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FINAL REPORT

ON

REGIONAL CO-OPERATION

FOR

TELECOMMUNICATIONS IN ASIA
(INDIA , INDONESIA & CHINA)

DECEMBER 1991

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	[illegible]	[illegible] Investment	[illegible]
	[illegible]	Growth in [illegible] Equipment	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
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LIST OF ABBREVIATIONS

ASIC	: Application Specific Integrated Circuit
AT&T	: American Telegraph & Telephone
BEL	: Bharat Electronics Ltd
BHEL	: Bharat Heavy Electronics Ltd
Bill	: Billion
CDOT	: Centre For Development Of Telematics
CGM	: Chief General Manager
CMC	: Computer Maintenance Corporation
DDD	: Direct Distance Dialing
DEL	: Direct Exchange Line
DMM	: Digital Multimeter
DOE	: Department Of Electronics
DOT	: Department Of Telecommunication
Dig	: Digital
EPABX	: Electronic Private Auto Branch Exchange
Elx	: Electronics
FAX	: Fascimile
FDM	: Frequency Division Multiplexing
FE	: Foreign Exchange
FERA	: Foreign Exchange Regulation Act
GNP	: Gross National Product
HCL	: Hindustan Cables Ltd
HPA	: High Power Amplifier
HTL	: Hindustan Teleprinter Ltd
IC	: Integrated Circuit
INTELSAT	: Indian Telephone Satellite
ISD	: International Subscriber Dialing
ISDN	: Integrated Services Digital Network
ISRO	: Indian Space Research Organisation
ITI	: Indian Telephone Industries
Kwhr	: Kilo Watt Hour
LAN	: Local Area Network
LDC	: Less Developed Countries
LDPT	: Longe Distance Public Telephone
LSI	: Large Scale Integration
MARR	: Multi-access Radio Relay
MAX	: Main Automatic Exchange
Mill	: Million
MMEI	: Ministry Of Machinery & Electronic Industry
MNC	: Multinational Companies
MPT	: Ministry Of Post & Telecommunication
MRTP	: Monopolies Restrictive Trade Practices
MSC	: Main Switching Centre
MTNL	: Mahanagar Telephone Nigam Ltd
MTPT	: Ministry Of Tourism, Post & Telecommunication
Mb	: Megabytes
Modem	: Modulator & Demodulator
NEC	: Nec Corporation
ONGC	: Oil & Natural Gas Corporation
OSP	: Outside Plant
PABX	: Private Automatic Branch Exchange
PAPT	: Provincial Administration Of Post & Teleco
PCB	: Printed Circuit Board

Contd ...

PCI	: Per Capita Income
PCM	: Pulse Code Modulation
PSC	: Primary Switching Centre
PSTN	: Public Switched Telephone Network
PTIC	: Post & Telecom Industry Corporation
R&D	: Research & Development
RABMN	: Remote Area Business Message Network
RAX	: Rural Automatic Exchange
RLU	: Rural Local Unit
RKM	: Route Kilometer
SEZ	: Specially Economic Zones
SKD	: Semi Knock Down
SPC	: Stored Program Control
SSC	: Secondary Switching Centre
STD	: Subscriber Trunk Dialing
Sys	: System
TCIL	: Telecommunication Consultants India Limited
TDM	: Time Division Multiplexing
TR	: Transistor
TRC	: Telecom Research Centre
TSC	: Tertiary Switching Centre
TTL	: Transistor Transistor Logic
TVRO	: Television Receive Only
Te.ecom	: Telecommunication
UAE	: Union Of Arab Emperor
VFT	: Voice Frequency Transmission
VHF	: Very High Frequency
VLSI	: Very Large Scale Integration
VSATS	: Very Small Aparture Terminal Satellite
VSNL	: Videsh Sanchar Nigam Ltd
Vac	: Vacuum
WAN	: Wide Area Network

EXECUTIVE SUMMARY

During the last decade the technologies of microelectronics, computers and communication have converged into a sophisticated and multidisciplinary industry which is still innovating and advancing at a fast rate. The resulting power of telecom has made it an important ingredient for rapid technical and economic development especially in developing countries. These countries, in their quest for growth with equity, are hampered by an inadequate and relatively low-performing network made up mostly of equipments of earlier generations. Though their governments are now becoming increasingly aware of this important lacuna, they face several technical as well as economical constraints as they try upgrade their telecom infrastructure.

Over recent decades, telecom technology has changed with accelerating pace. One can discern five generations of technology which may be termed---- mechanical; electro-mechanical; analog-semi-electronic; digital solidstate; and eventually Integrated Systems Digital Network (ISDN). For many countries the rather sudden change in telecom technology from analog to digital, its capital intensiveness and the need for increasing self-reliance have created a set of problems which individual developing countries will find difficult to solve without external help.

This study of China, India and Indonesia was undertaken with a view to understand these problems in a broad way, find out the extent of their needs and suggest ways in which sub-regional, regional and international cooperation can ease and expedite solutions.

The three countries are similar in that they are among the five largest populated countries of the world and their present state of development brackets them in the third world. They also share a common need to upgrade their telecom networks and are heading in the same technological direction and are making efforts to become more self-reliant in design as well as local added value.

Details of individual countries are provided in this report but some of the key points can be summarized here. The role of Government is substantial in all three countries but this could be graded in the order---China, India, Indonesia. The resources poured into telecom and the size of their networks even on per-capita basis can be put in the same order. While in all three cases rural telecom has got secondary consideration, India seems to be somewhat ahead in this area with some recent technology starting to benefit remote villages.

Production base for assembling telecom equipments is large in China in terms of aggregate volume but leaves the impression of being scattered over many organizations not all of them at acceptable levels of productivity. India and Indonesia have progressively smaller aggregate production concentrated into fewer organizations thus indicating prospects of better efficiency of resource use. All three countries however have to continue to install earlier generations of equipments (electro-mechanical, semi-electronic and analog) since they cannot produce (or acquire) the

latest digital solid-state equipments test enough. In this respect--- India, China, Indonesia will be the order of competence and use of modern equipments in their networks as shown in attached chart.

Keeping integration and self-sufficiency, while all three countries can indigenously produce mechanical, electrical, cable and other requirements, their capability to locally provide the important electronic components of telecom quality varies quite substantially. In this respect, Indonesia is almost entirely dependent on foreign sources for their electronics components; in many cases these come bundled as part of the technology transfer arrangement. China has a vast component base for consumer components and this ensures supply of many routine components of the passive and electro-mechanical kind; they may not be the latest but they help in increasing the local added-value. India seems to be ahead in having local supply of a fair range of professional grade components of all kinds with adequate assurance of professional quality.

It is in the area of microelectronics (including surface mount components) that all developing countries (as way behind their own needs leave alone the standards of the western world. Beginnings that are made in China and India (not Indonesia) take them only a small step of the way---perhaps in hybrid-circuits and small-scale integration. But in terms of the latest requirements of VLSI, the dependence on advanced countries is total. The generally proprietary nature of VLSI makes this dependence all the more problematic.

Past, present and perhaps future inputs of technology for telecom equipments design, development, engineering and production have in large measure been coming from industrialized nations---- notably Europe and Japan----in all three countries. However, each country has also made investments and progress in their own research and development (R & D). Investments in R.& D in absolute terms as well as in proportion to output are far lower than those made even by individual telecom companies in the advanced nations. Nevertheless, this effort is increasing and has enabled progress in absorbing and adapting the technologies acquired and progressively increasing local content the designs which came in from abroad in the past.

In terms of number of institutions and manpower devoted to research, China stands somewhat ahead of other developing countries with India fairly close in achievements though with numerically lesser institutions and manpower. However, technological progress in advanced countries continues to run ahead: further, the quantitative needs of their networks for up-to-date digital equipments remain urgent. The plan for increased self-reliance proceeds in three steps (as explained to us in China)---procure latest equipments for urgent needs: negotiate and acquire corresponding technology and plant for production of the same: undertake research to adapt, improve and indegenise the designs as may suit local requirements.

Independent research on a mission basis has enabled India to evolve indigenous designs of certain levels of digital equipments in the area of switching and partially in rural multi-access radio. These designs are going into the field and would be proof that

developing nations can indeed focus and succeed in developing some of their latest needs albeit only in certain areas if not across the board. A similar situation applies in case of small earth stations for satellite communication in Indonesia where private initiative has made some headway through the device of buying into a small enterprise in USA to avail of their expertise.

Modern digital equipment can be quite software-intensive and a considerable part of the transfer cost is accounted for by the supply of software. When this is generated abroad, the costs are high not only due to proprietary nature of the basic software but also the generation of specific user oriented programs at the high manpower rates applicable abroad. Capability exists to varying degrees in the countries studied for progressively taking on increasing part of software development locally. In order of progress in this direction one may assess India, China, Indonesia in that order.

While local capability is in a position (with earlier generations of equipments) to partially undertake the task of enhancing their telecom networks, the reliance of even these major developing countries or the advanced nations continues to be substantial as far as advanced systems are concerned. Even if some part of the advanced technology can be handled (thus reducing the overall burden of dependence) the problem is compounded by the general approach followed by MNC's to offer bundled packages not only of technology, equipment, components but often incorporating bilateral finance, even where parts of the requirements could be handled locally or sub-regionally. The task thus becomes highly complicated. A suggested way of unbundling telecom equipment technology is illustrated in the next chart.

From the study it seems clear that the larger developing countries can partially become self-reliant in telecom equipments and components each to a varying degree and each in different aspects and generations of the technology. This provides the complementarity in competence which could be optimally harnessed through regional cooperation not only among themselves but also with smaller nations in their sub-region.

Overviewing the needs and capabilities of developing countries in telecom, one can draw some suggestions for sub-regional, regional and even international cooperation. Certain basic recommendations stand out. First comes the need for surveying and establishing a data-base of the what exists, what is needed and what is the capability to fulfill the regional requirements. Much more than this present cursory study will be called for. This data-base should be kept current by pooling in tender and offer information as soon as it is generated. When this is accessible to all countries in the region, regional procurement can be seeded.

Practically speaking, there has to be a common approach to standardization, specification and testing between regional countries. While several countries do have their own institutions for this, many of the smaller countries do not. There is scope for a regional body (perhaps supported by ITU) to take up such a program as an essential prerequisite to sub-regional cooperation.

Regional procurement can be catalyzed in two ways. Smaller developing countries in the region having modest telecom requirements can neither produce it themselves nor can they spare hard currency to any substantial extent for purchases from developed nations. Their telecom programs can be accelerated through cooperation with the larger developing countries for at least part of their requirements as well as for technical assistance to undertake themselves some of the low-technology tasks where scale is not a factor.

This study goes into the areas of telecom where each of the surveyed countries is competent. There is a meshing of these capabilities. Thus inter-regional procurement can be generated through regional cooperation. Earlier suggestions regarding thorough survey, data network, information access, standards and so on are steps to make this possible. We are suggesting the possibility of a "trade secretariat" (perhaps embedded in one of the existing regional telecom bodies) which would catalyse commercial interchange between developing countries.

Unbundling of hard currency requirement from the total package would go a long way to induce regional developing countries to work to meet their needs among themselves to the extent possible. This would firstly enable the regional resources to go a longer way (due to lower supply costs when regionally met); further, the actual hard currency needs would also drop since they would be required only to the extent of the essential component needs of the regional supplier and not the total package which the buyer would have to obtain from advanced nations. Existing financial bodies like World Bank, ADB, and others could consider specialized cells to go into this new area.

Scant resources for R & D deployed in each country naturally go mainly towards topics of main importance to that country. In different countries, the areas of emphasis are different. This provides scope for partitioning and sharing R & D results and working towards avoiding duplication. To ensure access of each country, there could be delegation of scientist into joint programs concentrating all brain-power into focused programmes...as for example is done even in advanced countries.

Finally, one could consider the formation of a regional center/s of excellence combining training and research where postgrad level of activity is undertaken in the many disciplines which now combine to make telecom the powerful infrastructure that it is today.

MANUFACTURING STATUS FOR REGIONAL COOPERATION

			[illegible]		INDIA		INDONESIA	
			Capacity	Tech.	Capacity	Tech.	Capacity	Tech.
A. SUBSCRIBER								
Telephone	-	Mech.	A	Z	A	Z	A	X
	-	Elec.	A	Z	A	Y	A	X
Teletypter	-	Mech.	Z	-	A	Z	A	X
	-	Elect.	B	Z	A	Y	A	X
PAX			Z	-	D	X	Z	-
Payphones	-	Mech.	Z	Y	A	Z	Z	-
	-	Elec.	Z	Y	B	Y	Z	X
Modems			A	Z	A	Z	B	Y
EPABX			Z	Y	A	Z	C	X
Teletext			B	-	Z	-	-	-
VSAT for Telecom			Z	X	Z	X	A	Y
B. TRANSMISSION								
Cable	-	Copper base	A	Z	A	Z	A	Z
	-	Optical	C	X	B	Y	D	-
M/W Sys.	-	Analog	A	Z	B	Y	A	Y
	-	Digital	C	X	C	Y	C	X
Satellite System	-	Ground	C	-	B	Y	B	Y
C. SWITCHING								
Manual			A	Z	A	Z	A	Z
Strowger			A	Z	A	Z	B	Z
Crossbar			A	Z	A	Z	B	Z
Semi-electronic			B	Y	D	-	B	Y
Digital			C	X	C	Y	C	X

A = Excess Capacity B = Adequate Capacity C = Insufficient Cap.

D = No Capacity X = SKD/CKD Assy. Y = Partial Mfgr.

Z = Total Mfgr. (Excl. VLSI)

TECHNOLOGY UNBUNDLING

	Scenistic.	High	Medium	Low
NETWORK PLANNING	•			
SYSTEM INTEGRATION		•		
SOFTWARE		•		
SWITCHING				
- Central Office	•			
- Rural		•		
- Subscriber			•	
TRANSMISSION				
- High Cap. Channeling	•			
- Low Cap. Channeling		•		
- 2 - 4 Wire				•
- Multicore Cable				•
- Coaxial			•	
- Optical	•			
WIRELESS COMMUNICATION				
- VHF UHF			•	
- Microwave		•		
- Satellite	•			
- Cellular	•			
SUBSCRIBER				
- Ord. Telephone				•
- Cordless				•
- Pay Phone			•	
- Cellular	•			
- Telex			•	
- FAX	•			
ACCESSORIES				
- Test Equipments	•			
- Power Plant			•	
- Antennas			•	
- Outside Plant				•

CHAPTER 1 : GENERAL

1.1 Origin Of Study

1.1.1 Background & Objectives

1.1.11 Telecom industry has taken astonishing strides in terms of innovation, technology, performance & services in recent past. In households, offices, industries, governance, the spread effect of telecom has greatly benefited society as a whole. Telecom public network is seen more as a key national resource rather than just as service medium.

1.1.12 Telecom is a complex discipline involving national and international developmental, operational & service issues. Convergence of telecom, microelectronics & computer technology has provided a completely new technological base promising enormous future possibilities which are just being understood by developing nations who are falling farther behind as time passes.

1.1.13 Knowledge-base, fast-change, high investments needed to improve the telecom network with sufficient force are barriers which will have to be surmounted if developing nations are to emerge as participants in world economy.

1.1.14 This study looks broadly at the public telecom scene in three large developing countries (viz. India, China, & Indonesia). Purpose is to understand the present status, know their forthcoming plans and suggest ways and means for regional co-operation aimed at enhancing their capabilities towards developing, manufacturing, installing and maintaining upgraded telecom systems, equipments and components.

1.1.15 The findings of this study will be part of the discussions at a regional meeting directed towards finding ways of increasing regional co-operation for improved, efficient & cost effective telecommunication services which in turn would result in faster industrialization of developing countries.

1.1.2 Study Treatment

1.1.21 Besides a substantial review of published data from various sources **(Annexure A)**, the study relies on visits to the country capitals & important cities in India, China and Indonesia for meeting responsible people currently involved in telecom planning, operations & production.

1.1.22 The major limitation of this study is the compressed time and the selective visit arrangements made available by governments to study the multi-disciplinary area in three different economies. The broad & overall data which was made available has to be considered as a start of the process of analysis, needing refinement & detailing by further concentrated studies.

1.1.23 Variations of language, different ways of presenting data, currency changes are further barriers despite which this study provides main directions for discussions and undertaking detailed

inquiry. Chapter 1 sets the frame work of the study while Chapters 2, 3 & 4 cover India, Indonesia & China respectively. Chapter 5 speculates on areas for regional cooperation on which discussions can focus at the regional meetings.

1.2 CLASSIFICATION OF TELECOM EQUIPMENTS

1.2.1 By Communication Modes

1.2.11 Over a period of time the range of public communication has expanded through many orders giving rise to a cornucopia of new products & services as shown in **Figure 1.1**. The characteristics of these products & services --- lower costs, more features, greater reliability --- have led to a tremendous expansion of their applications as effective & efficient means of communication in all walks of life.

1.2.12 In the main however, these elaborate service- products can be grouped into five presently existing modes:-

a. Voice (including music) has remained the dominant mode of personal messaging .

b. Text (including displayed) is a basic need of business & governmental transactions .

c. Image (including writing & pictures) has entered the scene through facsimile .

d. Video (moving images on screen) can create face-to-face impact.

e. Data flow (between computers) allows the exercises of intelligence at a distance.

1.2.13 Combinations & refinements of these modes have also yielded other types of more useful services fulfilling innovative needs and creating additional markets -- Radio paging, Confra-vision, Electronic-mail, Tele-shopping; Tele-control. The innovations & refinements have not yet ended.

