of the trunk network market. Each application would be considered on its merits, taking into account in particular the service proposed, the ability of the applicant to fulfill its plans, the extent to which it might result in more effective competition in the trunk market, the implications for competition in the local markets and the environmental impact of any request for Code powers".  

A similar statement has been made for local telecommunications service.  

3.27 It is not clear whether transitional market structures, such as duopolies, were adopted for administrative convenience or because it was believed that they were an economically optimal response to the nature of telecommunications technology. Those making decisions today, however, might consider seriously the possibility that entry policy will need to evolve with increasing experience and with changing technological circumstances. Thus it is desirable that the policy framework be flexible enough to allow decision-making to respond rapidly as new and better information becomes available.

3.28 Where entry is restricted, rent-seeking behavior is likely to occur. The costs of such behavior are well known. Over time, the most effective solution is likely to be a policy that creates a prima facie case for entry, subject to technical constraints such as limitation of the frequency spectrum and minimum performance requirements for new entrants. The review criteria would need to be clearly defined, the review process would need to be time bound, and the burden of disapproving any request for entry would need to be on the regulator.

3.29 As new entry occurs, it is likely, and highly desirable, that joint ventures be formed with international partners. In the last few years, international alliances in telecommunications provisions have become widespread and are likely to become the norm rather. This is because modern telecommunications services are highly sophisticated and dynamic. They need an

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A local loop connects a phone to the local exchange; a cluster of local exchanges forms the local network. A trunk network connects local networks.
expertise that is not only high calibre but that can continually renew itself by taking into account evolving developments.

Abuse of Monopoly Power to Deter Entry

3.30 Dominant suppliers can block new entrants by refusing to interconnect them to the existing network, a situation that is virtually fatal for the new aspirant. Dominant suppliers may also price in a predatory fashion to severely discourage new entry; having gained a monopoly hold over the market, they may then be in a position to exploit consumers.

3.31 Interconnection has two elements: technical standards and pricing.

(i) To interconnect, the technical standards of the two networks must mesh. In this regard, the prognosis for India is good, since internationally available standards can guide the evolution of the Indian network. Equipment producers worldwide are under pressure to conform to these standards because as telecom operators are increasingly exercising their prerogative to mix and match equipment from different suppliers. Thus, active participation in international standards-making bodies and the diffusion of standards within the country should be an important objective.

(ii) The other key issue is that even when technical interconnection is possible, the dominant provider may set an excessive price for the service. The price for interconnection is often referred to as the "access" charge. Particularly in the local loop (the service that links the ultimate consumer to the nearest exchange), monopoly is a real threat. The monopoly provider of this vital link could demand a price for interconnection that greatly exceeds his costs.

3.32 Ensuring that new entrants have access to endusers is, therefore, an important task of the regulator. Regulatory practice over the past decade has arrived at practical solutions to this problem. Typically, the entrant is expected to negotiate with the monopoly provider for terms of access to the dominant network. The parties concerned are required to negotiate in good faith.

3.33 The regulator's role lies in arbitration and dispute resolution. If negotiations fail, the regulatory body works within guidelines to enforce a connection. Ideally, regulators would require cost information from the dominant provider to determine the price that he should be charging for interconnection. This is one reason transparent cost accounting is important for effective regulation. If cost data are not available, the prices charged by the dominant provider for comparable services to other users can be used as the benchmark instead. Other benchmarks from local and international cost data are also sometimes used. In other words, although the interconnection issue is critical, technical and organizational solutions exist to allow greater entry.

3.34 Predatory pricing, or pricing well below long-run incremental costs, by a dominant carrier is also a threat to potential entrants. It is important to encourage DOT, as the dominant provider, to develop accounting systems that identify the long-run incremental costs of key segments of its business
operations. DOT’s reliance on separate subsidiaries could also facilitate the implementation of effective accounting systems and competitive safeguards. "Price-floors" based on benchmark costs can be used by regulators to monitor predatory pricing.\(^8\)

**Regulating the Dominant Carrier.**

3.35 A delicate balance has to be struck when regulating the dominant carrier. Certain discipline has necessarily to be imposed on the carrier to ensure that its commanding position is not misused; yet sufficient flexibility of operation has to be provided if the carrier is to grow and provide the services demanded.

3.36 In Mexico, Venezuela, and the United Kingdom, for example, the governments negotiated a concession agreement from the dominant carriers. The Mexican concession agreement included provisions relating to Telmex’s interconnection obligations, safeguards with respect to its participation in competitive activities, and provisions relating to its obligations to develop infrastructure and meet quality-of-service standards.

3.37 While regulation is motivated primarily by the need to prevent anti-competitive behavior, it should not be the case that the dominant provider is discriminated against. In fact, as discussed above, good reasons exist for strengthening the dominant carrier, particularly in the Indian situation where much of the network still needs to be developed and all efforts at doing so need to be harnessed.

3.38 The established service provider needs the flexibility to respond to the initiatives of new entrants. It must be able to respond to price cutting by new providers without being accused of predatory pricing practices.

3.39 Experience in the United States has shown that competition with excessive regulation is a severe damper on the growth of telecommunications. The growth of Regional Bell Operating Companies (RBOCs) is restricted under the existing regulatory regime even though these companies already face significant competition. Some commentators believe that these restrictions have been unwarranted and have unnecessarily reduced the growth of services (e.g., Crandall 1991).

**Rate Re-balancing for Attracting Investment**

3.40 Historically, in most countries residential and rural customers have been subsidized by business and urban customers. In turn, long-distance services have subsidized local services. As in other countries, such cross-subsidy has occurred in India with the dominant carrier. While the international trend has

\(^{8}\) "Price-caps", as distinct from "price-floors", become relevant when the dominant provider already has an unassailable monopoly position. See further discussion.
been to eliminate these cross-subsidies, cross-subsidies in India have grown in recent years as long-distance rates have been raised with the ostensible purpose of subsidizing other services (e.g., rural communications. See McDowell 1990.)

3.41 In a more decentralized and open-entry system, implicit cross-subsidies would have to be phased out as new providers offer demand and cost-driven services and as established entrants seek to respond competitively.

3.42 Rate re-balancing, or bringing tariffs more in line with long-run incremental costs, is a high-priority task. The rate structure has a major influence on how much entry and investment occur in particular segments of the telecom market. Re-balancing is of critical importance because, in the long-run, local infrastructure investment cannot be effectively financed through cross-subsidies from international and inter-exchange carriers. In addition, the rate structure has distributional implications.

3.43 The investment and distributional aspects of the rate structure should be kept analytically distinct. We first discuss investment issues (in this subsection) and then the distributional concerns (in the next subsection).