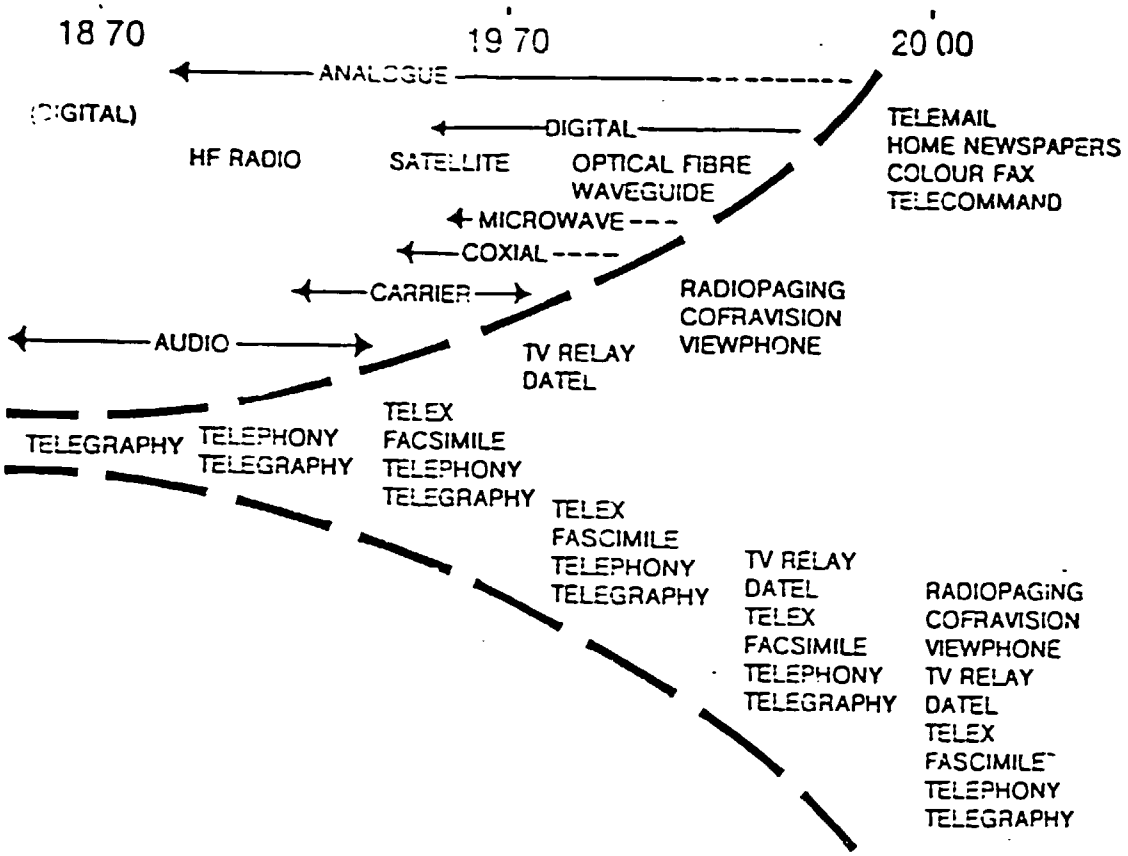
1.2.2 By Network Types

1.2.21 Telecom services can reach across land, sea, air & space enabling exchange of information by various modes discussed earlier. The network comprises numerous systems, equipments & accessories which are continuously modernizing & changing. A typical telecom network enables transmission , switching & reception of information in its various modes as illustrated in **Figure 1.2.**

1.2.22 The details of the network vary from place to place and time to time depending on the needs & economic status of the users. A typical network can be divided into following groups :-

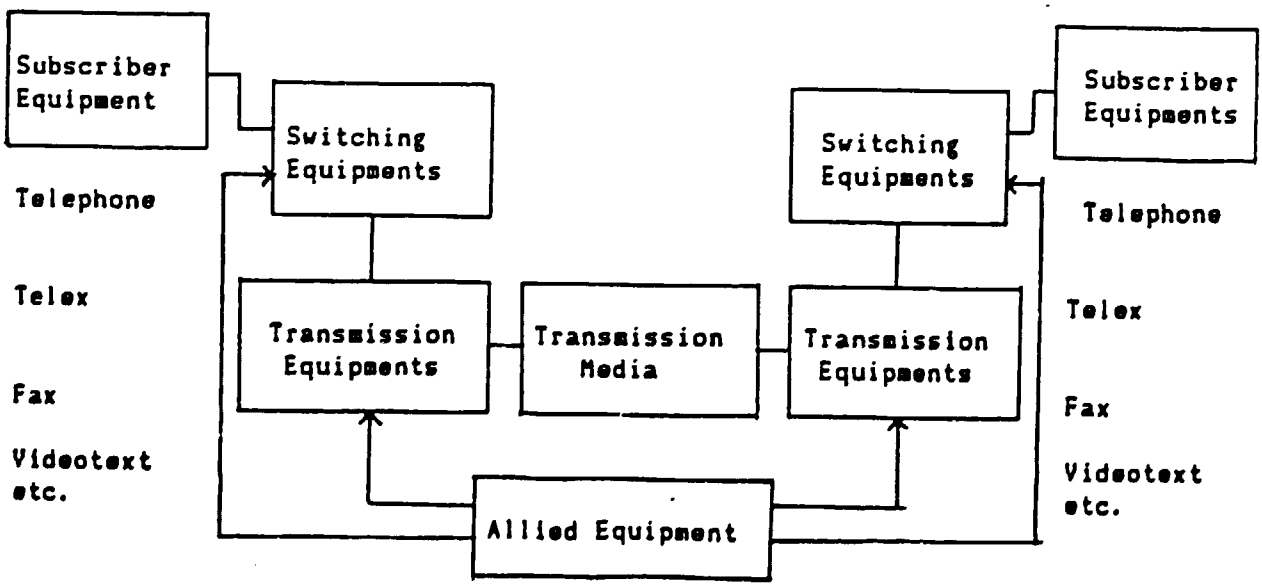
a. Local Network : connecting subscribers in a defined area via a local switch.

FIGURE : 1.1 GROWTH IN NEW PRODUCTS & SERVICES IN TELECOM



SOURCE : INDIAS TELECOM MISSION

FIGURE : 1.2 KEY CONSTITUENTS OF TELECOM NETWORK



b. Inland Network: connecting subscribers in various regions of a country going through trunk switches and long distance transmission..

c. International Network : connecting subscribers of the networks of various countries across national boundaries.

d. Private Networks : Dedicated systems created for certain entities having specialized needs.

1.2.23 As communication technology has evolved and as newer services are created, individual networks having requisite specifications and characteristics suitable for particular applications have evolved as below :-

- Telex Network (providing a slow & limited transmission of textual pulses)
- Telephone Network (having voice bandwidth)
- Data Network (incorporating high digital speeds and intelligence.)
- Satellite Network (for connection of remote locations)
- Dedicated Network (designed for particular & limited use)

1.2.24 The improvements in the constituent parts of these networks have brought about the possibility of eventually creating a single network having such an ideal combination of properties that all the present and future imaginable modes can be incorporated in one single network to be termed "Integrated Services Digital Network" (ISDN).

1.2.3 By Functional Technologies

1.2.31 Telecom network consists of numerous equipments which can be grouped as under :-

a. Subscriber (or Terminal) Equipment
b. Switching Equipment
c. Transmission Equipment
d. Allied Equipment

Various major equipments falling under these categories are listed in **Figure 1.3** in the form of a classification tree.

1.2.32 These equipments are designed to perform specific functions which can be knowledgeably combined to form telecom networks for any desired application. Each of these equipments is constantly undergoing developmental changes to improve performance, provide additional features, make itself compatible with improved technologies of other equipments of the network.

1.2.33 Key element in the modernisation of telecom has been the transition from manual to mechanical to electro-mechanical to semi-electronic and finally to fully solid-state in various equipments (especially switching). Major leaps forward in technology are

FIGURE : 1.3 CLASSIFICATION OF TELECOM EQUIPMENTS

TELECOM EQUIPMENTS

Subscriber	**Switching**	**Transmission**	**Allied**
- Telephones	- Subscriber		- Supervisory Eqpt
			- Test Eqpt
- Rotary - Dial	- Manual Boards		- Power Plant
- Push button	- Relay Consoles		- Batteries
- Pay-phone	- Crossbar PABX		- Outside Plant
- Cordless phone	- Elx. PABX		
- Cellular phone			
- Teleprinter Telex	- Central Exchange		
- Electro-mech	- Strowger		
- Electronic	- Cross-bar		
- Teletext	- Electronic Analog		
	- Digital SPC		
- Facsimile	- Rural Auto Exchange		
- Workstation			
- Modem			

Channelling Equip	Transmission media	Accessories
- Multiplexer	- Copper Cable	- Antenna
- Modulators Demodulators	- Open Wire	- Wave Guide
	- 2 pair cable	
- Concentrators	- Multicore cable	
- Terminals & Regenerator	- Pressurised cable	
	- Jelly filled cable	
- Repeaters	- Optical fiber cable	
- Amplifiers	- VHF/UHF links	
- Modems Interfaces	- Microwave links	
- Satellite Earth Station Equip.	- Satellite links	
	- Cellular	
- DAMS		

illustrated in **Figure 1.4.**

1.2.34 The second major change has been to process the intended "message" (which used to remain in analog form), by converting into digital form which provided numerous advantages at all stages of the network. It also opened the door to adding "intelligence" to the network through use of computers and software.

1.2.35 Additionally, perfection of radio technology through UHF,VHF Microwave, Millimeterwave (and eventually, to optical) has moved parallely to other advancements in electronics. These new means of sending and receiving signals have enabled increasing amount of communications a cross any terrain -- be it desert, forest, sea, mountains, space or galactic. The available transmission media are compared in **Figure 1.5** over time and costs.

1.2.36 These innovations would not have been easy to accomplish were it not for the rapid development of Micro-electronics (particularly microprocessors and memories), which are responsible for bringing together computers and communications ("compunications" in the words of Dr. Sheshagiri) or information and automation ("informatique" as coined by the French).

1.2.4 **By Generations of Telecom Systems**

1.2.41 The simultaneous and fortuitous advancements in several areas of electronics and their coming together to provide several generations of telecom systems is succintly shown in **Figure 1.6.** Each new technology has resulted in the development of new switching, transmission & terminal equipments. Each and every part of the network has undergone change to match the performance of the other.

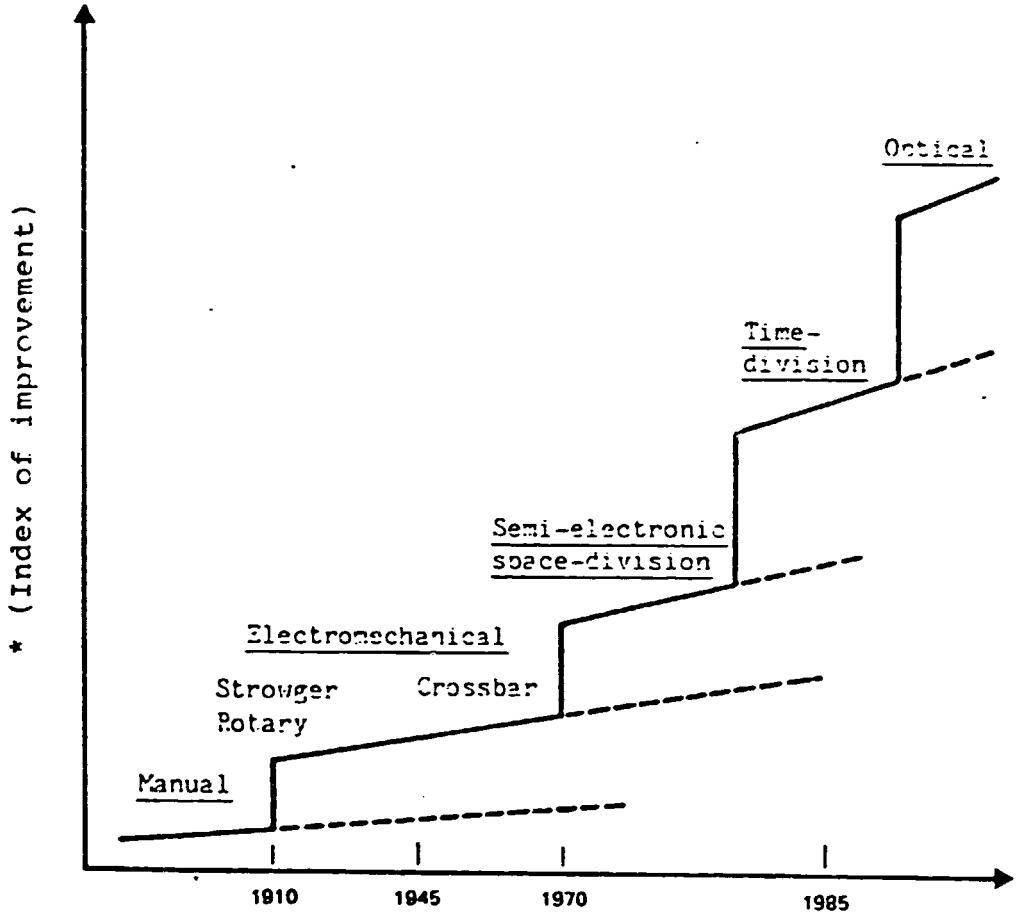
1.2.42 FIRST GENERATION : can be recalled as the "Morse Telegraph:"Crank" Telephone: open-wire lines: operator plugged circuit board and hardly any other services. Antique though it is, in developing countries, there are parts of the network that have to be satisfied with keeping going these obsolete and cast-off systems.

1.2.43 SECOND GENERATION : comprises mechanical teletype , dial telephone, switch-board operator, twisted pair circuits: step-by-step exchanges: coaxial transmission in analog format. A substantial part of the network in developing countries has not been able to afford change-over from this rather basic set of equipments which can hardly cater to non-voice services.

1.2.44 THIRD GENERATION : installed in many of even developing nations is based on electronic (store-and-forward) telex: push button electronic phone: [illegible] cable circuits: analog electronic exchanges: analog microwave long-distance links. These networks are capable of adding the new non-voice services like facsimile, [illegible] data modems, and so on.

1.2.45 FOURTH GENERATION : [illegible] services needed [illegible] computerised telex, Fax, [illegible] cable circuits, [illegible] digital microwave links or satellite [illegible]

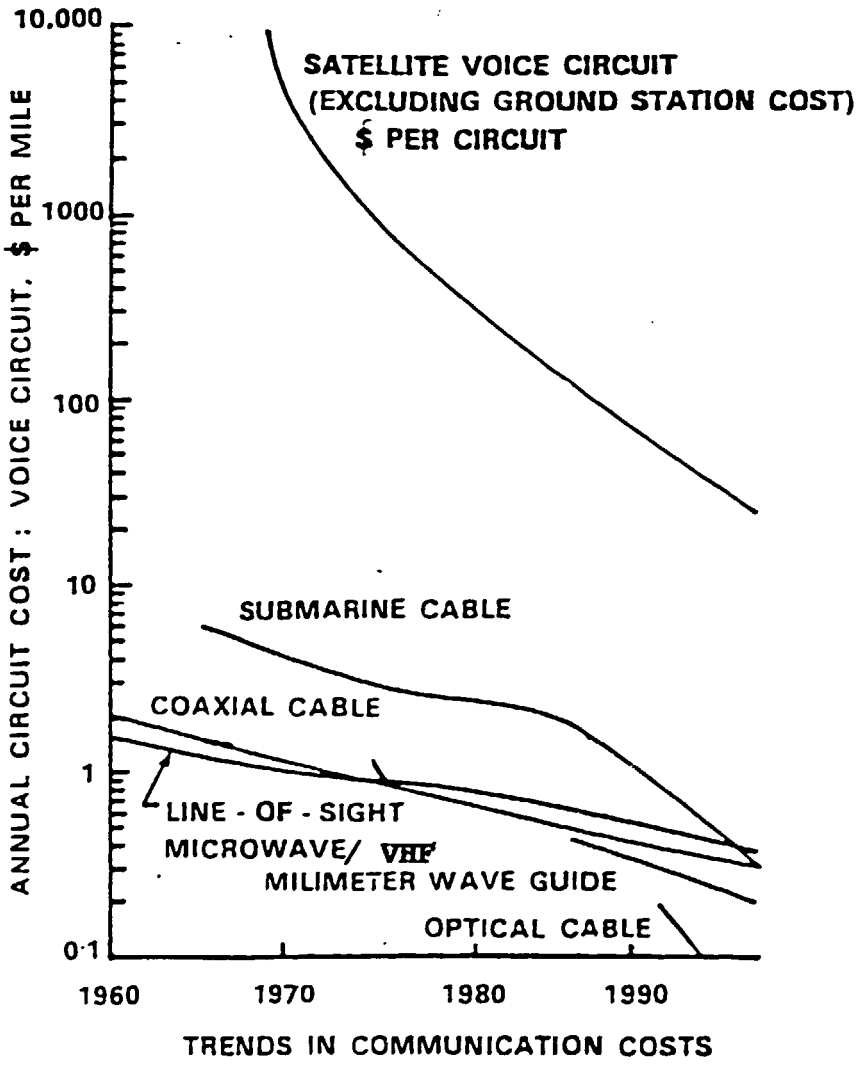
FIGURE : 1.4 GENERATION OF SWITCHING TECHNOLOGIES



* Index of improvement in switching technology in terms of number of channels, speed, costs,size, etc.

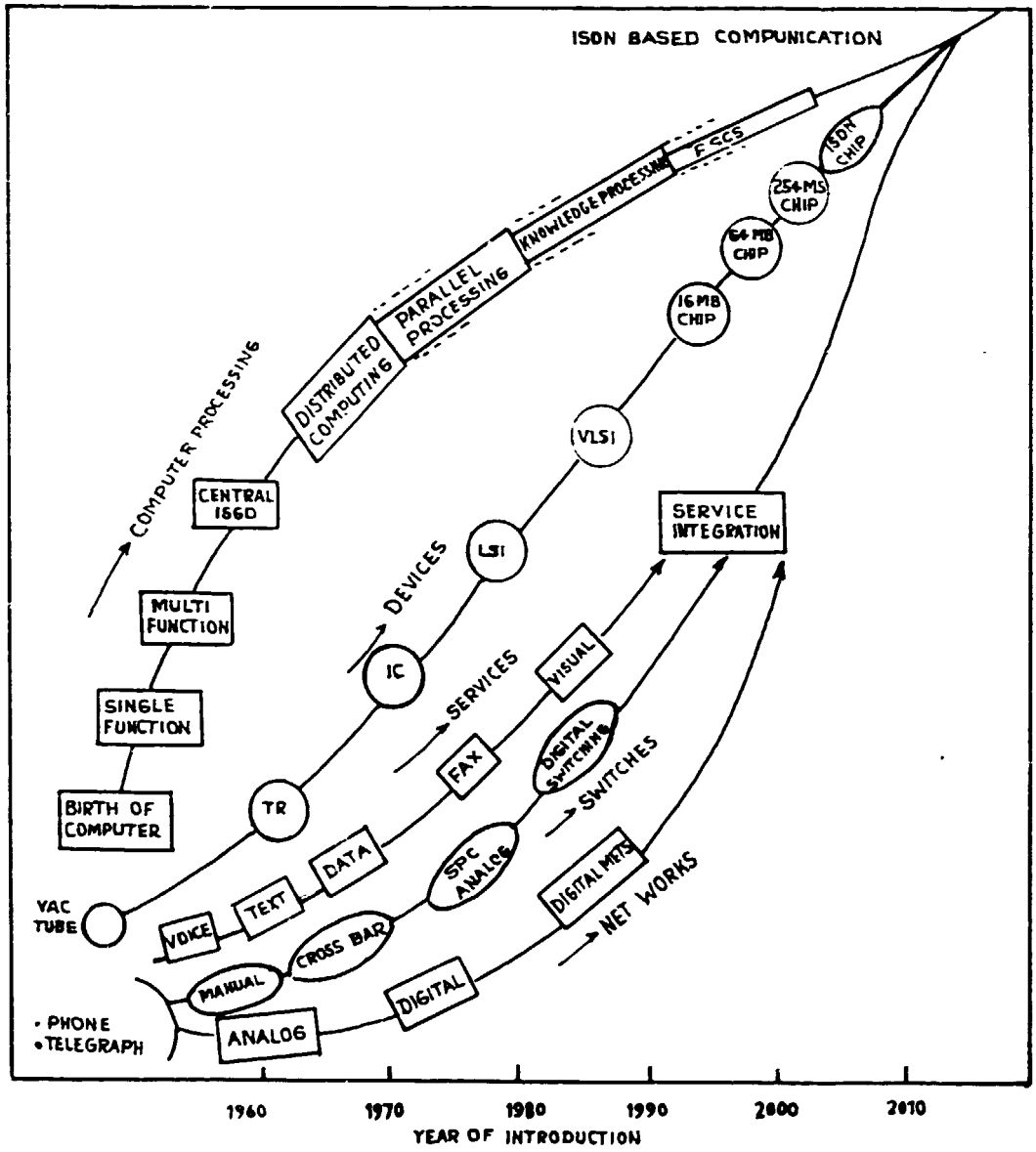
SOURCE : ECE SECRETARIAT

FIGURE : 1.5 TRANSMISSION MEDIA COMPARISON



(Source : India's Telecom Mission)

FIGURE : 1.6 SCHEMATIC OF EVOLUTION OF COMPUNICATION SERVICES



SOURCE : GLOBAL COMPUNICATION -- BY DR. N. SESHAGIRI -- ELECTRONICS TODAY MAY 1991.

[illegible] "value added" [illegible]

[illegible] GENERATION : is expected to be an all-embracing and diversified "communications" tool, carrying all conceivable services on one network — via ISDN. Advantages : flexibility ; cheap economical services ; [illegible] ; resilience at high levels ; computer monitoring & control ; simplification in physical design ; mass production of components ; & reliable installation & maintenance.

1.2.5 Increasing Role of Software

1.2.51 The general trend of miniaturization of electronic devices & components is also reflected in telecom equipments. Micro-electronic devices add intelligence to the telecom equipments and systems which calls for specialised software to instruct these devices to operate as needed for each application.

1.2.52 Rapidly changing technologies in hardware & software will affect the economic life of communication equipments. The need to introduce & adapt new technologies quickly requires hardware & software strengths to design, produce, install and maintain such powerful systems.

1.3 TELECOM & DEVELOPMENT

1.3.1 Economic Status of a Country

1.3.11 Numerous studies have demonstrated close correlation between per capita GNP and telephone density. Also suspected is the tightening relationship as a country's economy moves from primary to secondary to tertiary sector dominance. This should at least shows that there is a "back and forth" relationship between the two --- one aiding the other to higher status.

1.3.12 It is also interesting to note that telecom may be of assistance in more equitable distribution of prosperity. **Figure 1.7** gives comparative telephone density (ie. per 100 population) separately for urban and rural parts of several economies. Countries showing great differences between rural and urban telecom are also those with considerable rural poverty.

1.3.13 Additional modes of "non-voice" communication developed in the last decade have demonstrated ample power in operation and accentuated the gap between countries of differing economic status. This has forcefully brought home the message to developing countries leading them to give increasing priority to rapid modernisation and expansion of their telecom systems.

1.3.2 Telecom Power

1.3.21 In this century , the pool of information & knowledge has been growing exponentially. Information generated at one place can be useful in another whether it be for weather , agriculture , people , health , science , commerce or whatever. Not only is it to be used to accelerate progress but also to avoid calamity.

1.3.22 The growth in quantum & availability of information is matched by a burgeoning in variety and form. To be meaningful

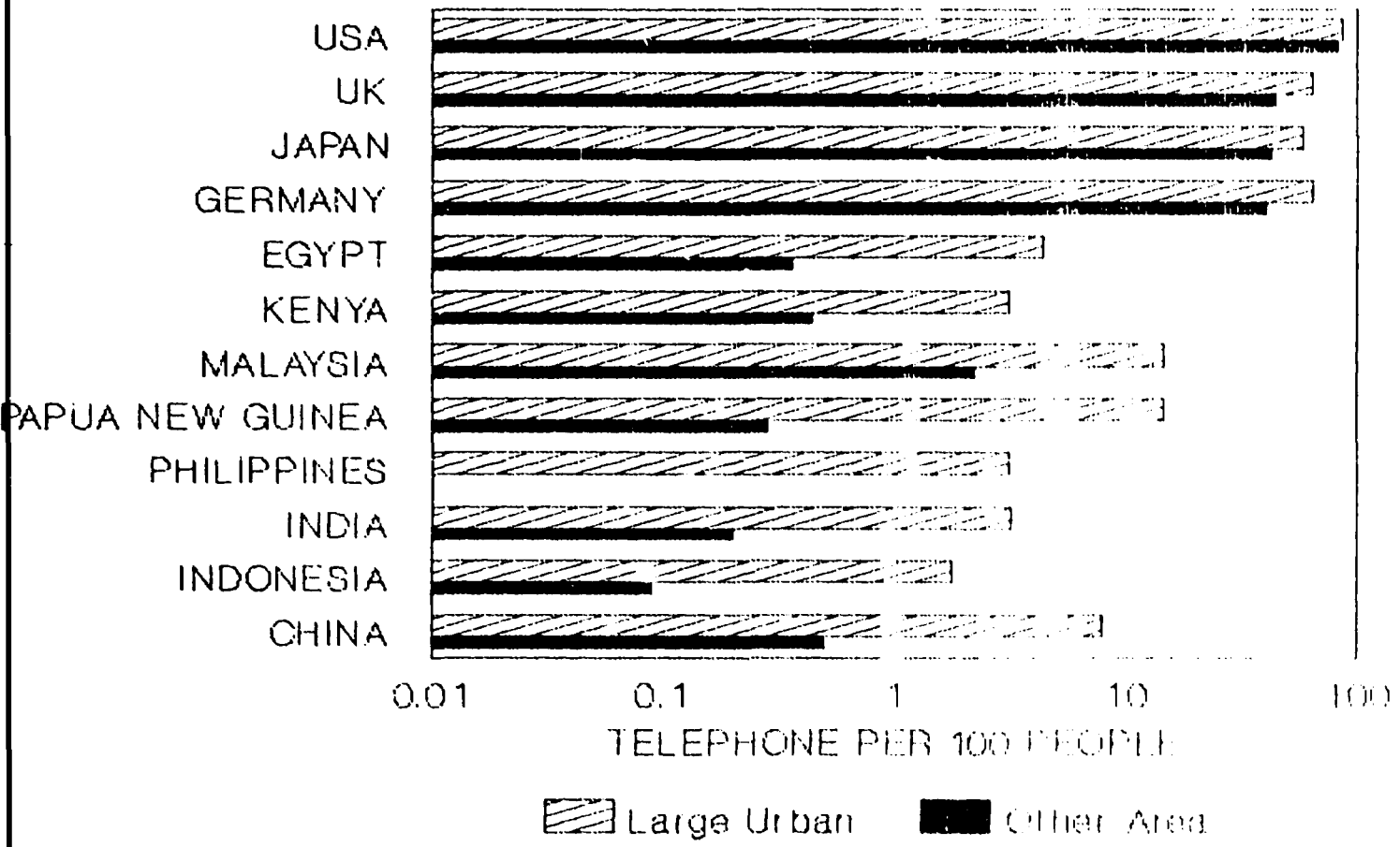


FIGURE : 1.7 TELEPHONE DENSITY DISTRIBUTION

SOURCE : AT & T CORPN, THE WORLD TELEPHONES & WORLD BANK DATA .... TELECOM & ECONOMIC DEVELOPMENT

information exists not only as voice or text but also as data, picture and often in multimode form. .This information may need to be transmitted over a few meters or thousands of kilometers. In either event: speed & accuracy & reliability are equally important.

1.3.23 The increasing power and importance of telecom derives from it growing ability to move the correct information from its source to the user instantly and in the required form .it also allows interaction between user & supplier in forms which lead to beneficial transaction.

1.3.24 Driven by new microelectronics technology and in tandem with computers telecom has become a highly dynamic sector undergoing rapid and profound changes having few comparisions with other economic sectors.

1.3.25 New technologies have enabled telecom systems to cater to more traffic & reach out to more destinations more economically than ever before. The use of microwave transmission and satellite technology enable todays systems to provide round-the-clock, near instant access to almost any destination across the globe.

1.3.26 The border line between microelectronics, computers and telecom is fast disappearing. This convergence has resulted in greater intelligence being built into switching, transmission & terminal equipment evolving new products & services and expanding the market. Services like Fax,Electronic Mail, Video conferencing etc which were in the realm of fiction a while ago are already in significant use in advanced nations.

1.3.3 **Spread Effect :**

1.3.31 Telecom and its hand-maiden electronics have become the fastest growing and profitable segments of many economies. These industries have generated considerable scientific advancement and applications which are aiding other sectors to modernise and grow. It would be hard to imagine, for instance what the aviation industry would be like without electronics and telecom.

1.3.32 Telecom services can substitute for and are more effective and more efficient in terms of time, energy, materials, and quality than all other forms of communication. With a reliable telecom system, new forms of communication are generated and more productive communication patterns built up , through direct and indirect interaction with numerous production and distribution functions.

1.3.33 Physical constraints on organizational communication are removed in various sectors of the economy, permitting increased productivity through better management in both the public and private sectors, making it possible to adopt different structures and locations. Rapid responses to market signals become possible, and access to market information is extended at village, town, city, regional, national, and worldwide levels.

1.3.3- The direct contribution of [illegible] welfare cannot be dismissed by certain [illegible] social" telephone calls. The well being [illegible] by telecom, with the provision of rapid access to [illegible] needed to preserve life, health, and property, and with enhanced contact with kin, friends, and special interest groups. Telecom contributes the development of a shared communication environment reaching a country's most remote areas and it can facilitate political, cultural, economic and social integration.

1.3.4 Status in LDC's

1.3.41 In developing countries, the stark reality is that investments in telecom infrastructure were given low priority by the controlling governments. This is probably because, telecom infrastructure requires high investment with long lead time and diffused benefits as compared to other infrastructural investments. Telecom authorities therefore have faced great obstacles in arranging priority to this investment. Further, there was a strong perception that telecom services conferred benefits only to a narrow and privileged portion of the population (foreigners and upper income groups).

1.3.42 As a result, the telecom sector in most developing countries has suffered from massive under investment, relative both to demand and economic return. **Figure 1.8** shows the pattern of growth of telephones over the last 2 decades in 15 selected countries -- advanced, advancing and LDC's. One can clearly see the sizeable growth in telepones continuing in advanced countries inspite of their existing large installed base of network. In the Pacific Rim countries -- which have made an impact on the world economic scene in the last few years, there is virtual doubling of telecom infrastructure every five years with periods of even greater growth in the periods closer to their individual emergence. The comparison also reveals the gap the LDC's have to bridge in their own telecom set-ups.

1.3.43 As a consequence of this investment shortfall whatever services that do exist (in developing countries) are concentrated in the cities. A typical position in the early 80's for selected countries is shown earlier (Figure 1.7) More often then not, service is of extremely poor quality. There is generally heavy call congestion with a high percentage of unmet or broken calls resulting in redialling which further overloads an already overburdened system. Poor equipment maintenance often results in breakdowns resulting in long periods of no service at all.

1.3.44 Governments of developing countries now agree on the need to devote a much greater share of their investible resources to the telecom sector. The increasing scale of such investments is shown in the **Figure 1.9**. The figures clearly show the higher growth rate of investment in developing countries as compared to the advanced countries though in absolute terms , the latter are far ahead.

FIGURE : 1.8 GROWTH IN TELEPHONE NETWORK

COUNTRY	TELEPHONES '70		TELEPHONES '75		TELEPHONES '81		TELEPHONES '87	
	Receivers '000	Persons per Receiver	Receivers '000	Persons Per Receiver	Receivers '000	Persons Per Receiver	Receivers '000	Persons Per Receiver
1. CHINA	NA	NA	NA	NA	NA	NA	5857	134.00
2. EGYPT	365	87.72	583	72.99	834	88.33	1455	34.00
3. FRANCE	8114	6.23	12485	4.25	24888	2.18	37120	1.50
4. HONG KONG	521	8.83	955	4.39	1675	3.25	2661	2.10
5. INDIA	1162	476.19	1689	344.82	2765	250.00	4421	150.00
6. INDONESIA	183	625.00	285	434.78	391	500.00	690	191.00
7. JAPAN	23132	4.46	41905	2.63	58007	1.82	66006	1.60
8. SOUTH KOREA	561	55.55	1014	32.25	3387	10.99	10732	3.90
9. MALAYSIA	169	83.29	259	45.24	597	22.72	1521	11.00
10. MEXICO	1325	37.45	2546	22.55	5283	13.15	8237	8.70
11. NIGERIA	NA	NA	111	625.00	154	500.00	255	337.01
12. SINGAPORE	136	14.91	288	7.95	781	3.43	1164	2.50
13. THAILAND	135	283.15	271	151.50	496	90.90	1000	55.00
14. U.K.	13947	4.01	20342	2.75	27784	2.01	29518	1.90
15. U.S.A.	115221	1.76	143972	1.51	191595	1.19	181891	1.30

Source : Encyclopedia Britanica ... Year Books ... Various Years

FIGURE : 1.9 TELECOMMUNICATION EQUIPMENT EXPENDITURE BY REGION

REGION	US $ Bill.			% Growth
	1984	1989	1994	1989-94
NORTH AMERICA	**30.3**	**40.2**	**48.8**	**4.9**
EUROPE	**28.0**	**36.0**	**47.5**	**6.2**
ASIA	**14.0**	**20.1**	**25.4**	**6.1**
JAPAN	6.6	8.5	9.8	4.0
MIDDLE EAST	1.4	2.4	3.3	9.0
INDIA	1.0	1.9	2.8	10.0
CHINA	1.1	1.8	2.8	9.8
ASEAN	0.9	1.5	2.0	8.3
OTHER ASIAN	3.0	4.0	4.9	5.0
LATIN AMERICA & CARIBBEAN	**3.0**	**4.4**	**5.1**	**5.5**
OCEANIA	**1.2**	**2.0**	**3.8**	**12.2**
AFRICA	**1.6**	**2.4**	**3.0**	**8.5**
WORLD TOTAL	**76.1**	**106.0**	**133.6**	**5.8**

Source : Arthur D. Little Inc., estimates

1.4 Socio - Economic Data of Region

1.4.1 Demographic Data

1.4.11 Important indicators of the overall demographic data for the countries under study are presented in the table below :

		Unit	INDIA	CHINA	INDONESIA
a.	**Area**	Mlln. Sq.Km	3.17	9.57	1.92
	- Arable	%	55	10	6
	- Forested	%	23	14	66
b.	**Population**				
	- Mid Year 1989	Mill.Nos.	835	1104	177
	- Urban	%	24	21.2	22.3
	- Female	%	49.7	48.5	50.3
	- Growth (1984-89)	%	2.1	1.4	2.1
	- Estd. 2000	Mill.Nos.	1042	1310	214.4
c.	**Density**	Persons/Sq.Km.	264	115.4	92

1.4.12 China tops the list of world population followed by India while Indonesia is ranked at 5th. Inspite of differing geographies & cultures it is interesting to note the close similarities in extent of urbanisation which has direct bearing on telecom demand

1.4.2 Major Resources

1.4.21 The following table shows the comparative position of each country regarding major national resources :

		UNIT	INDIA	CHINA	INDONESIA
1.	Mineral Prodn.(1986)	Mill US $	5818	11296	8374
	Coal Reserves	Bill.Tons	2	109	23
	Crude Petrol	Bill.Barrels	8	22	63
	Grain Output (1988)	Mill. Tons	176	352	48
2.	Electricity	Billion	217	497	35
	- Fuel	%	71	80	79
	- Hydro	%	27	20	21
	- Nuclear	%	2	-	Neg
3.	Literacy Rate	%	41	73	74
	- Male	%	55	84	83

- Female	%	26	41	48
e. Economically active	Millions.	245	3[illegible]	
- Agri. & Related	%	63	71	54
- Manufacturing		11	14	8

(* Data for 1981)

1.4.22 As seen from the statistics, Indonesia is rich in minerals and fuel reserves. All the three rely primarily on thermal & hydroelectric power. India leads in nuclear power generation. All the three countries are self sufficient in food grains.