3.44 The introduction of competition directly, or through the emergence of services that are alternatives to the public-switched services of DOT, would begin to reduce the traditional margins associated with inter-exchange (long-distance) services. Moreover, in the future the contribution of international services to the pool of capital for new infrastructure development will begin to diminish as a result of recent internationally-coordinated measures that are reducing the level of collection and settlement rates for international services.

3.45 If cross-subsidies persist, inefficient entry is likely to occur. New entrants would be attracted to those segments of the market that generate high profits for the dominant carrier. However, since these monopoly profits do not reflect the social benefit of serving that segment, entry could be inefficiently biased toward that segment. In the Indian situation, the needs of the business community are so large that extra provision of services for these users will have very positive results; however, the neglect of local service provision--because there the dominant carrier is highly subsidized--could be harmful.

Brazil presents a recent example of major rate re-balancing. International phone calls from Brazil are among the most expensive in the world. International services plus domestic long-distance services substantially subsidize local calls. In 1989, real local telephone rates were 20 per cent of the rates in the 1970s. Since then, local rates have been raised very substantially, and the process of re-balancing is expected to continue. Such realignment of tariffs is viewed as an essential precondition for privatization of Telebras (the dominant carrier) and for attracting private investment (see Griffiths 1992).

21 The case for explicit cross-subsidies is discussed below.
Rate Re-balancing: Distributional Concerns

3.46 Legitimate social and long-term development objectives are part of any reform process. New policy initiatives would need to ensure the protection of critical societal necessities for some telecommunications services that might not be fully met through market-driven policies. In India, explicit subsidies would probably have to continue for a transitional period to support certain services (e.g., some local services, rural telecommunications, emergency services).

3.47 However, even in regard to social needs, India's current system has had limited success, and more efficient mechanisms likely could be put into place. Existing arrangements have produced neither the efficiencies of private sector management nor the benefits of a well-targeted scheme of public subsidies. Subsidies embedded in existing price arrangements are difficult to document and trace to assess their efficiency and societal consequences. Current policies thus may well be producing sub-optimal results both for those who can afford advanced telecommunications services and for those who cannot.

3.48 Certain social objectives may be set by the Government. These may include: access (which ensures that either public or private telephones are within reasonable reach of the population) and contingency plans for interconnection of networks (when the system fails). These can be achieved in two ways:

- It has been the practice (even in New Zealand, which has gone farthest in the reform process) to legislate a "golden" share for the government, to signify the obligation of telecom operators to provide reasonable access and even redundancy in the network in case of system failure.

- Tax-subsidy schemes could be useful, where certain services are taxed to subsidize socially desirable activities that would not be provided through competitive forces. The right way to approach subsidies would be to substitute open and transparent subsidies for the untargeted transfer payments embedded in DOT's current pricing structure.

3.49 Subsidies raise the difficult issue of defining the target group. The social objective clearly is to subsidize lower income groups. However, in practice this is not generally feasible. The subsidy could be restricted to new buyers of telecom services on the assumption that their incomes are, on average, lower than the incomes of those who already own phones. Moreover, the subsidy need not be provided to the end-user directly but to investors who develop networks in areas that would otherwise not be served. These are options that would need to be reviewed in light of economic efficiency as well as administrative ease.

3.50 Subsidies could be paid for by selling franchise rights to new entrants in regions where investment is clearly profitable. These could be set aside in an Infrastructure Development Fund. Initially, such a fund may be supplemented on a transitional basis through external sources. As such sources are phased out, they could be replaced by payments from a network-access fee.
3.51 In the longer run it is expected that subsidizing of socially desirable services will become unnecessary. This could happen even in the next decade. New technologies will make it more economical to serve dispersed users at low cost. Indications of such a process are already evident. For example, Bangladesh, three ventures (each with an international partner) provide local services in dispersed areas. Such private ventures, however, may need to cross-subsidize certain services within their jurisdiction, which will require flexibility in pricing.

Price Caps

3.52 Once subsidies have been largely eliminated and prices reflect costs, the overall rise in prices (particularly in monopolistic segments) would be monitored. Once again, international experience has allowed the development of basic principles of price regulation. Without elaborating these in detail, the rise in price of telecommunications services is usually restricted to a limit that is lower than the general price rise.

3.53 It is assumed that productivity gains in the telecommunications sector will be higher than in the rest of the economy, justifying the lower rate of increase in prices. The exact productivity factor that creates the gap between a general price rise and a telecom price increase varies and would need to be tailored to the Indian situation. In general, investors prefer such self-executing price-cap schemes, which provide limited leeway for politically-motivated price tampering.10

Research and Development

3.54 A telecom system requires certain pooled software resources related to operational standardization, testing, network design and optimization, and economic cost-benefit studies. Traditionally, these services have been provided by a research and development group of the monopoly provider. Under a more decentralized structure proposed, it would be necessary to ensure that these services continue to be provided.

3.55 A number of high quality research and development centers exist in India (e.g., Telecommunications Research Centre (TRC) and Centre for Development of Telematics (C-DOT)). These centers would be an obvious source of intellectual resources. However, the centers would also need to adapt to changed circumstances by developing a greater commercial orientation. Over time, many of the required services could be offered by the private sector. That such services can be provided on a commercial basis is demonstrated by the existence and viability of organizations such as Telecommunications Consultants of India, Ltd.

10 A large literature exists on incentive mechanisms in the telecommunication sector. These mechanisms focus on fostering efficiency and technical progress in the network while at the same time providing high quality service to customers. For a recent discussion on the benefits and limitations of price-caps, see Einhorn 1991.
3.56 Telecom structures are difficult to put into place and difficult to displace once in place. Therefore, a vision of where the system is going is needed. For this to occur, access to the best available knowledge on international trends in technology and organizational practices is critical. Two channels for such knowledge could be:

- Greater reliance on international alliances in service provision, as distinct from manufacturing, which has been the main focal point of discussion so far.

- Support of cooperative applied research, development, and pilot experimentation. In addition to TRC and C-DOT, bodies such as the National Informatics Centre (NIC) and the Centre for Development of Advanced Computing (C-DAC), could be reconstituted on a more commercial setting, and the intellectual capital embodied there could be exploited for new thinking on the development of the infrastructure. NIC's efforts in pioneering a VSAT-based satellite network are particularly noteworthy.

- Such centers could be financed partly out of a small tax levied on specified operators and partly through contracts. A parallel to this idea exists in Bellcore, the joint research body of the so-called "Baby Bells" in the United States.