1.4.23 Both China & Indonesia have a highly literate male & female population as compared to India. In all the three countries the majority of labour force is still engaged in Agriculture. It is interesting to note that, in China though majority of the work force (71%) is engaged in agriculture & related activities, only 11% of the land is cultivated. Manufacturing engages 16% & 11% of the labour force in China and India respectively and is the second largest employment sector in these countries. In Indonesia only 8% of the labour force is engaged in the manufacturing sector.

1.4.3 **Economic Data**

1.4.31 Important parameters of Indian, Chinese & Indonesian economy are presented in the following table :

		Unit	INDIA	CHINA	INDONESIA
a.	Per Capital GNP (1987)	US$	300	290	450
b.	Domestic Product (1987)	Mil.US$	220,830	293,380	69,670

			'65	'87	'65	'87	'65	'87
c.	Origin of Domestic Product							
	- Agriculture	%	47	30	39	31	56	26
	- Industry	%	22	30	38	49	13	33
	- Services etc.	%	31	40	23	20	31	41
d.	GDP Growth (1980-87)	%		5.4		9.6		4.2
e.	Trade : (1987)							
	- Exports	Mil. US$		12548		39542		17206
	- Fuels & Related	%		9		14		55
	- Agri. & Related	%		22		16		18
	- Manufacturing	%		69		70		27
	- Electronics	%		2.25		3.29		0.2
	- Telecom	%		0.63		29.01		-

- Exports (1987)	Mil. US$	16985	43392	14453
- Fuel Related	%	11	2	16
- Agri. & Related	%	16	14	6
- Manufacturing	%	73	84	78
- Electronics	%	10.5	2.0	4.6
- Telecom	%	10.5	12.6	58

1.4.32 A study of the origin of domestic product of a quarter century ago (1965 figs. in brackets) as compared to current position (1987) shows a marked decrease in the contribution of agriculture to the GDP even though, in this corresponding period each of these countries has become self-sufficient on this front.

1.4.33 The contribution of industrial output to GDP has grown fastest in Indonesia (0.8% per year) followed by China (0.44%/year) and then India (0.33%/year). The contribution of the services sector has also risen from 30% to 40% over this period in India & Indonesia though it has in fact reduced from 23% - 20% in China during the same time.

1.4.34 A review of the Trade figures show that whilst manufactured goods are a major import for all three countries, electronics has a significant share of imports in India. In Indonesia, telecom constitutes a predominant share of electronics imports. Fuels are the predominant export from Indonesia as against manufactured goods for India & China.

1.4.4 Infrastructure

1.4.41 The infrastructure consisting of different modes of transport and communication for the 3 countries is as shown below :

		Unit	INDIA	CHINA	INDONESIA
a.	Road length	km	1,772.000	983.000	220.000
	- Paved	%	47	83	39
b.	Rail-track	km	62.000	65.000	6.600
c.	Water (incl. inland)	km	10.000	110.000	13.400
d.	Airports	No	95	80	134
	- Intl.		6	5	6
e.	Radio (1988)				
	- Transmitters	No'	191	571	745
	- Receivers	'000 No.	53,937	121,212	21,785
	- Persons/Set		15	9	8
f.	Television (1988)				
	- Transmitters	No.	174	5,400	207
	- Receivers	'000 No.	13,200	126,000	7,112
	- Persons/Set		62	9	24
g.	Telephones (1987)				
	- Receivers	'000 No.	4,420	8,057	890
	- Persons/Receiver		180	134	193

1.4.42 The base of transport in India is dominated by road whereas substantial use of waterways is made in China. However, Indian railway service is known for its largest railway system in Asia. In Indonesia links by air are substantial in view of country's spread over many islands.

1.4.43 The relative affluence of Indonesia as seen from Per Capita income is reflected in the higher ownership level of radio and TV. India, with two-thirds the per capita income has half the radio/TV ownership of Indonesia. However, in China, despite per capita similar to India, while ownership of radio matches the Indonesian pattern, ownership of TV is thrice as high as even Indonesia.

1.4.44 China has by far the largest no. of telephones and comparatively higher availability of phones per population. India & Indonesia have near similar availability though India has nearly 5 times as many phones as Indonesia.

2.1 GOVERNMENT POLICY

2.1.1 Regional Linkages

2.1.11 India forms part of the South Asia subregion (including India, Pakistan, Bangladesh, Srilanka, etc.) as defined by the United Nations. In the Region, India has 88 % of the land area and 71 % of the population. It is clear that India has a large presence in the Region which will be reflected as an equally large communication network and production base.

2.1.12 The large presence of India in the South Asia Region leads to cautious bilateral relations with surrounding smaller countries. This sensitive relationship extends to telecom also. While India is technologically capable of assisting smaller neighboring countries, this subject may need to be approached cautiously from all sides.

2.1.13 The topography of the region is shown in **Figure 2.1**. India has about 3.29 million sq.mtr. area (7th largest country in the world) covering distance of 3214 Km North to South & 2933 kms from East to West. Land frontier is about 15,106 km where as coastline stretches to about 7516 km (including islands). Bordering countries comprise of China & USSR in the North; Pakistan & Afghanistan in west alongwith Male & Maldive islands in Indian Ocean; Srilanka in South separated by Palk Straits & Union of Myanmar in East.

2.1.14 Indian subcontinent is physically bounded in the north by the Great Himalaya Range, Bay of Bengal in the East, Indian Ocean (South) & Arabian Sea (West). The region is thus well marked off and forms a distinct geographical entity. Internally, India has Great mountain zone (North and North-East); Indo Gangetic Plain (Central India), Desert Region (West); Southern Peninsula (South) & islands of Andaman & Nicobar, Lakshadweep which forms part of Indian Union.

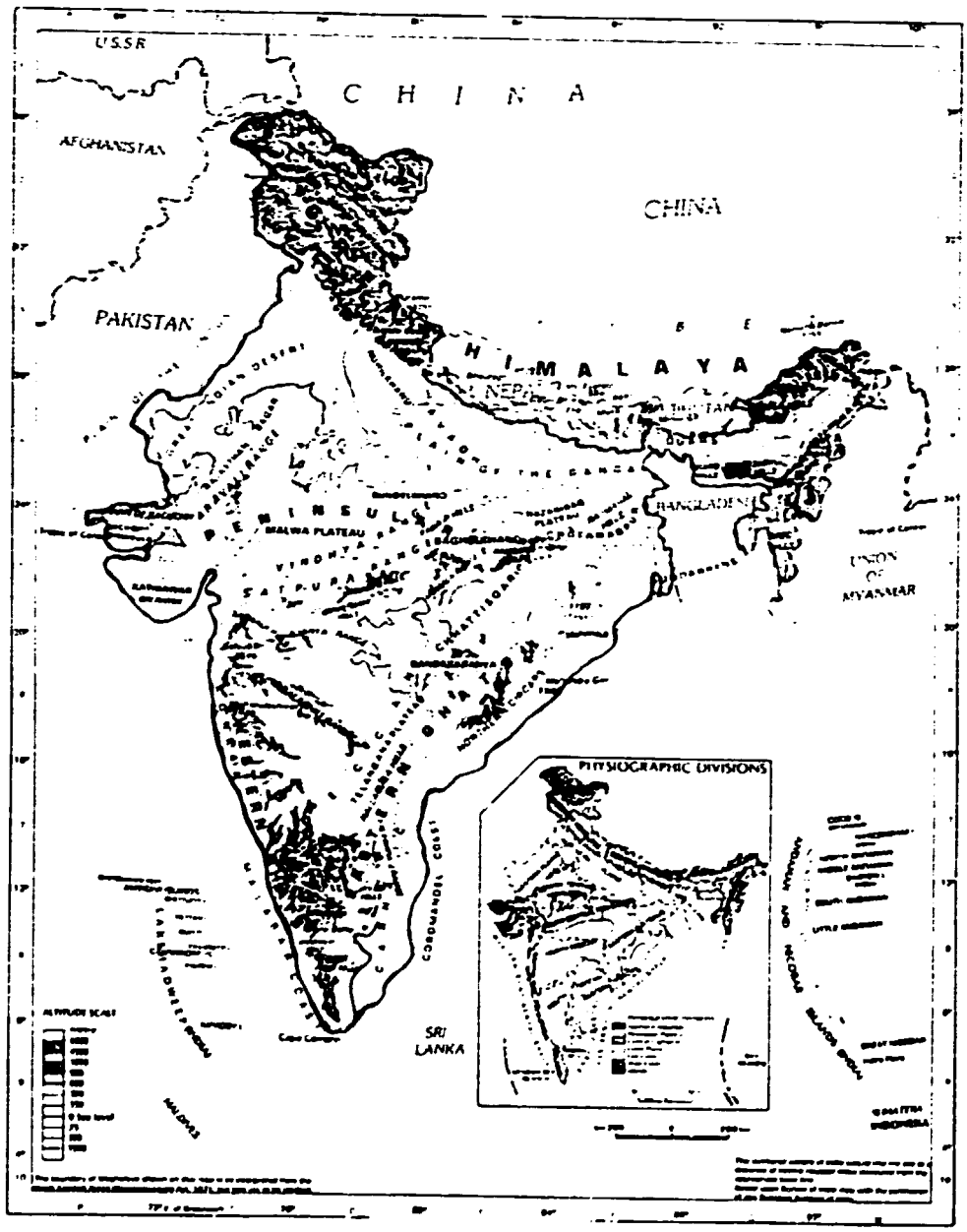
2.1.2 National Objectives

2.1.21 Successive governments, after independence in 1947, took up the daunting task of modernising the country involving, among other things, development of natural resources, core industries, transportation, education and telecom operation, production. A key intention has been to spread benefits of development to the countryside to accentuate equity, create job opportunities, minimise migration.

2.1.22 The last decade has increased government awareness of role of internal and external communication in the development process. Consequently, efforts in the field of electronics and telecomm have been intensified and increasingly opened out to private and even foreign enterprises to accelerate the development effort.

2.1.23 Administratively, the Central Government, under the President, has a number of Ministries, each headed by a Minister. The Senior Ministers of key ministries form the Cabinet, of whom the Prime Minister is the most important. Under the Ministry of Communications comes the Department of Posts & Telegraphs and the Department of Telecommunications (DOT). The separation of Posts from

FIGURE : 2.1 TOPOGRAPHY OF THE REGION



2.1.2 While DOT used to be the monopoly entity owning, operating and even producing the telecom needs, the increasing role of electronics technology has resulted in bringing into the picture the Department of Electronics (DOE). Since inputs to the telecom network are in way of electronic equipments and components, the promotion and regulation of their production lies in the hands of DOE.

2.1.3 **Industry and Technology Policy**

2.1.31 Development of industry was sought to be controlled through a series of licencing requirements :-

a. Industrial Licence
b. Capital Goods Licence
c. Foreign Collaboration Approval
d. Import of Raw Materials & Components

In addition other permissions required were pollution control, Factory's Act, etc., from local authority. Other procedures such as MRTP & FERA, sought to restrict monopolistic growth, foreign ownership respectively.

2.1.32 Local industry was protected through physical controls and high tariff walls. Small units were especially encouraged in certain products through reservations and fiscal incentives. Though these controls did enable the establishment of a wide industrial base, it also led to high cost, low quality products using rather dated technologies.

2.1.33 The 80's saw a turn-around in this situation and government began to liberalise the controls, lower the taxation and open doors to purchase of foreign technologies. The 90's are expected to speed up this process and carry liberalisation further towards a market economy. Reservations, permissions, controls are expected to be limited to certain essential areas while the rest of the industry is urged to "globalise".

2.1.34 The 1980's also saw fast growth of the electronic industry. With an active promotional policy implemented by the Department of Electronics, a vigorous electronics industry grew in stature. Since the 1980s, government, recognising the limitations of the public sector in providing products and services, began to open up production of selected telecom equipments to the states sector and later to the private sector.

2.1.35 The new government in 1991 has made major departures from traditional policy by conditionally delicensing industry in general. In Telecom, the operation of the network is retained in central government hands but increasingly, manufacture of equipments are permitted to the private sector.

2.1.36 In order to protect the indigenous equipment manufacturing the Government has levied duties ranging from 100 - 150% on finished equipments. However, certain equipment imports by DOT are allowed at concessional rate of duties. The import of components are permitted with levy of duty at 80-90%. The piece parts and basic raw materials carry duty of 40-50%.

2.1.- **R & D Approach**

2.1.1 Though there are several governmental R & D organisations with many laboratories under them, most of the R & D in Telecom has been centered at Indian Telephone Industries (Public Sector Undertaking) and Telecom Research Centre (under the DOT). There is virtually no R & D activity related to Telecom in the Private Sector thus far, since this area has only recently been opened to them.

2.1.2 The technical activity for telecom since the 1850s has been in the hands of DOT which has got its own technical wing coming under the Telecom Research Centre. This department of DOT has essentially two functions. One function was R&D to design and develop new products for manufacture and use on the network. The other function was to test and evaluate telecom products before they are used on the network. Thus, TRC was responsible for approving imported and indigenous products. They were also responsible for approval of products for which the private sector was signing collaborations.

2.1.43 Apart from this, each of the manufacturing units of DOT have their own R&D establishments. These R&D facilities range from miniscule to well established, well equipped and well funced facilities such as that of ITI. A comparison of R & D expenditure in ITI with other large MNC's shows that while the MNC's spend from 7 % (AT & T) to 14 % (NEC) of turnover on R & D, ITI spends hardly 1.4%.

2.1.44 In 1986, the Centre for Development of Telematics (CDOT) was set up with the specific objective of developing an indigenous switch in 36 months. This time schedule has slipped but C-DOT has developed an EPABX and RAX of 128 ports and 256 ports, which are in use in the network. RAX of 512 ports is under final development and will be manufactured within one year. In 1990 the TRC was bifurcated into two. The R&D activities of TRC was merged with CDOT. There was complementary in this arrangement since the emphasis of R&D in CDOT was on switching systems where as the emphasis in the erst while TRC was on transmission equipments. The merger brought together R&D activities of all telecom products under central control. The testing and evaluation functions of the erst while TRC where consolidated under a new department of DOT called Telecom Engineering Centre (TEC). CDOT is now the largest, best equiped and best funded telecom R&D centre in the country.

2.2 ROLE OF TELECOMMUNICATIONS

2.2.1 Socio-Economic Impact

2.2.11 India is a large country with considerable economic activity. It produces major materials such as steel, aluminium , fertilizers, oil, etc. and has a very large agriculture base. The country also has an affluent urban population. Though the percentage of this sector is small (25%) compared to India's total population, in absolute numbers the sector represents a market larger than many European countries.

2.2.12 While many parts in India are steeped in tradition and isolated from world trends, there is increasing economic activity which has to deal with domestic and international business. India is a major importer and it is trying to step up its exports urgently.

To achieve all this in an efficient manner, there is no alternative to having efficient communication which meshes well with international communication networks.

2.2.13 At the lowest economic activity level, a village in India is physically small. At the other end of the social spectrum, some of the largest metropolises in the world are in India. There are also culture differences over the country. Telecom is absolutely necessary to to ensure the efficient interaction between such disparate entities. Further, for government administration, the multi-tier government structure in India requires flow of information between Central Government at Delhi right down to the local Taluka office through various levels. Telecom is absolutely mandatory for achieving this efficiently rapidly.

2.2.2 Effect of Country Characteristic

2.2.21 Within the Union of India, all varieties of land forms are found. The world's highest mountains, some of the world's largest rivers, areas with some of the heaviest rainfall, deserts, islands, plateaus, coastlands, plains, moabs, etc., all exist. Weatherwise, there are areas with temperatures perennially below zero degrees Celsius, tropical rain forests, temperate grasslands and deserts are all found within India. The people are polygenetic and descendants of Negrito, Proto-Australoids, Mongoloids, Mediterrean, Western Brachycephals and Nords are all found in India. There are 15 official languages. The last census listed over 1500 different dialects as "mother tongues". Being an ancient civilization, each of these linguistic and cultural entities have existed for centuries and have developed their own traditions. It can be appreciated that the technical difficulties of setting up a national telecom network is compounded by geographical, climatic, linguistic and cultural differences extent in the country.