IV. REVITALIZING DOT

4.01 The transition of a dominant provider could potentially occur in a number of stages, from government department to state or parastatal enterprise, followed by state-owned company, and finally varying degrees of private ownership (Wellenius 1989). Such transitions have occurred, and are occurring, in many industrialized and developing countries. Not all these stages need necessarily be gone through, and, indeed, some stages are being skipped by various countries. How the transition is effected is a matter of strategy based on the conditions prevailing in a particular economy and in the telecommunications sector.

4.02 Operators in large industrialized economies, such as the U.K., Japan, and Germany, as well as in smaller economies, such as Denmark, New Zealand, and Australia, have moved away from direct governmental control to increasing autonomy and, in some cases, to private ownership. In virtually all these cases, the respective governments have also introduced, or plan to introduce, varying degrees of competition ranging from competition in the provision of value-added and mobile services, to long distance competition via limited duopoly arrangements, and gradually to full liberalization of service provision.¹¹/

¹¹/ Services, other than plain telephone services, that use existing telecommunications infrastructure are traditionally termed "value-added". These include data switching services (usually packet switching), electronic mail, electronic data interchange (EDI), paging, video text, voice announcements, and a variety of banking services such as "point of
4.03 Within Asia, telecom utilities in Malaysia, Sri Lanka, Nepal, Papua New Guinea, and the Philippines operate as corporations. In Latin America, Mexico, Chile and Argentina have privatized the operations of telecom utilities, and most other countries in the region are contemplating similar moves.

4.04 Various other mechanisms are being used to stimulate telecom development and attract private capital in Asia. Pakistan, Sri Lanka and Thailand now permit private companies to provide mobile telephone services; Philippines has introduced competition in mobile and international services; Thailand has contracted a new supplier to build-transfer-operate (BTO) an additional 2 million new telephone lines in Bangkok and has sought proposals to let a similar contract for provision of lines in provincial areas. Indonesia is studying alternative methods for providing a comparable expansion of services.

4.05 This is not to suggest that the approaches adopted in other countries are wholly relevant to India. These examples are intended to suggest that an organizational upheaval is occurring in the telecommunications sectors of most countries in response to their needs and the evolution in technologies. Taking heed of these changes, India would want to develop a non-ideological and pragmatic policy response designed to attract new capital into the sector.

4.06 The Athreya Committee has made extensive proposals on the restructuring of DOT. These suggestions are very much in the spirit of international trends described above. It is not our mandate here to offer a critique of the proposals of that committee. However, a basic commentary on the proposals seems to be in order. These observations are not intended to supplant recommendations but to focus on elements of the recommendations that are least controversial.

4.07 The first element relates to the need for an arms-length relationship between the operator and government. A related issue is that a method of ensuring the accountability of the operator needs to be developed. Whether these objectives are achieved through corporatization and eventual privatization is a matter for examination in the context of sector reform and taking into account Indian realities.

4.08 Second, the principle of decentralization of activities, as suggested in the evolution of regional companies, is again a desirable one. As noted, the economies of scale in telecommunications networks have declined over time, and it is easy to conceive of regions in India that are large enough to sustain efficient telecom providers.

4.09 India was a pioneer among developing countries in experimenting with corporatization. The creation of the Mahanagar Telephone Nigam Ltd. (MTNL) was

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12/ About 98% of telecommunications operations in the Philippines is privately owned.

13/ Many more examples of restructuring and efforts to attract private capital are given in Ambrose, Hennemeyer, and Chapon (1990).
intended to decentralize operations and bring greater entrepreneurial initiative to telecom operations. MTNL has introduced several service innovations in the Indian context: telephone directories have been made more current, special facilities provided for customers to make telephone calls, better billing methods introduced, and design and construction of new buildings speeded up.

4.10 However, backlogs have not improved perceptibly. This does not imply that corporatization is irrelevant to the Indian situation. Rather, the limited success of MTNL reflects the lack of effective autonomy in technical, financial, and institutional aspects of their operation.

4.11 MTNL has been constrained by mandated equipment specifications and supply shortages. They can use only an E10B or ILT512 switch, and given the lack of production capacity in the former, their ability to expand services has been severely constrained. Sources and amount of capital raised from the capital market have been restricted. In addition, prices have been set nationally, rather than by the MTNL. The implication, therefore, is that for corporatization to be successful: autonomy of operation, including technology and equipment choice, is critical. Corporations must be able to raise resources and set prices. Implicit in this conclusion is the idea that foreign partnerships should also be autonomously decided upon by individual corporations.

4.12 Before privatizing its telecom utility, the New Zealand government first converted the utility into a corporation. This corporatization experience, while exceptional in some ways, offers interesting and instructive clues to successful public sector corporate operation.

- As the principal shareholder, the government set financial objectives; however, full financial autonomy in raising and managing funds was provided to the management.

- Government representation on the board of directors was completely precluded, and the directors instead consisted of distinguished private sector managers, user-groups, and labor.

- A chief executive with substantial international experience and wide knowledge both of technical and organizational matters was appointed.

These changes were regarded as central to high quality and autonomous functioning of the corporation.

4.13 **New Partnerships**\(^a\). In addition to conventional revitalization or restructuring, new energies could be brought into the organization through...\(^b\)

\(^a\) It should be noted that although the partnership schemes described are especially relevant to DOT, competing operators should naturally be allowed the same flexibility in forming innovative relationships.
collaborative ventures with local and foreign private capital. Besides expanding the network and creating new services, new partnerships are also a mechanism for solving the employment problems of a dominant operator, such as DOT. In addition, partnerships between the existing elements of the government-run network could help in rationalizing service and improving call completion rates.

4.14 Among newly industrializing economies, Brazil has recently made a concerted effort at crafting public-private partnerships. Mr. Jose Ignacio Ferreira, President of Telebras (the partially state-owned dominant carrier), is reported to have said: "We will not only tolerate private investment [in the sector], we want to attract it." Significant portions of Brazilian network construction have been contracted out to private business (See Griffiths 1992.)

4.15 Three types of partnerships are possible for India's telecom. First, DOT, or its regionally spun-off companies, could form new business ventures in collaboration with private parties. These could include some of the new ventures described in the next section, such as regional overlay networks. Publicly owned telecom operators like FranceTelecom, Deutsche Telekom, and the Dutch PTT have found innovative ways of approaching the restructuring process. Rather than take head-on a difficult and controversial task, they have used a more decentralized and incremental approach. This has involved the creation of new business units in partnership with specialized experts or sources of private capital.

4.16 Second, a specific contractual relationship for extending the DOT network, which we describe as franchising, makes economic sense and could also assist in tariff reform. Under a franchising scheme, the telecom operator would organize itself to provide services both on a retail basis (directly to subscribers) and on a wholesale basis. Operating as a wholesaler, the telecom operator would enter into contractual agreements with independent entities that would undertake responsibility for installing facilities to link a subscriber's premises to the operator's "interface point." The franchise agreement would establish technical standards for franchisees, a formula for dividing revenues, and other marketing or operational obligations imposed by the franchisor—the telecom operator.

4.17 A franchising scheme of this type is particularly relevant for the local loop, and its implications for tariff reform are discussed in Section V.

4.18 Creating new business units as franchisees through contractual ties could provide the telecom organization new flexibility and energy. Employees could be permitted to keep their pension and employee rights but would be encouraged to strike out as entrepreneurs. Employees who become entrepreneurs as franchisees could ultimately acquire shares in the telecom organization, not because of their past service to the telecom operator, but because of their current contributions to establishing new income streams for telecom operators.

4.19 Third, particular relationships within the existing set-up, such as between the international carrier Videsh Sanchar Nigam Ltd. (VSNL) and MTNL, make economic sense. VSNL suffers from a call-completion rate that is approximately half the level of international carriers in many other countries. This low call-completion rate deprives VSN and the Indian telecom sector of significant amounts of foreign exchange.
4.20 VSNL, possibly through a joint venture with MTNL, could construct national access trunks for international circuits. Such an investment might result from the formation of a joint venture with VSNL's most significant overseas correspondents -- for example, British Telecom, AT&T, NTT, Teleglobe Canada, France Telecom, Deutsche Telekom. These carriers might contribute investment capital for overlay facilities in order to increase call completions and revenues from international calling.

4.21 For their part, foreign carriers would undoubtedly be interested, in seeing VSNL adopt a more demand-oriented pricing scheme to stimulate higher calling volumes. The motivation for this type of foreign investment would be less an effort on the part of foreign carriers to participate in management and operations than to increase the profitability of international telephone services.

4.22 VSNL clearly is prepared to invest in infrastructure beyond the international gateway switch. Integration between the international and domestic elements of the Indian telecom sector would be quite consistent with international trends. For example, OTC in Australia has been merged with Telecom Australia, while British Telecom and AT&T are integrating their domestic and international networking activities.

4.23 Government revenues. An area of policy concern is the impact of the greater DOT financial and operational autonomy might have on revenues derived by the Government from the telecom sector. This concern ought to be addressed candidly if the sectoral reform process is to proceed on a vigorous basis.

4.24 The factors that will need to be considered are as follows:

- The government will receive from the DOT, and any new corporate entrants, revenues based on the corporate tax rate.
- The government will not have to find funds for capital financing and other expenditures.
- The larger benefits are expected to be immense, raising the overall tax base. In particular, the creation of new sectors providing services that do not currently exist will lead to both job creation and increased revenues.

V. POTENTIAL FOR PRIVATE SECTOR INVESTMENT IN INDIAN TELECOM

5.01 An underlying premise of this paper has been that rapid expansion of telecommunications services will be greatly facilitated by the entry of private service providers. This raises three sets of questions. First, what are the mechanisms needed to ensure that private entry will occur in a socially productive manner? Second, will there, in fact, be sufficient interest on the part of private investors to enter this new and possibly risky area? And finally, related to the second issue, can private investment really make an impact, or are the new, modular technologies relevant only for niche uses?
A. Productive Private Sector Investments.

5.02 Private investment could take many forms. Small investors may be interested in minor extensions of the network in a franchising arrangement with DOT. Large investors may seek to create new networks that operate in parallel to the existing networks and yet interconnect with the existing network infrastructure at so-called interface points. Other networks could open up new areas not at present served by telecommunications: rural networks are an example. In doing this, private investors would use a mix of technologies, some conventional and some new and cutting-edge.

5.03 It is not easy to predict the form and geographical coverage that new investments might take. For this reason, it is crucial (as discussed in Section III) that a clear policy decision on interconnection standards and pricing be made at the earliest to allow new networks the possibility of linking with the existing network, such that the total network size rapidly expands. In practice, full interconnection will not always be necessary, since some users will require only self-contained closed networks, such as those that link various branch offices of a large firm.

5.04 Rate rebalancing (also discussed in Section III) will influence the segments of the telecom market to which investors are attracted. Competition in international and long-distance services can be expected to lower prices in these segments. If the subsidized rates offered currently by DOT for local services are gradually eliminated, greater investment will occur in the local segment.

5.05 A fear is sometimes expressed that new investors could disrupt the network if they are allowed to invest in an uncontrolled manner. In practice, such fears are probably exaggerated. Apart from the normalizing role played by the regulator, small entrepreneurs building links to the dominant operator would be disciplined by the interface standards set by that operator. More substantial investors would have little incentive to set up networks that are not able to communicate efficiently with other networks. In addition, bankers and financiers of such large projects are likely to act as disciplining forces.

5.06 Will the Private Sector Respond? On the basis of international experience and a brief survey during the mission in November 1991, we can expect the Indian private sector to respond in a significant and efficient manner to a more open telecommunications regime. Despite existing constraints, private initiative has not been absent. A sign of pent-up private interest is the large investments being made by users even within the constrained system (e.g. SAILnet and SBInet). Some investments are being undertaken within the existing rules, others are skirting the rules and implicitly redefining them. Significant examples exist where the private sector has persisted in conceptual and technical development of major investment initiatives in the expectation of an eventual regime that allows greater entry.

5.07 Thus, our impression was that credible providers of telecommunication networks are ready to make substantial investments, that users have well-articulated needs, and that the capability to use communications technology effectively for strategic business purposes exists widely. After discussing some
of the basic forms of private sector participation, we will provide numerous examples of potentially viable private telecommunications investments.

B. Technical Characteristics and Viability of Competitive Investment.

5.08 It is common to distinguish between two forms of investment in the telecommunications sector. One is in the area of so-called value-added services. These are specialized services that can improve the effectiveness of the communications network, especially for commerce. Under such service-based investment, new entrants do not build the basic infrastructure; instead, they use the existing infrastructure to provide additional services. The measures that need to be addressed in liberalizing this area are well known by many countries and could be readily made available to Indian policy-makers. The focus of the European Community's Green Paper on Telecommunications, for example, was on regulatory mechanisms for encouraging service-based competition.

5.09 It seems very likely that substantial investment would flow into the development of value-added services in India if current regulatory restrictions could be removed.

5.10 However, when basic infrastructure is unavailable or of poor quality, service-based competition can have only a small overall impact. The challenge for policy-makers is to stimulate a rapid flow of investment into the core telecommunications infrastructure as well. Private capital and entrepreneurial energies could be harnessed for this purpose.