2.2.22 The population of India is distributed between about 3300 towns (population 5000 and above) and over 550,000 villages. There are 4 major metros and 30 city telephone districts (6 major and 24 minor) and about 134 other cities (with population 100000 and above).There is heavy use for telephones from the urban centres and in fact about 67.5 % of all telephones existing (as of 1987) in India are located in these 3300 centres.

2.2.23 The population distribution of over 550,000 villages (many not even connected by roads) is as follows:

	'000	Villages %	Rural Popln. %
Population below 500	271	49	12
Population 500 - 999	136	24	16
Population 1000 - 1999	95	17	24
Population 2000 - 4999	47	8	30
Population 5000 - 10000	7	1	10
Population 10000 & above	1	1	8
	558	100	100

2.2.24 For telecom, this distributed population implies that demand for local communication within a village is not an important consideration. Telecom will be required to communicate with other villages, with the taluka (subdistrict) headquarters, nearest town or district headquarters. Economic interaction of farmers will principally be regional and not national.

2.2.25 Government, industries, corporations, banks, etc. which have dealings with the villages, also have multilevel administrative structures. For them also the need will be for efficient communication with main branch offices, district offices, etc. This also implies that Trunk Dialing capability will be required.

2.2.26 To provide an efficient communication network in this diversity necessarily means all techniques/methods of telecom need to be used. To cope with this, the telecom network is divided into various operating agencies discussed in the next section.

2.2.3 Organization & Management

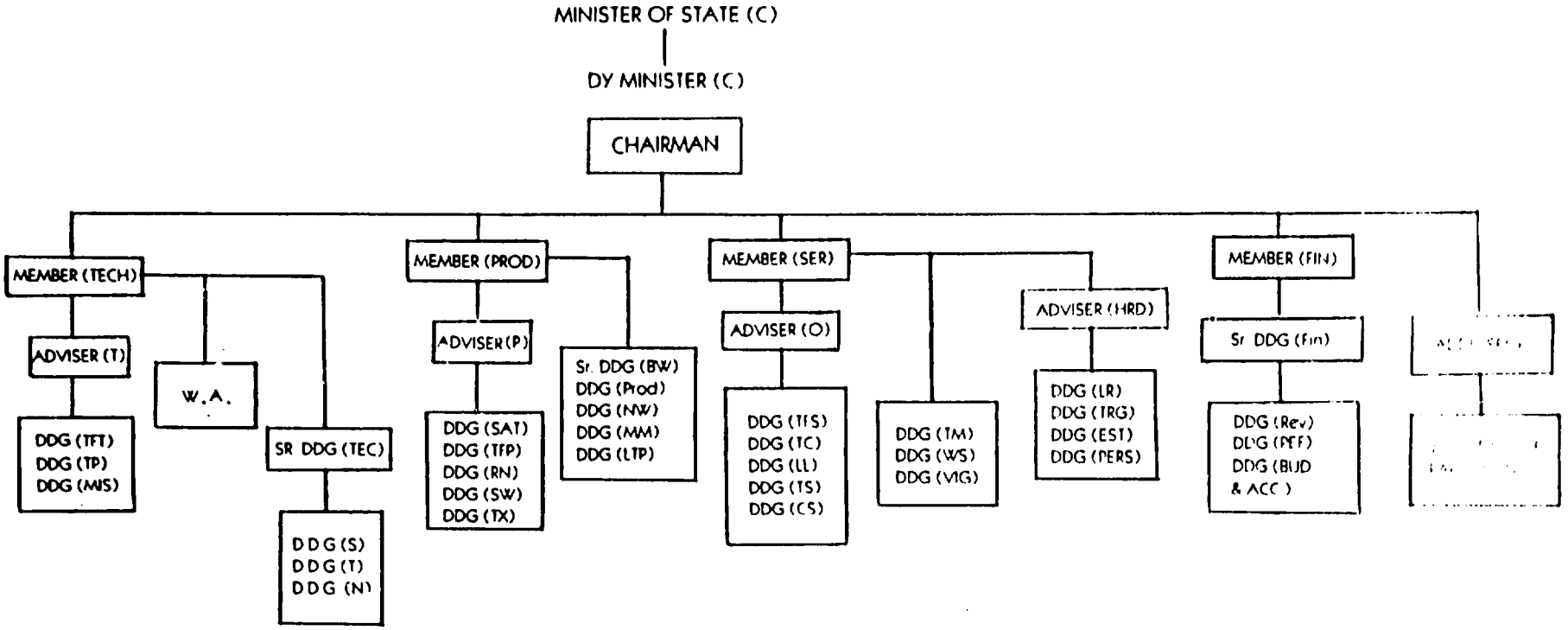
2.2.31 The operation of telecom services comes under a Minister of Communications under whom is a Telecom Commission and Department of Telecom . The organization structure is shown in **Figure 2.2.** with more complete description is given in **Figure 2.3.** In the 1970s a second ministry came into the scene. The Ministry of Electronics is entrusted with looking after the development and growth of the electronics industry in general. The DOE was concerned with licensing of manufacture and has been regulating this aspect both in terms of product and quantity since 1973. In the last few months, DOE's role has been reduced to some extent by the delicensing of industry in India. Nevertheless, it is still a crucial agency with regard to manufacture.

2.2.32 Until recently, manufacture of telecom products was mainly in the government's own telecom factories along with the public corporations - ITI, HTL, HCL. By early 1980s, demand for telecom services was far out-stripping supply, and the resources of the government to make additional investment in more corporations, was found to be limited. The government came in for severe criticism which resulted in dilution of its earlier socialistic proclivities and opening up of telecom manufacture to the private sector.

2.2.33 The first set of products to be opened for private enterprise was terminal equipment. CDOT was set up and was soon transferring knowhow for EPABX to manufacturers. The success of this exercise in eliminating supply constraints was so good that the government was opened up manufacture of small exchanges (RAX) also [illegible] the private sector. There is talk now of opening up manufacture of main exchanges also to the private sector although this has not been implemented as yet. It is likely therefore that the [illegible] will see a great increase in the role of the private sector in [illegible] manufacturing in India.

[illegible]

FIGURE : 2.2 ORGANISATION CHART OF TELECOM COMMISSION (DOT)



DDG	DEPUTY DIRECTOR GENERAL
P	PRODUCTION
FIN	FINANCE
HRD	HUMAN RESOURCE DEVELOPMENT
PROD	PRODUCTION
SER	SERVICES
T	TECHNOLOGY
O	OPERATIONS
TECH	TECHNOLOGY
RN	RURAL NETWORK
WA	WIRELESS ADVISER

BW	
TP	
MM	
LTP	
CS	
SAT	
TM	
WS	

SOURCE : DOT'S ANNUAL REPORT (1989-90)

FIGURE : 2.3 TELECOM ADMINISTRATION SET UP

Telecom Commission :

- Under Ministry of Communication
- Headed by Chairman, 4 full time and 4 part-time members.
- With full executive, administration and financial powers.
- 18 Circles covering regions other than metros headed by CGMs.
- Looking after planning, installation, operation & maintenance.
- Field administration through 18 Circles, 3 Telecom Districts (Calcutta & Madras) & Corporations (for Bombay & Delhi) as well as for overseas communication.
- Separate Project Department (Major Projects).
- Maintenance Department (long distance facilities)
- Civil Wing headed by CGM to look after inter - district activities.
- 5 Telecom factories (Jabalpur, Calcutta, Bombay, Delhi and Kharagpur.
- Satellite projects executed by CGM Satellites at Delhi.
- Consultants Corp. (TCIL)
- 38 Telecom Training Centres and 1 Advanced Training Centre at Ghaziabad.
- Manufacturing Corp. (ITI)

... limited areas. It is still early and no policy ... has emerged. The objective is for DOT to concentrate ... national networks and franchise those special services for ... demand will be limited. The franchise would have to ring the ... including the FE/ for providing the services.

2.2.48 The DOT generates its own surpluses which are reinvested after payment of government dues. Tariff setting is proposed by the DOT and implemented after government approval. This surplus has not been sufficient to expand the network as rapidly as demand required. Government departments cannot raise finances from the financial market. MTNLs were set up in Delhi/Bombay as corporations raise finances by issuing bonds, taking commercial loans, etc. and install and operate the network in metros. Thee resulting improvements have encouraging.

2.2.- **Injection of Technology**

2.2.41 The expansion of the network and detailed micro planning has been done and is being done by the DOT themselves. The DOT have used and would use the services of specialist Consultants from abroad to some extent. Nevertheless, network coverage , services and performance continues to be deficient. New theories and applications of large network optimisation could help India in getting the maximum out of the limited resources spared for telecom.

2.2.42 Technology for manufacture of new telecom products has largely been acquired through foreign collaboration. As many as 136 firms have signed collaborations for 40 different types of telecom products with 112 different foreign companies from 19 different countries. A wide variety of technologies are being inducted by public and private sectors and this creates problem of standardisation at system and component level.

2.2.43 While purchase of foreign technology has been rampant, past policies of the government were restrictive towards foreign investment. Consequently, the number of companies in telecom with foreign equity participation to any significant extent is very small. Thus technology upgradation has been a problem and each change in technology has required additional purchase of the next technology.

2.2.44 The Government has recently been accelerating the pace of liberalization. The need for investment and upgraded technology in telecom is acknowledged. Private sector is increasingly permitted to produce equipments which were a government monopoly earlier. Regulation of foreign collaboration is loosening and we may soon see larger participation in telecom production by MNC.

2.2.5 **Available Modes of Communication**

2.2.51 Most of the older telecom services are available in India though not on geographically well distributed basis. Newer services like datacom, electronic paging, cellular telephone, are being tried on limited basis at high density centres. **Figure 2.4** shows the services available in India and indicates a measure of their availability.

FIGURE : 2.4 PUBLIC TELECOM SERVICES AVAILABLE IN INDIA

SERVICES	METROS	CITIES	TOWNS	VILLAGE
1. Local Telephone	***	***	**	*
2. National Trunk Dialling (STD)	***	***	**	*
3. Intern'l Dialing (ISD)	***	***	**	
4. Telex - National	***	***	**	
5. Telex - International	***	***	*	
6. FAX	***	***	**	
7. Telegraph	***	***	***	*
8. Data Com. on PSTN	**	**	**	*
9. DataCom on upto 9600 bps	*	*		
10. Radio Mobile Service	*			
11. Radio paging service	*			

1. Above services are not all available at all locations.
2. * indicate intensity of availability

FIGURE 2.5 TECHNOLOGIES IN USE IN INDIA

Switching

- Telephone
  - Strowger
  - PC Crossbar
  - C400 Analogue Exchanges
  - SPC Analogue
  - E10B Exchanges
- Fax
  - PC Crossbar
  - SPC Analog
  - E10B
- Telex
  - Strowger
  - SPC Analogue

Transmission

- Copper Pairs
- PCM System on Copper Pans
- Digital Coax.(140mb)
- Optical Fibre (140mb)
- Analog Mw
- Digital Mw (34Mb, 140Mb)
- Analog VHF/UHF
- Digital VHF/UHF

Terminal

- Telephone
  - Electronic Telephone
  - Electromechanical
  - Payphone
  - Cordless phones
- Branch Exch.
  - EPABX
  - PABX
  - PBX
- Telex
  - Electronic Telex
  - Electromechanical Telex
  - Telex cards for PC
- Fax
  - Fax machines
  - Fax cards for PC

2.2.12 **Figure 2.5** shows the various equipments used in the network at various stages. It should be clarified that some of the main switched items used are imported as complete equipments, but demand large, the bulk of the other items are indigenously produced.

2.2.13 Cellular telephone is being seriously considered in India, but not for the reasons they are being introduced in developed countries. There, cellular telephones are for providing mobile telephone service. In India, the cost of providing and maintaining wired telephone network in the countryside (where revenue is low) would be unremunerative. Cellular is expected to provide a quicker, easier and cheaper means of providing rural service. One base station linked to the main network at a district town can take in the cluster villages in the surrounding 200 sq. kms. Malaysia has set up 36 such stations in 2 years at a cost of US$ 2000 per subscriber.

2.3 NETWORK USAGE PATTERN

2.3.1 Internal Traffic

2.3.11 **Figure 2.6** shows the major landmarks of domestic telecom growth in India. Worthy of note is the large time gap before E 10B digital exchange was introduced. This was because, despite local development of semi-electronic reed relay exchange, this stage was skipped and India rather preferred to wait for perfection of the full scale state digital exchange. Parallel with acquiring E10B technology, India also started the C-DOT program of digital exchange development.

2.3.12 Prior to 1985, the Post and Telecom were combined; as a result telecom revenue was subsidising posts. One of the reasons for the slow growth of telecom in the 1970s was this cross subsidy. With separation of post from telecom the latter is better able to deploy its resources.

2.3.13 Within telecom operation, there is at present an element of subsidy for expanding the Rural telecom network. The Rural network, because of its distributed nature, is more expensive to install, and, at the same time, revenue is also less. Expansion of the rural network is a policy decision of the government for social objectives. The surplus income generated by urban networks are used to subsidise rural network.

2.3.14 More advanced services are now beginning to enter the domestic network. A Public Switched Data Network has been created with major nodes at the four metros with 32 ports at 1200 bps and 16 ports at 9600 bps. Four minor nodes are located in four commercially important cities and in addition 12 concentrators at secondary towns. The program originally termed VIKRAM now operates under the name INET

2.3.15 Remote Area Business Message Network (RABMN) will provide telex, fax, message communication and interactive datacom services through INSAT, at speeds upto 1200 bps. The master earth station is located at Sikandrabad (UP), which will be linked to Delhi by optical fibre. Upto 1000, subscriber owned microstations @ Rs.0.25 M from ITI) can be used on this network. This service is already operational.

2.3.16 Mobile comunication (radio or cellular) has been provided by the domestic operator in limited areas of urban activity. However

FIGURE : 2.6 MAJOR TELECOM LANDMARKS IN INDIA

YEAR	STATUS
1947	Open wire short haul systems Valve type 3 channel carrier between cities Manual local trunk exchanges
1949	Indian Telephone Industries established
1950	12 channel open wire systems
1951	Improved strowger system
1956	First Coax. systems (4 MHz)
1960	STD between Delhi & Kanpur
1964	Microwave system
1967	Pentaconta Crossbar system
1985	Digital electronic exchange
1986	VSNL & MTNL incorporated Posts and Telecom bifurcated
1989	Indigenous digital electronic exchange

the service has not yet caught on and is not being extended.

2.3.2 International Traffic

2.3.21 The DOT has set up (April 1, 1986) a public sector company called Videsh Sanchar Nigam Ltd. (VSNL), which is entrusted with the task of Planning, Operating, Developing & Accelerating International telecommunication services. It is this agency which interacts with similar agencies of other countries to coordinate inter country telecommunications.

2.3.22 VSNL currently provides ISD services to 177 countries, IDD service to 154 countries, Bureaufax to 34 countries and Datacom services at 64 kbps via the INTELSAT. These services are provided via 2640 telephone circuits, 1200 Telex circuits, 204 Telegram circuits, 82 leased voice circuits, 612 International cable circuits and 240 Satellite Circuits. VSNL also operates a submarine cable of 1152 telephone channels between India & UAE. An analog link operates between its main centre at Bombay and the International Earth Station at Arvi. This is augmented by an 8 GHz digital link.

2.3.23 Rooftop FD type earth stations are being located at the 4 metros cities and INTELSAT business service is being extended at customer premises (including technology parks) for software export.

2.3.3 Private Networks

2.3.31 The public network in India operated by DOT is the largest and most widespread network by far. It handles over 90% of telecommunication traffic in the country. However, there are requirements by other agencies. These agencies include the Defence Services, railways, power transmission companies, oil and natural gas agencies, etc.

2.3.32 The special telecom requirements of these agencies arise under unusual conditions. These agencies require communication facilities at locations (usually remote) where DOT's own network is inadequate. The DOT often does expand its own network to accomodate such requirements, but this is not always possible. In such cases the concerned agencies set up and operate their own network, including lines leased from DOT where possible.

2.3.33 The medium of the network may be wired or wireless. It will be custom designed and intended to provide efficient communications at places and to the extent required by the agencies. The public has no access to such networks. The requirements of these agencies vary from time to time and place to place. Sometimes part of the service is over lines which are leased from DOT. In toto, such private networks constitute only around 10% of the total.

2.3.34 It may be added here that the CMC, using the INET network is offering private datacom service in limited locations. To conform with legal requirements, CMC offers a "total" service through use of its own computers. This is available to all users, but does not form a business in the accepted sense.

2.3.35 Data communications service has yet to take off in India in a big way. Though computer use started decades ago, widespread usage only started in the mid 1980s. Even then, the simpler computers

(PCs) were used in stand alone mode. Networking of computers has started only since 1990. Again the emphasis has been on local area networks. Mass usage of datacom is expected to take place in 1995. The exception to this are some large companies like BHEL, etc. who are multilocational, and large users of computers. Data communications is of importance to them. While the present plans for datacom by DOT appear adequate, it is expected that the general demand for data communications will increase steeply in the years, and present systems will be inadequate to meet the demand.

2.3.4 Rural Network

2.3.41 The special requirements of rural telecom were discussed earlier keeping in mind the objective to fulfill the need for regional and national trunk telephone service rather than for in-village communications the emphasis of DOT has shifted from private telephones to public telephones in villages. It is now proposed to have at least one public call box with national and international direct dialing facilities in each village. Progressively this public call box will be upgraded to handle telexes, fax and even datacomm. The emphasis is providing a service accessible to a large number of persons.