5.11 The other form of investment involves the creation of facilities or networks to allow entry of international/long-distance/local service providers, supplementing and competing with DOT's network. While the first type of investment improves the value of the network, the second would aim to rapidly increase the size of the network and the number of consumers provided with basic service. It is a more complex task to administer and regulate network expansion; however, mechanisms for allowing effective open entry are also well proven, and readily available to help India tailor an open entry system suitable for its needs. If all economically viable proposals are given a fair opportunity to prove themselves, private sector investment would be unleashed to the maximum extent.

5.12 Each of these thrusts is discussed below in further detail. We should, however, reemphasize that the beneficial effects of competitive entry would only accrue if DOT were revitalized and, in the process, its goals reoriented toward meeting user needs. As discussed in Section IV, this would require that DOT be given autonomy in investment and pricing decisions. Also, if DOT's long-distance and local services were separated, as could occur

\[\text{12/} \] As discussed above (paras 3.53 and 3.54), such autonomy should be subject to price caps (to prevent excessive prices charged to customers) and price floors to prevent entry deterring practices. Other providers would be subject to the same constraints.
under the recommendations of the Athreya Committee's report, it would be appropriate to require a similar separation in the operations of new competitors.

5.13 In the rest of this section, therefore, the focus is on conventional facilities-based entry and investment. Within facilities-based investment, a distinction is often made between local and long-distance networks. The local loop connects the final consumer to a local telephone exchange. These loops and closely clustered local exchanges form local networks. Exchanges and trunks connecting geographically dispersed local networks form the long-distance part of the network.

Long distance.

5.14 Competition in international/long-distance telephone services is now well established, even in relatively small countries. Economies of scale are not sufficiently large to warrant a single provider in a large country such as India. Indeed, it is likely that more than two providers could operate economically in this market segment. Multiplicity of providers is particularly relevant when it is recognized that some of the operators will provide distinct services tailored to particular user groups. An open entry policy is, therefore, a well proven option. Once long-distance competition is permitted, competition in the provision of international services logically follows.

Railways

5.15 The process of generating sufficient competition in telecommunications can be a slow one since firms must take time to develop business plans and implement them. Without in any way restricting other possibilities, one mechanism to jump-start a competitive market would be for a venture to use the right-of-way already held by Indian Railways. Such a venture could draw upon both international and domestic capital and expertise. In addition, other specialized providers that target specific user groups would contribute to a competitive market structure. (See Appendix C for a further discussion on the role of the railways.)

Other Providers and Networking Concepts

5.16 At this point it is useful to comment on other Indian networks that are potentially national in scale. A satellite-based network, NICNET, already covers all the districts of the country. Established and run by the National Informatics Centre (NIC), this network uses very small aperture terminals (VSATs) and, in fact, was an international pioneer in the use of this technology. In the past five years, the technology has evolved rapidly, making it possible to use much smaller terminals and thus substantially lower the cost of using this medium as a public carrier. The network is currently used for data transmission within the Government, by an increasing number of public sector firms, by educational institutions, and on an experimental basis by the public through coin-operated booths. Similar networks in the United States and Europe have been rapidly upgraded for a variety of uses.

5.17 In the light of willingness and available resources in the private sector, it may be unnecessary for NIC to invest in and manage a nationwide public
data network; NIC has played an important seeding role and could continue to provide technical consultancy from the expertise it has developed thus far. However, the investment and management of such a network could benefit from the skills of an experienced operator familiar with running modern data networks and a joint venture operation, or sale of the network could be considered.

5.18 In India other public enterprises and private firms are developing networks consisting in part of lines leased from DOT as well as certain of their own facilities. For example, one major business concern has to do with the process of installing an integrated voice, data, and video network that would use satellite technology; the network is intended as a vital link for logistical control of firms' activities throughout the country. Immediate action on a pending proposal to liberalize interconnection of private networks and leased lines with the public switched network would signal an important commitment by the Government to the liberalization of the telecom sector.

5.19 Networking capabilities installed by large firms can also be used by other firms located in areas where the large firms operate. Arrangements to share basic infrastructure investment with other firms -- and even nearby communities -- can assist in the overall development of the telecom infrastructure. Public infrastructure can thus be constructed in a modular, or "tinker toy," fashion.

5.20 Some years ago, in collaboration with DOT, the Confederation of Engineering Industries ("CEI") surveyed the largest Indian business firms to determine the possibility of developing an overlay network for business users. Apparently no steps were taken by DOT to follow up on this idea. More recently, representatives of large Indian industrial groups and major foreign operators have expressed their interest in participating in an overlay network linking major urban centers in India. Such a network might involve investment by a wide range of Indian businesses as well as a consortium of foreign investors.

Local Competition.16/

5.21 To meet local demand and alleviate key bottlenecks, new ventures in the local loop will be required. These could be either private partnerships with DOT or independent competitive ventures. More important, many areas of India continue to remain unserved, and here local entry could usefully supplement DOT's efforts. Removal of regulatory barriers to rural communications would be a prerequisite in this regard.

5.22 Internationally, competitive entry in local services is increasing gradually. There exists some debate on whether local services are a "natural monopoly", i.e., whether a single supplier will always provide services at the lowest cost. Evolution of technology suggests that local competition is now partially viable and will become increasingly workable over the coming decade (Huber 1987, Faulhaber 1987, Fowler, Halprin and Schlichting 1986). Some

16/ See also Appendix D for a further discussion of some local competition issues.
analysts contend that the appearance of natural monopoly arises more from existing regulatory constraints on entry rather than from more fundamental technological reasons (U.S. Department of Commerce 1991). Competition in the local services is permitted in England and New Zealand and is being introduced to a lesser extent in Australia, Thailand, Poland, and Bangladesh.

5.23 Those favoring greater competition at the local level argue that even if a natural monopoly exists in a technical sense, no harm is done by allowing the possibility of greater entry. The strongest policy-making advocates of open entry in local telecommunications have been the U.K.’s Department of Trade and Industry (see DTI 1991) and the National Telecommunications and Information Administration in the U.S. (see U.S. Department of Commerce 1991). The positive result of the threat of entry would be to keep an incumbent supplier on its toes and increase efficiency (see Greenwald and Sharkey 1989).

5.24 In the Indian context, new entry at the local level may be essential if the demand for telephone services is to be approached within the next 10 to 20 years. Two facets of new entry could be considered: new monopoly entry could be permitted in unserved areas, or competitive entry could be allowed. Many countries allow multiple operators to provide local service. Usually each operator is allocated a specific franchise area over which it has monopoly control. In India, where service is often available only on a patchwork basis, options exist to allocate specific and sometimes very small franchise areas to new entrants. It may be even be reasonable for DOT to sell its franchise in some areas to new entrants eager to establish a foothold.

5.25 A bolder measure would be to allow competitive entry, as in the U.K. and New Zealand. One attractive opportunity for new entrants would be to rely on radio to provide local services in major cities. Using radio, attractive mobile and fixed cellular services could be offered to business and residential consumers in urgent need. Bypassing the underground cable loop would minimize working problems and enable the fast service.

5.26 A new operator of this type would likely interconnect its special exchanges with DOT’s network at each city. Starting from local service provision, some of these new entrants could grow to provide more comprehensive service in alliance with other operators. Initially, the entrant could lease DOT circuits to provide intercity links as required. Through alliances with foreign international operators, the new entrant could also provide its own international access for both incoming and outgoing calls.

5.27 Using local-loop radio would permit the new entrant to mobilize service quickly with minimal capital. Its rate of growth, however, would depend upon attracting new consumers, and in this regard its costs would depend heavily on whether it has full access to the DOT network at fair interconnect prices. Demand would also depend on whether DOT consumers were to choose the new entrant as their national or international carrier. Under fair competition, the new entrant should soon attract enough traffic to build its own intercity long-distance network. In doing so it could reduce infrastructure costs by sharing networks with the Indian Railways or other large corporations.
There are three additional possibilities. First, apart from urban areas, private investment in provincial telecommunications is becoming an increasingly viable option. Recent studies for Pakistan indicate that stand-alone provincial telecommunications development can be commercially viable under certain circumstances. In many cases it would be uneconomic for more than one operator to service a given rural community group or area. Second, certain specialized regional overlay networks could meet the needs of specific user groups. Third, franchising could be effectively used to extend the network.

Rural telecommunications

Penetration of telephones into India's rural areas is so far minuscule, and rural users have legitimate economic, social and life-support needs that are not being met. A need is, therefore, often expressed for continual subsidy of rural consumers and hence for government monopoly that charges high rates elsewhere to subsidize rural consumers.

However, the low penetration of telephone services into rural areas has probably been overly influential in determining telecommunications policy. Three points need to be made in this regard. First, many rural consumers can pay relatively large sums for telecommunications connections, and the need for subsidizing them is not likely warranted. The Government policy of dispersing industry has had the effect of relocating substantial industrial firms in rural areas, and connections rather than subsidies are what they require. Many such firms are willing to finance communication networks either by themselves or through cooperative ventures. A regulatory framework that prevents such investment is the principal barrier to the growth of such communication networks.

It is important to note here that if regulatory barriers to private investment in rural communications were eliminated, the resulting networks would be in a position to supply at least some of the socially necessary telecommunications services at a small marginal cost. For example, the Steel Authority of India has a network that currently is used only for specified internal uses. This network could, at low cost, be used for certain emergency services for a wide population base in the areas covered by the network. Such service provisions could well form part of the regulatory framework and would not necessarily create onerous conditions for potential investors.

Second, rural investors are often in a position to make substantial investments. Most of their investment is now channeled into industry, transportation, and entertainment. Investments in public call offices and other telecommunications services could easily originate from rural investors.

Finally, new technologies have emerged in the past decade to make rural communications increasingly cheaper, and such developments are likely to continue. Digital cellular radio, very small aperture terminals (VSATs) for satellite communication, and wireless local loop are some of the technologies that are directly relevant for rural communications.

It may well be the case that despite these features, certain continued subsidies are needed for rural coverage. In that case the subsidies should be made explicit, as discussed in Section III.
Other examples of local/regional networks

Regional efforts to develop networks are also relevant. Over the past five years or so there has been an important effort supported by the State of Maharashtra to establish a business network linking major industrial parks and urban centers within this state. The proposed network was to be undertaken through a joint venture involving Mahindra and Mahindra, British Telecom, and, potentially, other investors. However, this proposal has foundered in talks with DOT, which underlines the need to separate regulation from operation.

Further, paging and cellular services can make an immediate contribution to filling the needs of the business community. For example, at low cost, paging services can give brief messages to subscribers in areas with telephone shortages. These users can, if necessary, use phones available for public use to respond to the person paging. This arrangement increases the efficiency of the existing telephone service. For DOT to make a major commitment in this area may represent a diversion of scarce capital and managerial resources from developing basic infrastructure. On the other hand, private entrepreneurial energy is ready to target the development of such systems now.

In many countries in central Europe, cellular systems are being deployed on a high-priority basis to relieve severe deficiencies in the existing basic telephone system. Moreover, with the evolution of wireless technology, cellular radio capabilities may increasingly begin to be an alternative to wire-based networks.

Franchising

Where local competition is not considered feasible, there are interesting mechanisms through which new service providers and established carriers might be able to collaborate in constructing new access facilities, as briefly noted above (paras 4.17 and 4.18). Under a franchising scheme, a private entrepreneur agrees to wire a specific condominium, block of houses, or industrial park. The franchisor may also build the link between the main network and the interface point to his customers.

The economics of franchising are potentially very good. As is discussed in Appendix A on recent technical developments, on-the-margin switching is a substitute for transmission. As the costs of switching are falling, adding small switches to the network to save on transmission is increasingly an attractive proposition. A franchise agreement of the kind described does precisely that.

A franchising scheme would also accelerate the process of tariff reform. For example, it would permit MTNL to differentiate existing tariffs from those for new infrastructure installed by franchisees. Rationalizing prices and encouraging more cost-based prices, especially for local exchange services, as noted above in Section III, is an important part of the overall reform program.
In addition, microwave and Pulse Code Modulation (PCM) technology provided a means for bypassing the local loop and in the USA there was a significant increase in private network capacity. In many countries, retailers of network capacity were treated differently than wholesalers that owned networks. In Japan for example, businesses that relied on the use of other carrier's networks and facilities were classified as Type II. Under their Telecommunications Business Law there were virtually no restrictions on entry or tariffs for small Type II business. Type I businesses, who owned network facilities, required special permission to operate and tariffs were regulated.

The accelerated pace of technology change has continued to influence the extent to which telecommunications operators are structured and competition introduced. Profound developments in telecommunications technology have increased the flexibility, reduced the cost of services, and altered the way in which economies of scale apply to the extent that there is no longer economic justification to retain a monopoly provider of service.

These developments include digital exchanges which can analyze and route calls selectively through networks owned by different operators while at the same time providing the information necessary for proper billing of those calls. An important point made by Huber (1987) and others is that developments in switching technology have lowered the price of switching relative to transmission. Since switches can, on the margin, substitute for transmission, the density of switches in the network has increased. In other words, it makes economic sense to collect calls at many switching points while running some high capacity trunks between these points rather than running many transmission cables from a few switches to end-users.