2.3.42 A decision has been taken by DOT to provide at the earliest, Long distance Public Telephone (LDPT) initially to villages with population of more than 5000. In addition, a scheme has been worked out to provide a LDPT within 5 km of any village using Multi Access Rural Telephone systems. The emphasis has changed in DOT from providing private connection , to providing accessibility to public telecom at the rural level. The DOT has developed 1+9 & 2+15 analog sharing systems for low traffic village with privacy or speech.

2.3.43 The rural network envisages a 4 tier system. At the uppermost level, 4 main switching centres (MSC) will be located at the 4 metros. Each of these will be connected to about 10 Primary Switching Centres (PSC) located at State Capital or District HQ or main industrial location. A network of about 319 Secondary Switching Centres (SSC) will be located at District HQ level. Finally, 2400 Tertiary Switching Centres (TSC) coinciding with one or more Tehsils.

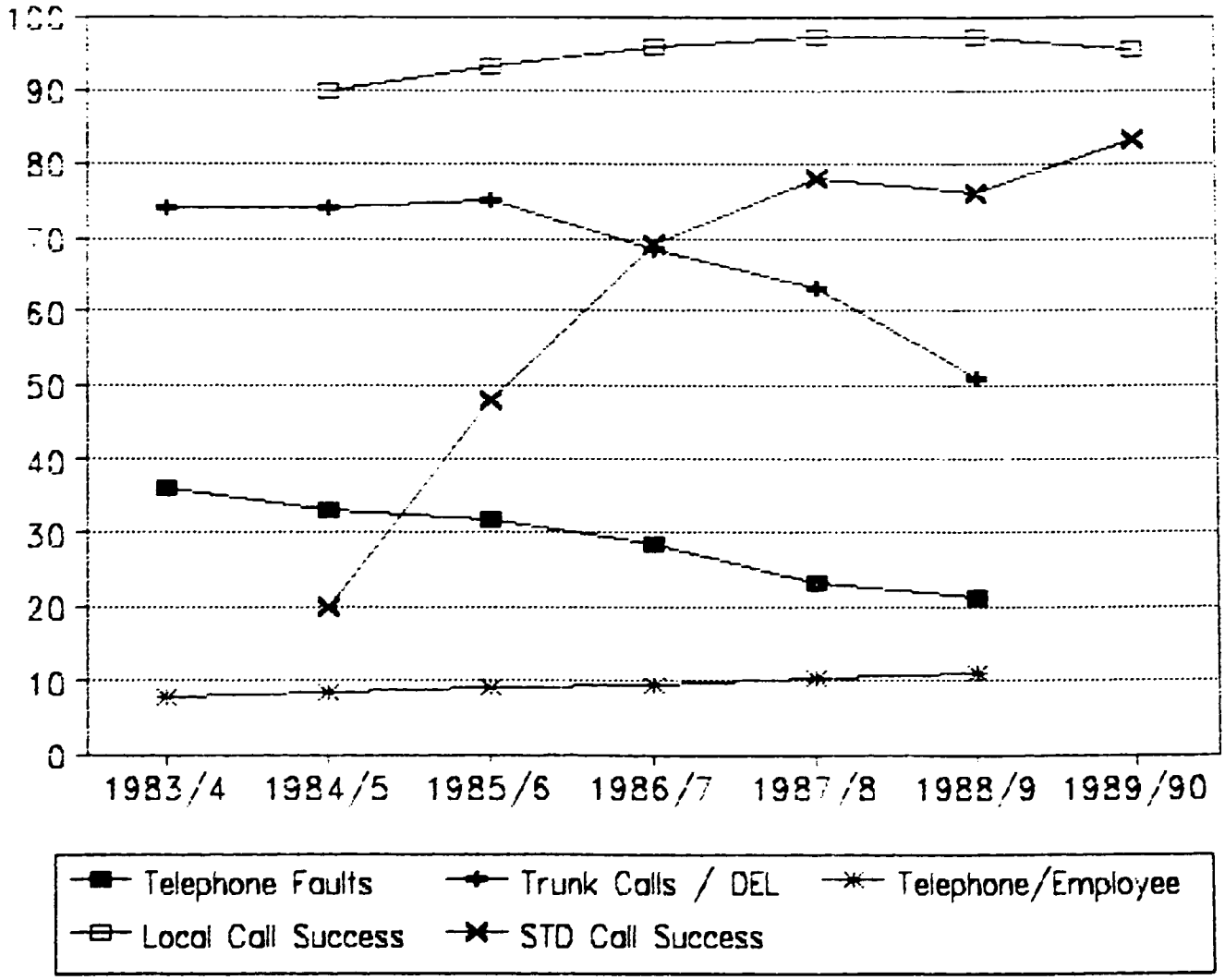
2.3.44 Connection from MSC to PSC and between PSC will use Wideband Microwave, Coaxial or Satellite link. SSC will link to PSC by Narrow band Microwave, Coaxial or UHF. Connection between SSC's will use TAX and within SSC's UHF and cable pairs will be used.

2.3.5 Network Performance

2.3.51 Several parameters of network performance are given in **Figure 2.7** It is clear that in addition to the increase in services and expansion of the network, the performance of the service is showing significant improvement in the last 5 years.

2.3.52 Despite these improvements, however, performance of the Indian network is still below norms for efficient communication. Further, the performance has improved mainly in urban areas where electronic and even digital exchanges are installed and new OSP is laid. This brings the average up. In areas with older equipments and rural surroundings different averages apply.

FIGURE : 2.7 TELEPHONE NETWORK PERFORMANCE



2.4.1 Development of Telecom

2.4.11 Allocation of resources is done by the Planning Commission, who scales departmental plans down to suit resources available. The VII Five Year Plan has been completed and the VIII Five Year Plan has technically started. However, the recent change of two governments in the last two years has created a hiatus in the planning process. The VIII 5 Year Plan is now rescheduled for the next 5 years i.e.1992-96.

2.4.12 DOT's Plans and targets for the VII Plan and for the years 1988-89, 1989-90 and 1990-91 are shown in **Figure 2.8** alongwith level of achievement.

2.4.13 The predominant transmission media used in Indian telecom network are Voice Frequency Transmitter (VFT), Coaxial cable & microwave. As at 1991, terrestrial cable covered 18.9 million circuit kms. distance followed by VFT (15.33 M.km.); Microwave (11.76 M km) and open wire (2.55 M km). The growth in route kilometer is the highest in case of VFT.

2.4.14 Switching exchanges of the network totaled to about 12,300 numbers in 1987 of manual, strowger, cross-bar & electronic digital types. In terms of numbers, about 85% exchanges are of strowger type. The future growth is expected to be highest for electronic digital exchanges which can comprise many lines in each exchange.

2.4.2 **Telephone Services**

2.4.21 **Figure 2.9** shows the growth in telephone demand and supply, which shows a widening gap. Estimate of "demand" is subjective in the sense that only the expressed or waitlisted demand is considered. In many locations, the waiting period runs into years. This acts as a disincentive and people do not register on the waitlist. Considering India's vast and growing population, and the present low level of telecom service, real demand can be taken as almost infinite.

2.4.22 **Figure 2.10** compares the density of telephones by population and by area. It is clear that even though there has been significant absolute growth in telephones, much of the increase is nullified by the growth of population.. To achieve a breakthrough, growth of telephones must be at a rate very much faster than the growth rate of population.

2.4.23 The distribution of telephone exchange capacity in 1990 in various telecom regions is summarised in the table below :

Area	Total Instal (Mill.)	% of India Total	Wait-list (Mill.)
4 Metros	1.75	35.0	0.50
6 Telecom Districts	0.58	11.6	0.25
17 Telecom Circles	2.66	53.4	0.60
All India	**4.99**	**100**	**1.30**

FIGURE : 2.3 OVERALL PERFORMANCE TO PLAN

PROGRAMME	UNIT	7TH PLAN PROPOSED TARGETS OVER 5 YEARS	1988-89		1989-90			1990-91
			TARGETS	ACHIEVEMENTS	TARGET ORIGINAL	TARGETS REVISED (ACTION PLAN TARGET)	LIKELY ACHIEVE-MENTS	TARGETS
(a) LOCAL TELEPHONE SYSTEMS								
(i) Switching capacity	Lakh Lines	21	5.18	4.85	5.62	4.94	4.94	5.5
(ii) DELs	Lakh Lines	16	4.84	3.76	5.00	3.94	3.94	5.5
(b) LONG DISTANCE SWITCHING SYSTEMS								
(i) TAX	Numbers	25	5.00	5.00	5.00	6	7.00	8.0
(ii) TAX Capacity	Lines	121400	17500	18120	37500	25000	25000	33700
(iii) Manua. Trunk Boards	Numbers	1100	60	127	60	60	60	60
(c) LONG DISTANCE TRANSMISSION SYSTEM								
(i) Coax. Cable Sys	RKMS	6670	1327	664	2351	2062	2090	3170
(ii) Microwave Sys	RKMS	11184	300	839	3581	2531	1764	3481
(iii) UHF system	RKMS	1294	2000	1385	3530	1535	2205	2420
(iv) Satellite Comm. Scheme								
a) Earth station fixed	Numbers	90	37	8	36		10	31
(v) Optical fibre sys	RKMS	5144			2636	2111	1697	5493
(d) OPENWIRE AND TELEGRAPHS								
(i) Telegraph Offices	Numbers			1270			1000	1000
(ii) LDPTS	Nos.Gross	15000	2400	2636	3000	3000	3000	15000
(iii) Telex Exchange	Numbers	100	22	38	30	30	30	30
(iv) Telex Cap. - Local	Lines	32200	10462	2356	2000	1840	1000	1766
- Trans	Lines	4600	3090	782	1750	-	1900	1626

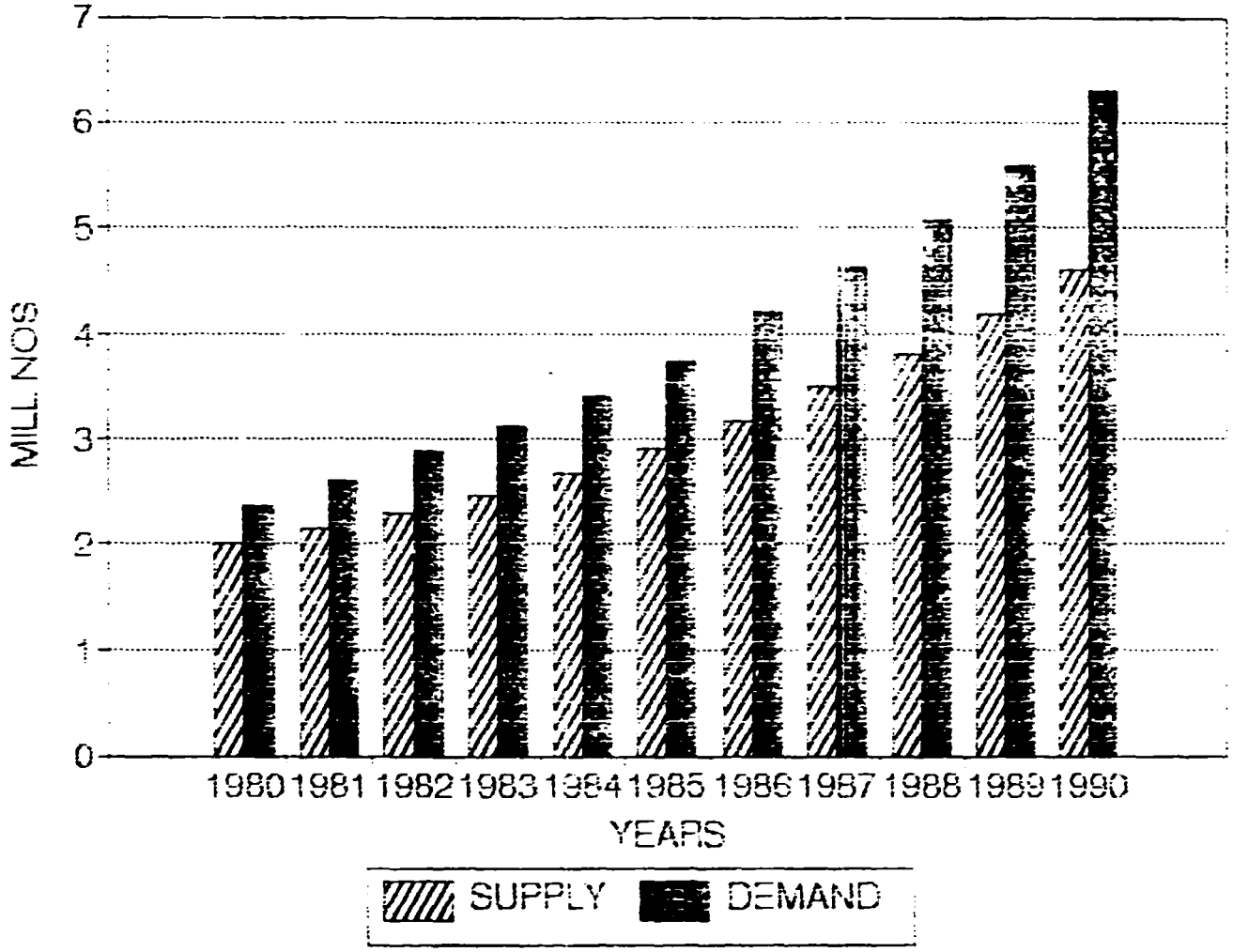
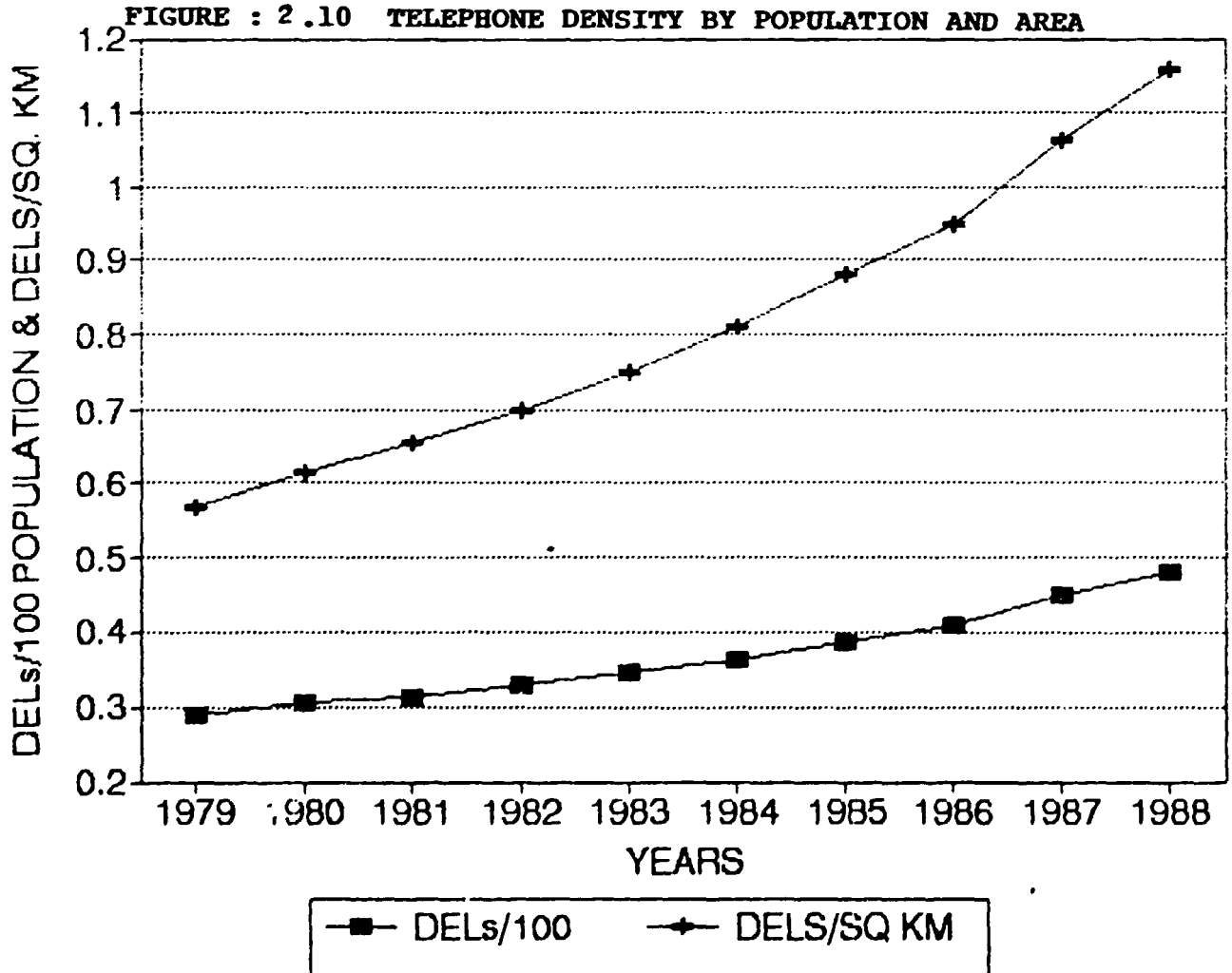


FIGURE : 2.10 TELEPHONE DENSITY BY POPULATION AND AREA



2.4.3 Text & Data Services

2.4.31 In view of limited telephone density and rural terms, telegraph continues to be a major method of transmission of information in India. This is extensively used by private citizens and to a lesser extent by government and the press. Overall usage in the last 5 years or so is essentially constant around 75 million numbers per year, 85 % of which is private. It is the increased availability of phones & telex facilities which limits the growth of telegraph usage.