This technological development has meant that users are now installing their own switches to a greater extent and managing their networks. Network use and intelligence has, therefore, become more decentralized.

In the transmission area, the main developments reducing scale economies have been the microwave technology (noted above), satellite technology (using "very small aperture terminals" -- or VSATs), and, most radically, the availability of mobile radio cellular telephone systems at rapidly falling prices through which basic telephone service can be provided at prices competitive to the traditional copper wire service both in city and provincial environments.

Moreover, these advances in technology have been accompanied by an increasing rate of development of detailed and flexible interconnection standards which ensure switch, transmission and facility manufactures produce compatible products.

The main technological trend that goes in favor of a somewhat larger scale of operation is the trend in optic fiber technology. Optic fibers produce

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12/ In the main text, we refer to this as "service-based competition".
18/ In the main text, we refer to this as "facilities-based competition".
huge transmission capacity at relatively low unit cost. For many traffic loads, it makes sense to have just one cable covering a particular route, rather than two or more cables installed by competing companies. However, studies at the British Office of Telecommunications (Oftel) show that the cost disadvantage of duplicating cables is small and the presumption is that the benefits of competition outweigh these costs (Bell and Cave 1991).

Moreover, ongoing technology development will continue to strengthen the economics at the local and long distance levels for competing telecommunication service providers. Transmission systems over optic fiber cables will continue to fall in price and significantly increase in capacity. Synchronous digital hierarchy transmission systems (SDH), which are now becoming available, will provide increased flexibility at low cost and permit the insertion and drop-off of individual data streams from within broadband systems (again permitting the improved viability of smaller networks).

Advances in computer technology are enabling higher capacity exchanges from which electronic interfaces can be split off and placed close to subscriber groups thereby allowing the economic use of fiber cable as a substitute for copper. Furthermore, standards for open network telecommunications interconnection are being developed which will readily permit the whole array of facilities to inter-work smoothly. These will include personal communications, mobile services, advanced virtual private networks, intelligent networks, X.400 messaging, and X.500 directory services. These technology changes will continue to provide greater opportunities for efficient competition in the provision of value-added, local loop and long distance services.

**Competition and Efficiency**

The evidence on the positive effect of competition on increased efficiency is very clear. Robert Crandall of the Brookings Institution in a recent book has shown that productivity of telephone companies sharply accelerated when competition increased in the seventies, even before the break of AT&T; after a dip in productivity during the initial years after divestiture (1984-1985), rapid growth in productivity resumed (Crandall 1991).

A study of productivity at NTT (the main Japanese telecommunications provider) similarly conclude that competition forced more rapid technical change (see Oniki, Oum, and Stevenson 1990).

Similar studies at the local exchange level, confirm an acceleration of productivity growth as well as better utilization of resources when competition increases (Banker, Chang, and Majumdar 1991a).
ANNEX B: BROAD ISSUES OF REGULATORY STRUCTURE.

Prior to establishing a regulatory regime, a crucial consideration is the extent to which regulation should be regionalized.

Both USA and Canada are large countries which have a variety of small local operators as well as large operators providing telephone services throughout the country. Both countries use State and Federal regulators. In the US, responsibility is divided between the State run Public Utility Commissions (PUC) and the Federal Communications Commission (FCC). Canada also has both Provincial based regulators and a central Canadian Radio-television and Telecommunications Commission. The distribution of responsibilities between regulators in the USA differs from the Canadian arrangement.

In contrast, UK, Australia, New Zealand, Philippines, Mexico and Chile have opted for a single centralized regulator. These countries have varying degrees of competition. Some examples of regulatory functions, showing also the separation between policy, regulation and operation, are attached.

In India the most appropriate type of regulatory structure will depend to a large extent on the degree of competition permitted. If only national competition is permitted then obviously regional regulators would not be appropriate. However, if the DOT operations are divided into various state operations similar to the Regional Bell Operating Companies (RBOCs) in USA and/or competition is encouraged at local levels, then there may be advantages in having regional regulation.

Regional regulators could be given the freedom to set entry rules on what best suits the local environment. This could result in a useful variation between states in the extent and type of state competition that is permitted. By broadening the experience in this way different regions would be able to learn from others thereby maximizing the use of entrepreneurial skills. Furthermore, by permitting state regulators to make their own decisions, responsibility for quality of services and success of competitive entry would rest with the individual states.

On the other hand a degree of centralized control may be appropriate. A central regulator would more readily develop the expertise for evaluating and understanding issues related to access, pricing and entry. Overriding decisions related to international and long distance services which affect a number of States may be handled more efficiently at a central point. Furthermore, under a regionalized scheme, large operators would need to seek approval from each state regulator before proceeding with any investment. The bureaucratic load in this case may mitigate against the rapid entry of new operators and unnecessarily constrain expansion. Moreover, the management of spectrum usage and national service quality and type approval standards should be centralized.

It may be appropriate to establish only a central regulator at the outset, especially if a gradual introduction of competition is proposed. However, it would be useful to propose a final regulatory structure when preparing legislation. This may permit, if appropriate, the evolution of a separate regionalized regulatory structure without subsequent recourse to complex legislative changes.
Examples of Regulatory Organisation and Functions in Industrialised Countries

**UNITED KINGDOM**
- **Prime Minister**
  - Department of Trade and Industry (Telecom & Post Div)
  - Office of Telecommunications (OFTEL)

  - Develops telecom licence conditions
  - Monitors and enforces licence compliance
  - Investigates complaints
  - Monitors activities of telecom firms

**UNITED STATES**
- **President**
  - **Congress**
  - Federal Communications Commission (FCC)
  - Public Utility Commissions (PUC)

  - Regulates local, long distance and international communications
  - Regulates tariffs
  - Ensures network inter-operability
  - Certifies equipment for network use
  - Monitors and regulates predatory activities by service providers
  - Allocates radio spectrum
  - Investigates complaints

**JAPAN**
- **Prime Minister**
  - Ministry of Post & Telecommunications (MPT)
  - Japan Approvals Institute for Telecom Equipment (JAITE)

  - Regulates Type I and II telecom carriers
  - Supervises market entry and pricing
  - Certifies proposed equipment
  - Funded by equipment manufacturers

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**TELECOM OPERATORS**
- British Telecom
  - Mercury
  - Other Services Providers

- Bell Operating Companies
  - AT&T
  - Type I Providers
  - Type II Providers

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**LEGEND:**
- Regulatory Body or Function
- Regulated Service Provider
Examples of Regulatory Organisation In Middle Income Countries