2.4.32 Telex services are extensively used by business community as an efficient and cost effective mode of text communication. The growth in no. of telex lines is shown in **Figure 2.11** .

2.4.33 Opening of subscriber equipment installation has led to the attachment of several newer types of equipments to the telephone lines without much control from the operating authority. Among these are EPABX , FAX, Computer communication cards and so on. PTT is unable to keep track as registration is avoided by many users. Many of these are imported though much is available locally. General concensus is that growth is high though the base figure is small.

2.4.4 Status of Waiting List

2.4.41 We have seen earlier that with an existing population of 5 million phones, a known waiting list of nearly 1.5 million exists. DOT sources themselves estimate that for a reasonable level of telephone satisfaction nearly 30 million additional lines would need to be made available. Even if this were achieved, telephone density in India will not even be remotely comparable to that of developed countries.

2.4.42 In metros, telex lines are available virtually on demand. In other locations, there are waiting lists, though much lower than for telephones. With the recent advent of FAX, it is clear that usage of FAX is increasing rapidly. Even internationally, this is becoming the preferred communication mode. In addition to official connections, there are a large number of imported (smuggled) FAX machines unauthorisedly connected to telephone lines. Items like EPABX etc. are freely available and no waiting is required.

2.4.43 DOT revenues have grown from about Rs. 6-7 million in 1980 to about Rs. 29 billion (including increases in tariff). Revenue from telephones still constitutes over 85% of this revenue. However, since 1987, revenues from MTNL & VSNL are growing rapidly.

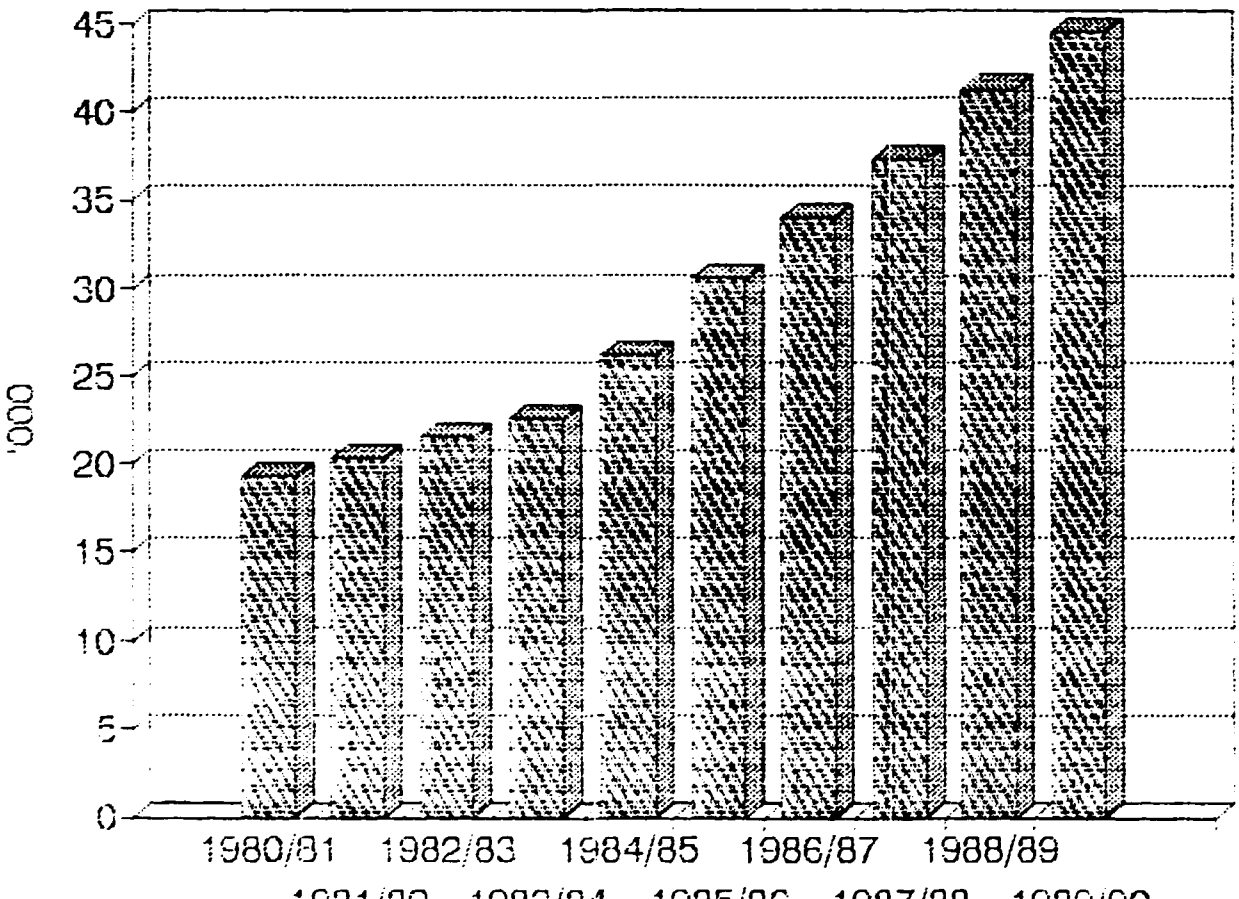
2.5 NETWORK EQUIPMENT DEMAND

2.5.1 Network Growth

2.5.11 Availability is so low compared to requirement that for many years to come, the growth of network will be limited by resources available and not by demand.

2.5.12 The new proposal put in by DOT to the Planning Commission is scaled (without reference to the needs of the country) so that 75% of investment requirements will be met from internal resources and the balance 25%, through external borrowings. It is therefore

FIGURE : 2.11 GROWTH IN TELEX LINES



likely that a very substantial portion of the new proposal will be sanctioned by the finance ministry since no budgetary support is required.

2.5.13 **Figure 2.12** gives the summary of requirement of equipments during VIII plan (details are given in **Appendix A**). The stated requirement is for the Plan period i.e. for 5 years. This is the demand for telecom products for the VIII Plan period estimated by a Panel set up for the purpose by the government in 1988. The demand figures given include not only likely consumption by DOT, but also by Railways, Electrical Power Generating and Distributing Agencies, etc.

2.5.14 It should be noted that DOT requirements would be estimated on the basis of the earlier VIII Plan (1991-95) prepared by DOT. The revised requirement for new VIII Plan (1992-96) is still in the process of finalization. Our discussions with DOT officials indicate that the requirements, if approved by Planning Commission, could, in fact, be higher than given in Figure 2.13 .

2.5.2 **Local Supply**

2.5.21 We give here an overview in broad value terms of the extent of the shortfall that Indian industry has to "catch up". It should be noted that production is dynamic and, in general, will be increasing from year to year. Particularly when new technologies are involved (as for electronic exchanges, electronic telephones, fax, etc.) the yearwise growth may be very substantial.

2.5.22 Given below is the reported value production for the year 1990, and the average value of annualised requirement, obtained from the VIII Plan figures given above:

Scale : Rs. Mill.

ITEM	PRODUCTION (1990)	ANNUAL REQUIREMENT
Large exchanges	5400	12366
Small exchanges	94	1750
Cables	1300	10126
Telephones	1900	1067
Teleprinter	564	1585
Fax	80	2018

Some qualification of the above apparent huge shortfall will be necessary.

2.5.23 Main exchanges are increasingly going to be E10B produced from the CIT Alcatel technology ; the CDOT MAX I is yet to be productionised. Strowger exchange production has been phased out.; crossbar production has been phased out in the main ITI Bangalore, but is continuing at Naini Division since E10B production has not picked up sufficiently. Private sector projects for main exchanges may be approved to fill the gap .

2.5.24 In small exchanges, CDOT technology is the preferred choice, with ITI's MILT for use in smaller (64 ports) applications. CDOT RAX manufacture has started with 8 companies being given the technology

FIGURE : 2.12 SUMMARISED REQUIREMENT OF COMMUNICATION EQUIPMENT

(Scale : Rs.Mill.)

ITEM	AMOUNT
A. SWITCHES	
Small Capacity Loc. Exch	6140
Large Capacity Loc. Exch	57240
Trunk Exchanges	4590
Transit Switch	1350
Telex Switch	960
Others	300
TOTAL	**70580**
B. TRANSMISSION	
Digital UHF	1161
Digital Microwave	5790
Satellite Comm	3093
Digital Coax	182
Optical Fibre	3229
Multiplexers	8858
Underground cables	47400
Carrier & VFT systems	1493
Rural Transmission Systems	16827
TOTAL	**88032**
C. TERMINAL	
Telephones	5336
Teleprinter	7923
Fax	10092
Payphones	1120
Modems	229
PC Fax	1375
Videotex Terminals	500
Economic Message Terminals	1000
TOTAL	**27575**
D. DATA COMMUNICATION EQUIPMENT	382
E. TELEGRAPH EQUIPMENT	500
F. MISCELLANEOUS EQUIPMENTS	3000
GRAND TOTAL OVER 5 YEARS	**190089**

2.5.1 ... that indigenous production of small ... to meet demand.

2.5.10 There is cable capacity well in excess of demand already with several private and public sector companies manufacturing a wide range of cables. The reported production figure of Rs. 1200 M appears, on the face of it, to be underreported, probably on account of data reported under electric cables, or not being reported at all.

2.5.11 Telephone instrument capacity is adequate and this is, in fact so, since several companies are working below capacity. In teleprinters, mechanical machines have been phased out and electronic machine production is picking up. According to discussions with DOT persons, there appears to be a slow down (stagnation) in the demand for telex services in certain areas. This is attributed to the increase in use of telephone and fax services.

2.6 LOCAL PRODUCTION

2.6.1 Growth of Production

2.6.11 The electronics industry in general has been growing at an average Annual Growth rate of 30% p.a for the last decade. The politics, uncertainty and FE crises in 1990-91 resulted in some short term policies being adopted to curb imports. This has had a depressing effect on the industry and may result in some slow down when looked at retrospectively. Figures are not yet available to identify definitive results.

2.6.12 Telecommunication equipments in India constitute only 20% of electronics equipment production. Since the demand for telecom equipment stems mainly from DOT, and since DOTs requirement are not market driven but budget driven, its growth rate has been steady but not spectacular. The telecom sector's production has been growing at the rate of 26% in the past few years. Details of production of switching systems, transmission media and terminal equipment are given in **Figure 2.13.**

2.6.13 The production facilities of telecom in India comprise the following:

a) Departmental - 5 telecom factories for outside plant
b) DOT Companies - 3 telecom companies for network eqpt
d) Other Central and State Public Sector Units
c) Private Sector Units

A directory of telecom manufacturers forms an **Annexure B** to this Report.

2.6.2 Public sector capacity

2.6.21 The product range and turnover of the main factories of telecom equipment (units coming under DOT) are given in **Figure 2.14.**

FIGURE : 2.13 PAST PRODUCTION OF TELECOM EQUIPMENTS

(SCALE : Rs. Mill)

PARTICULARS	1981	1986	1987	1988	1989	1990
Total Electronics	6700	34400	47200	55000	83000	92000
Large Local Exchanges						
Strowger	270	700	800	900	1000	800
Crossbar	117	550	760	700	500	500
Electronic	13	840	1500	1600	4300	4100
RAX (Electronic)	-	-	-	0.20	0.76	94
PABX/PAX (Electronic)	-	1.2	170	300	800	1000
Intercoms	-	160	70	8	24	16
Telephone cables	1.3	700	1500	1700	675	1300
Coaxial cables	-	-	-	-	-	0.04
Telephones						
Electromechanical	170	570	640	840	840	1000
Electronic	-	30	40	330	600	900
Payphones	-	-	-	-	-	0.45
Cordless phones	-	-	-	-	-	0.03
TELEPRINTER						
Elmech	61	100	100	70	35	4
Electronic	-	110	40	180	330	560
Teltx Terminals	-	-	-	-	1	1.2
Facsimile Eqpt.	-	-	-	2	25	80

FIGURE : 2.14 MANUFACTURING UNITS UNDER DOT

ORGANIZATION	PRODUCTS	TURNOVER (Rs. Mill.)
1. Telecom Factory, Calcutta	Boards, Boxes, Cabinets & Hardware	
2. Telecom Factory, Bombay	Local /STD Payphones, Cable Termination boxes, relay racks	
3. Telecom Factory, Jabalpur; Richaai ;	Poles, Towers, Cable Termination hardware	783.00
4. Telecom Factory, Bhilai	Lightweight MW Towers	
5. Telecom Factory, Kharagpur	Foundry Items	
6. ITI, Bangalore	MAX (Strowger, Crossbar, CDOT) RAX, EPABX, Telephones, Transmission Equipment	3300.00
Rai Bareilli	MAX (Strowger)	1012.00
Mankapur	MAX (E10B)	3320.00
Palghat	TAX (E10B)	999.00
Srinagar	Telephones	79.00
Naini	Transmission Equipment	1289.00
7. Hindustan Teleprinters Ltd.	Electromechanical & Elex. Teleprinter, Modems	345.00
8. Hindustan Cables Ltd.	Coaxial cables, Paper insulated cables, Jelly filled PVC cables Plastic coated wires Copper coated steel wires Optical Fibre Cables	5650.00
	Grand Total	16839.00

Note : a. On the above turnover telecom factories posted a loss of Rs. 67 Mill. ITI & HTL posted a gross profit of Rs. 461 Mill. & Rs. 18 Mill. respectively.

b. ITI is the main player, however, othr public sector and state sector factories like BEL, ECIL, KELTRON, UPTRON also produce equipments needed by DOT.

2.6.3 Organized Private Sector

2.6.31 The private sector in India comprises large units, medium units and small scale units. In general, the large and medium units are termed as organised sector. These are characterised by fairly large production, well established brands, reasonable quality, sophisticated products (usually with collaboration), etc.

2.6.32 The advent of the private sector in certain limited telecom areas has seen a rapid increase in investments and capacity in these areas. The initial euphoria however, has been short-lived since the growth in telecom investments by the Government has not matched the steep growth in capacity. Consequently, many of the private sector telecom units are facing demand constraints resulting in serious financial difficulties. A few are trying to export for survival.

2.6.33 The private sector, however, has mainly been licensed to produce subscriber end equipment viz. telephone instruments, EPABX, Telex machines, modems etc. Joint Sector units are also allowed in the area of smaller and medium switching systems. There is now a prospect of all types of switching equipments being licensed for production in the Joint as well as Private Sector.

2.6.34 The DOT has standardized on various technologies to be adopted for different types of equipments. In the area of switching systems, the system will be built around technology from M/s. CIT Alcatel of France. In the area of EPABX, technologies selected are those from M/s. Oki of Japan, Jeumont Schnider of France and CDOT. For telephones, M/s. Ericsson of Sweden, Siemens of Germany and M/s. ITT-FACE of Italy are standardized. No other technologies were permitted. Total output of this sector in these product areas is estimated at Rs.500 Mill.

2.6.4 Small Scale

2.6.41 The Small Scale sector in India was traditionally defined as those units with investment level below Rs. 2.5 Mill. Recently this level has been increased to Rs. 6 Mill. Many of the Medium Scale units set up a few years ago, now come under the Small Scale definition.

2.6.42 SSU are generally started by technical entrepreneurs and are characterised by average technology, limited facilities, limited marketing capability, average quality, etc. Their role in telecom has been restricted to supply of peripheral & ancillary equipment such as power supplies, mechanical-ware, etc. However, they have become the vanguard of sub-contracting in the Telecom field.

2.6.5 Sub-Contracting

2.6.51 It is expensive to attempt certain types of low technology work (such as metal press ware, simple sub-assemblies, harnessing, etc.) in the environment of highly structured public sector units. To benefit from the flexibility and agility of small organisations, M/s. ITI pioneered the idea of ancillary units. These are technically independent units to whom ITI assures orders and provides considerable technical support. This concept has by and large been successful though, such units do face extreme hardships when orders or payments are not forthcoming from the parent unit. on

the whole however, subcontracting industries has not been systematically organised and structured as in Japan & Korea. Not is it substantial in value. Benefit of technology transfer quality improvement besides cost reduction have thus been marginal.

2.6.6 Scope of Additional Items

2.6.61 Given the continuing need for qualitative and quantitative network improvement in the future, a whole range of telecom equipment will continue to be required. Satellite communication, digital transmission, digital switching, are all part of telecom business in the future. These items have growing potential for investment.

2.6.62 Advanced versions of subscriber equipments such as fax, modems, datacom, networking products will form increasing markets as the main network digitalises and spreads in extent.

2.7 PROCUREMENT PRACTICES

2.7.1 Procurement Size

2.7.11 Typical requirements of main equipments for VIII plan are already discussed in section 2.5. In order to meet their requirements a very large investment is needed. During the recent past it is observed that, an investment in the range of Rs. 5500/- - Rs. 6000/- is made per line. The investment per line has increased two times from 1986-87 to 1989-90. This give an idea of the size of procurement for telecom network.

2.7.12 The capital investment made during the past 10 years shows an average annual increase of 26 %. During the period 1985-86 to 1989-90 a total investment of about Rs. 78.30 Bill. was made. A typical distribution of capital outlay is shown in **Figure 2.15**.

2.7.13 This requirements during the past were met through various sources as shown in **Figure 2.16**. The bulk of supplies continue to be from public sector units. The private sevtor units contribution is showing an increase.