PORTUGAL
(Currently Being Implemented)

REGULATORY BODY

GOVERNMENT

INSTITUTE OF COMMUNICATIONS (Independent Regulator of Price, Quality, Cross-subsidies)

OPERATING ENTITY

HOLDING COMPANY

COMPANY FOR BASIC SERVICES FOR LISBON

51% GOVERNMENT OWNED

KUWAIT
(Adopted 1990)

REGULATORY BODY

GOVERNMENT

KUWAIT OFFICE OF TELECOM (Independent Regulator of Price, Quality, Interoperability; Supervises Management Contractors)

OPERATING ENTITY

OUTSIDE MANAGEMENT CONTRACTOR

COMPANY FOR BASIC SERVICES OUTSIDE LISBON

100% GOVERNMENT OWNED

COMPANY FOR INTERNATIONAL TELECOM

MEXICO
(Recently Implemented)

REGULATORY BODY

GOVERNMENT

MINISTRY OF COMMUNICATION & TRANSPORTATION (Regulates Tariffs but Also Provides Limited Services to Villages, and in Some New Technological Areas)

OPERATING ENTITY

TELMEX

OUTSIDE MANAGEMENT CONTRACTOR

KUWAIT MOBILE TELEPHONE SERVICE

65% GOVERNMENT OWNED

19.5% GOVERNMENT OWNED

OUTSIDE MANAGEMENT CONTRACTOR

LOCAL TELCO

100% GOVERNMENT OWNED

INTERNATIONAL TELCO

LEGEND:

Regulatory Body Or Function
Regulated Service Provider
<table>
<thead>
<tr>
<th>PRIMARY AUSTEL RESPONSIBILITIES UNDER THE TELECOM ACT OF 1991</th>
<th>MINISTERIAL RESPONSIBILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Promoting competition -- positively promoting competition rather than simply preventing operators from engaging in unfair practices</td>
<td>• Retains ultimate authority over the telecom sector</td>
</tr>
<tr>
<td>• Licensing -- issue class licences for new providers of wireless, resale, and value added services</td>
<td>• Appoints Austel members</td>
</tr>
<tr>
<td>• Technical regulation and standards -- designate technical standards for network equipment, including CPE; manage Australia's input to international standards bodies</td>
<td>• Control Austel budget</td>
</tr>
<tr>
<td>• Carrier interconnection agreements -- authorise carriers' interconnection/access agreements, or arbitrate and determine terms and conditions of interconnection if no agreement exists</td>
<td>• Authority over most Austel activities such as licensing equipment or issue service class licences</td>
</tr>
<tr>
<td>• Numbering plan -- develop and manage the national numbering plan</td>
<td>• Decides whether carrier services are subject to price control</td>
</tr>
<tr>
<td>• Monitoring carrier performance -- report to the Minister on carriers' quality of service, establish a cost allocation manual for price regulation, and universal service obligations</td>
<td>• Control all uses of radio frequency spectrum</td>
</tr>
<tr>
<td>• Consumer protection</td>
<td>• Power to require Austel to investigate and report on any matter concerning telecom services and operators</td>
</tr>
</tbody>
</table>
ANNEX C: ROLE OF THE RAILWAYS.

In many parts of the United States and Canada, and now in Britain and other parts of Europe, railways are taking an aggressive position in the telecommunications service market.

Railways have three assets that make them a serious contender for provision of telecommunications services. They own land, and hence, can provide right-of-way for laying cables. They have a pre-existing telecommunications network that they have used for internal communications. They have an organizational infrastructure in terms of communications technicians, civil engineers, and maintenance staff that can oversee the installation of cables and their maintenance.

In the Indian situation, the right-of-way is an important asset that could well be exploited to create a genuine long-distance public carrier that provides effective competition to DOT. However, since the railways have no real expertise in running a modern telecommunications network and have no need to develop such expertise, they should aim at leasing the right of way to a venture that brings substantial management expertise in modern networks. In return, they could requisition a small portion of the network for their own use. Where relevant, their trained technicians and civil works experience could also be used.

The plans and issues surrounding British Rail’s entry into communications offer an instructive guide. By the current law, British Rail is required to form an independent joint venture if it is to provide public telecommunications services. It is required to seek a venture partner that has expertise in the management of modern networks in a competitive marketplace (and, hence, British Rail is discussing venture possibilities with the Regional Bell Operating Companies in the United States and with some European companies). British Rail will have a non-controlling interest in any venture.

British Rail has a significant telecommunications network, though this will have to be substantially modernized and expanded. However, the organizational capabilities that already exist are viewed as an important asset in getting off to a running start. For example, Mercury (the only existing long distance competitor to British Telecom) had to start building an organization from scratch and has taken seven years to reach a position of stability. It is expected that a British Rail venture would take only a few years and about half the investment to become a credible telecommunications organization.
ANNEX D: COMPETITION IN THE LOCAL LOOP.

There are a number of aspects of local competition that are worthy of discussion.

In heavily congested areas such as Bombay and Calcutta, it may not be feasible nor desirable for a competitor to lay its own underground cables. However, linkage between subscriber clusters and the local exchange could be viable using radio. Cellular radio, either fixed or mobile, would permit individual subscribers to be connected to the network with no disruption to outside plant. Consumers availing themselves of immediate connection through these competitive networks would normally expect to pay prices above those charged by DOT for ordinary service.

In city areas, competitors should be given limited access to DOT’s duct network at a marginal cost. Competitors should be free to use these ducts to provide services direct to large user buildings using optical fiber. Any conflicts between DOT and its competitors over the terms of duct usage would be resolved by the Regulator. The overriding objective would be to permit consumers to choose between DOT and its competitors. Permitting competitors to access minimal duct space for optic fiber cables would maximize scale economies and minimize disruptive digging of roads.

At the same time, it would be feasible to permit new suppliers or independent outsources to provide their own duct networks where new ducts would in any case be required. These providers would be obliged to install sufficient capacity for long term demand so as to minimize future disruptions to access ways. They would then lease capacity to DOT and other competitors at marginal cost. The primary objective would be to ensure that any new arrangements maximize the use of resources, provide service where demand occurs, and maintain adequate quality standards of provision and maintenance.

In less dense areas, new entrants may wish to service pockets of suburban communities or small rural communities. Again, connection of community telecommunications services to local exchanges by radio could be permitted with minimal disruption to underground plant. Satellite or terrestrial radio (cellular, multi-access radio systems or microwave) could be economically feasible depending upon the location. In unserved areas, new entrants may be permitted to use underground cabling to provide services. In these cases the Regulator would be required to arbitrate if necessary on access and provision arrangements and set quality standards.
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