2.7.14 Of the total purchases for the network, import content is only to the extent of about 10-12%. The level of indigenization in various systems being manufactured in india today is high. Eg. E10B switch has indigenious content of about 89 %. CDOT RAX and EPABX has import content of about 65%. The import content in equipments is largely in certain microelectronic devices & electro-mechanical components. Most of the hardware items, wound components, PCBs, etc., are available locally of required quality & quantity.

2.7.2 Procuring Institutions

2.7.21 Equipments used on the network are procured directly by the network operators i.e. DOT, MTNL (Bombay, Delhi) and VSNL for overseas communication. The two corporations have considerable independance in procurement from local sources. DOT is kept fully in formed to obviate interface problems.

FIGURE : 2.15 CAPITAL OUTLAY DISTRIBUTION (1987/88)

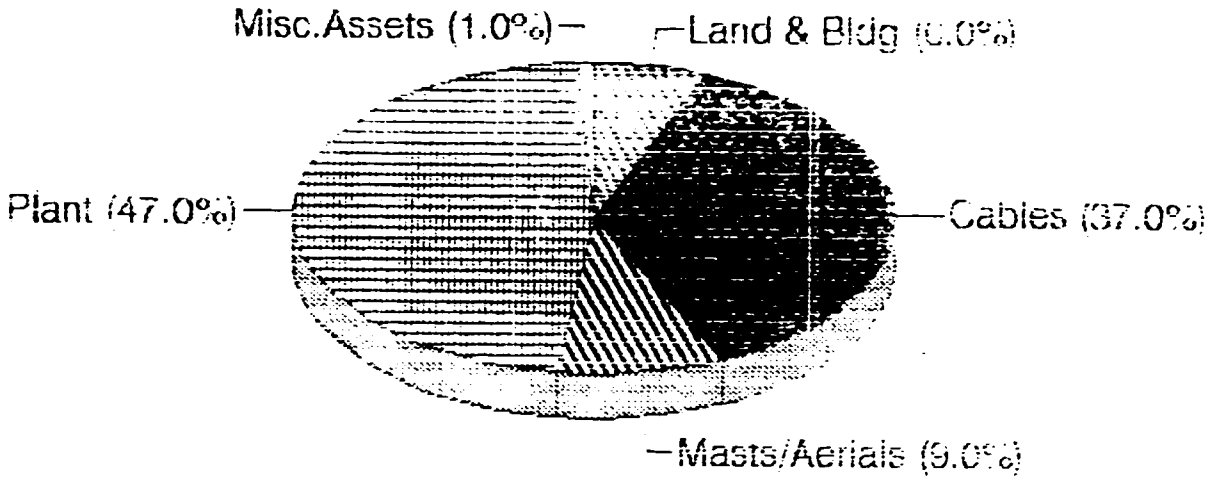
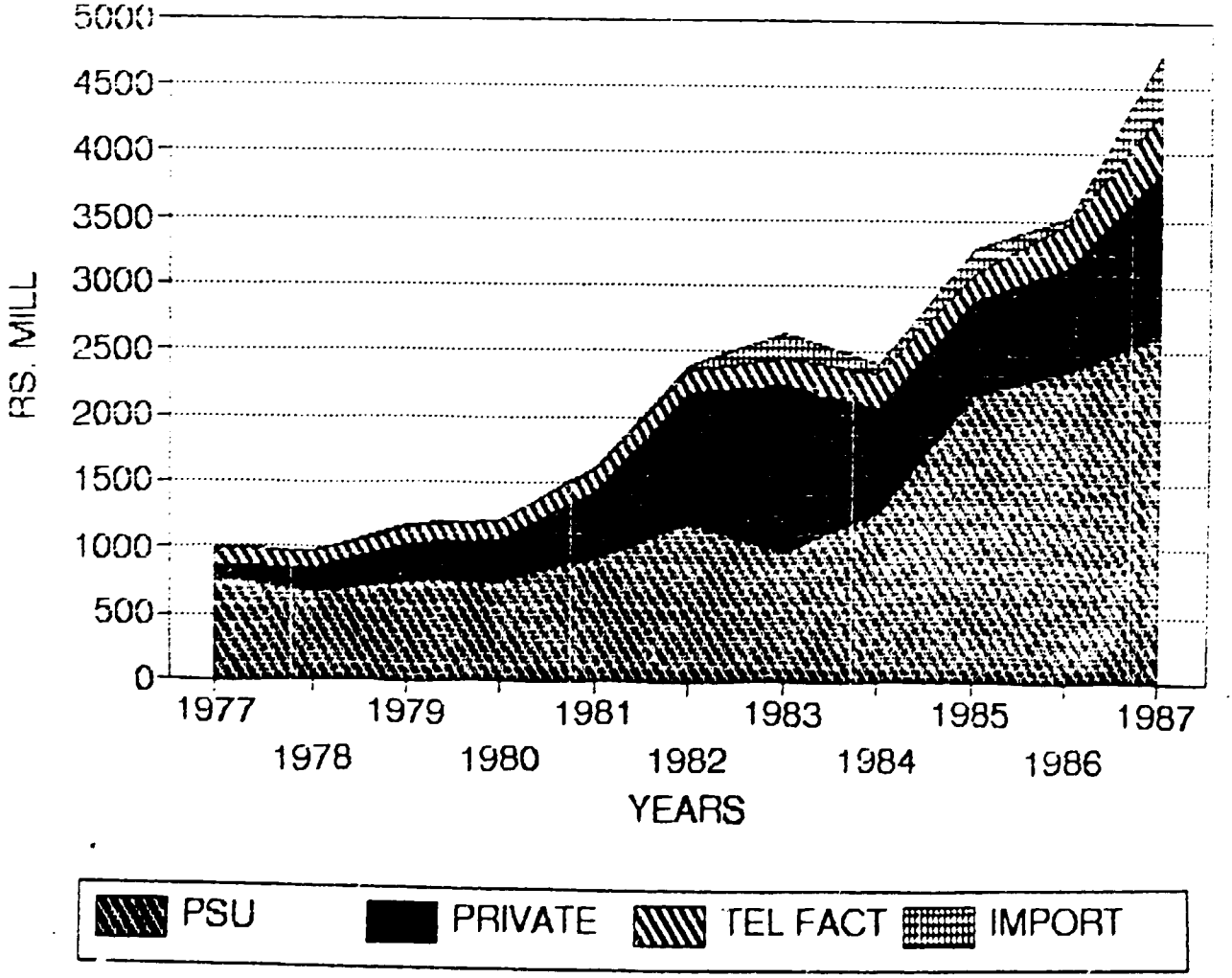


FIGURE : 2.16 INVENTORY PROCUREMENT BY SOURCE



2.7.22 Selection of equipment is done at the level of detailed technical evaluation. The depth of evaluation depends upon the value of purchase. After specs are drawn up tenders are called. All comparisons made and suppliers listed in order of preference. Thereafter, the commercial staff of DOT looks at commercial aspects and a final choice is made.

2.7.23 Purchase of technology or components subassemblies by the private sector follow normal commercial practice. Collaboration agreements, in the past, were scrutinised by the government to review the need to import the technology & terms of the agreement to fit within the guidelines. This procedure is now much simplified. Technical approval of the product by DOT is also required. The private sector manufacturer has to take this into account, when negotiating with foreign parties.

2.7.3 Global Procurement

2.7.31 In the case of major import proposals for the network eg. switches, decisions are made at ministerial level on account of the FE outflow involved. In such decisions, the finance ministry, the commerce ministry, DOE, Dept. of Industries, etc. all get involved with the Ministry of Finance having overall say in the financial decision. Technical and commercial comparison only comes after a decision to import in principle is taken at this high level. In India, because of resource constraints, the decision in the past often has been to defer purchase (import) so as to save scarce FE resources for other requirements, even though import may be desirable and necessary from solely network considerations.

2.7.32 In major international purchase of equipments and technology, the decision making is slow since number of institutions and government departments involved. Also, large value contracts acquire political overtones in India and even debates in Parliament. Long drawn out procedures tend to escalate costs, but introduces and element of openness in the decision making.

2.7.33 In case of technology procurement by private sector the Department of Electronics supervises purchase of technology . This control has now been liberalised. It should also be mentioned that about 4 years ago when telecom was opened to the private sector, the DOE negotiated technology for terminal equipment with three manufacturers for each equipment. The terms of the collaboration, the fees, etc., were finalised by DOE and it was left to individual manufacturers to select any one of the three selected collaborators, or from CDOT or ITI. This procedure has worked reasonably well. All manufacturers presently making these products are using technologies from one of the above collaborators.

2.7.4 Bilateral Country Linkages

2.7.41 The source of FE for purchases is a major consideration in any decision making. Since India's network requirements are large, continued import of equipments for the network will be restricted. A certain number of systems and subassemblies are imported as part of technology purchase.

[illegible] both based in India, a flexible debate to cover FE requirements is always given a favourable. However, this does not influence the decision making to any great extent. Most of the international purchases equipments & technology are against global tenders for competitive purchasing. In actual practice, technical requirements of the network and the commercial terms imposed, may reduce the actual number acceptable bids considered in the final decision making.

2.7.52 The Finance Ministry does influence the choice of collaboration by preferring one or other currency available with the country. This availability may be resulting from trade surpluses with different regions of the world, aid received, lines of credit negotiated, etc. This influence extends not only to the public sector, but also to the private sector. However, this factor affects technology & equipment purchase only to a limited extent.

2.7.5 Local Procurement

2.7.51 Purchase of items from indigenous sources used in the network are done more routinely. Most of the purchases of telecom products hitherto have been from ITI,where the purchase price is mutually agreed and supply is made. No tender is involved. Tenders become necessary when there are more than one suppliers in general, in such cases, DOT and other agencies like to divide orders among various suppliers so as to have a choice and also to ensure part supply in the event of one source failing.

2.7.52 Both MTNL and DOT have started the procedure of placing forward orders on suppliers who are yet to start production. This is to encourage indigenous manufacture. Investors are reluctant to invest without some assurance of orders since telecom products in India would have only one customer.

2.7.53 Purchase of components for indigenous manufacture of equipment is done at the level of the manufacturer and does not require any decision by the telecom network operator. The source of technology (collaborator, designer, etc) invariably specifies the component and possible sources. In the event of knowhow coming from a foreign collaborator, a phase indeginous approach is followed first with , mechanical hardware followed by passive components, components, PCBs, electromechanical components, etc. The last item to be indigenised microcircuits (depending upon availability). In the past imports were control through a series of licences and permits, but these have now been abandoned.

2.5.74 Major items of purchase are bought from established companies in the large or medium scale. Small scale suppliers are limited to supply of noncritical items such as outdoor plant, mechanical hardware, etc. A 15 % prererence is given to local items over imports ; another 15 % to small scale -- always subject to quality and delivery.

2.8 MARKETING PRACTICES

2.8.1 Local Marketing

2.8.11 The local market for Telecom equipments falls into 2 distinct categories Public network equipments (transmission & switching) and

subscriber end equipments. Local producers of equipments/parts for public network have essentially to service the DOT. They have to first get their product approved by DOT. A "rate contract" is then negotiated with DOT. An after-sales service back-up is always insisted by DOT. The marketing of subscriber end equipment is done by following standard marketing practices by having a mix of retailing & direct-selling methods.

2.8.12 Almost all major world players in telecom have their own offices or representatives in India. Their concentration is on major switching & transmission equipment sales to DOT and some of the high end subscriber equipments. The functions of such offices essentially centre around keeping tabs on developments in the market, following up tenders & bidding to DOT, providing initial level of technical liasion & support to DOT and selling technology to private companies and/or DOT.

2.8.2 Regional Marketing

2.8.21 Activities of Indian companies to market in the South Asia region is very limited. The other countries within the region face foreign exchange limitations just like India does. They require aid and assistance for purchase of telecom equipment. India is not in a position to extend aid. When aid comes from developed countries, it is generally tied to supply from the donor country.

2.8.22 The interest of Indian manufacturers is to earn hard currency foreign exchange. This cannot be achieved by selling to the region around in India. The regional countries themselves prefer to buy from MNCs as part of aid that is provided by those governments. Whether these countries are getting value for money is a separate matter.

2.8.3 International Marketing

2.8.31 International marketing of Indian products has just begun in a very small way. In the case of public sector units this has been through government to government agreements. Recently, C-DOT has signed a technology transfer agreement with the government of Vietnam for supplying technology for manufacturing RAX equipment. These are occasional events and are not a consistent marketing approach.

2.8.32 International marketing by the private sector has just begun and its effects are not yet clear. The role of the private sector in telecom in India is itself just beginning. Export will only come in a significant way after sometime. Some of the companies who are facing financial difficulties on account of limited offtake by DOT are looking to exports for reasons of sheer survival. The extent of [illegible]

2.9 REVIEW OF INPUTS

2.9.1 Semiconductor Devices

[illegible] The semiconductor [illegible] manufacturing [illegible] and [illegible] devices. However, [illegible]

their range to few largely used devices required for consumer electronic market. Production of processing grade devices is a secondary activity especially devices which continue to be imported.

2.9.11 Micro circuits form largest group of components by value required for telecom equipments but unfortunately the weakest area as far as India is concerned. Micro circuits upto the level of medium scale integration are made to a limited extent. The emphasis is on linear and TTL devices which are used in many other applications also. Diffusion technology is adequate to handle 5 micron geometries. Assembly of IC's from imported diffused wafers is undertaken for more complex but fast selling ICs.

2.9.12 The most prestigious government sponsored microcircuits manufacturing at Semiconductor Complex Ltd was destroyed in fire some years ago. A large investment is sanctioned to bring this project back on stream with up-graded technology to the level of 1 micron technology. ITI is implementing a project to make integrated circuits down to 1.5 micron CMOS technology. A tripartite agreement has been signed with VLSI Tech Inc & ARDUE-Tech Inc for transfer of technology for ASICS. Government clearances are awaited.

2.9.13 In case of Hybrid micro circuits, there are 2 public sector units and 3 private sector units, well established in this area. All these units have adequate technical and production capabilities. India thus can be stated to be well along in Thick Film Technology.

2.9.14 India has no silicon foundry for manufacture of ASICS presently. ASICS are being designed in India at various locations (ITI, BEL, CDOT, etc) and manufacture is being done by international companies. DOE has set up 10 VLSI design centres in India partially funded by UNDP. In fact, VLSI Technologies of USA has opened a branch office in Bangalore with the express purpose of assisting Indian designers in fabrication of ASICS using their foundry in the USA.

2.9.2 Passive Components

2.9.21 Thanks to a healthy growth in Consumer Electronics manufacturing for several decades, India has been able to establish a base in manufacture of passive components of many types and is essentially self sufficient for routine components. There is even some export. Special purpose passives including SMD are imported until volume requirements arise.

2.9.22 In the absence of any strong demand for Surface Mount Components, this area has lagged behind. Except for 2 companies beginning in Multilayer Ceramic Chip capacitors, there is absence of SMC in India. This is likely to be a major hurdle when manufacturing technologies change.

2.9.3 Electromechanicals

2.9.31 India is particularly strong in PCB manufacture with a number of independent companies in the field & also major telecom equipments producers having captive plants. Few local units are capable of producing multilayer PCB's & infact some of them are exporting these.

2.9.32 Connectors are also being made in the country but the variety of connectors needed is so large that not all types are economical to manufacture in India because of limited demand per type. This is an area which could profit by standardisation. There is, in fact, substantial import of connectors. The same is true, to a lesser extent, in the areas of relays and switches.

2.9.33 Most companies, including CDOT are taking a developmental approach with Indian manufacturers in this area. Where Indian component manufacturers are unable to match the quality of the product specifications, major Indian users work together with present manufacturers to improve their quality to the required level. Inspite of this, value wise there continues to be significant import in these areas (especially connectors).

2.9.34 Growth of local production of major components is shown in **Figure 2.17.**

2.9.4 Wires & Cables

2.9.41 India is presently self sufficient in the area of wires & cables. Manufacture of Jelly Filled Telephone Cables and Optical Fibre cables too has started and self sufficiency in the former will soon be achieved. In the latter area, presently there is self sufficiency with only two units in production. More capacity may however be needed in mid. 1990's. Manufacture of the optical fibre itself is also undertaken.

2.9.5 Production machinery

2.9.51 At the present levels of production, electronic equipment manufacturing is accomplished largely by manual or semi-automatic processes since the output does not justify the use of automated assembly systems. Suitable machines for manual and semi-auto levels are locally produced. For more advance technologies viz. SMT etc. the required machines are not available locally.

2.9.52 General Purpose Test Equipment like DMM's, Oscilloscopes, Power supplies etc. are produced locally in collaboration with renowned names like HP, Teletronics, Gould etc. Specialised test equipments (including automatic test equipment for use in telecom are presently being imported. It might be mentioned that DOT & MTNL themselves import specialised telecom test equipment for network maintenance.

2.9.53 Environmental Testing of Telecom equipment is required to ensure reliability. A wide range of simple environmental test chambers is available from local fabricators to meet these needs. Only the most sophisticated types of computerised temperature cycling chambers etc. need to be imported at present. Though technological capability to produce even such chambers exists.

2.9.6 Design centres

2.9.61 Telecom has long been the preserve of the Public sector and as such most of the Design & Development work has been under the aegis of Government agencies like CDOT (which now also includes the Telecommunications Research Centre) and ITI. Historically most of the research was done at ITI, for its own use, in its

FIGURE : 2.17 GROWTH IN COMPONENT PRODUCTION

(Scale : Rs. Mill.)

	1986	1987	1988	1989	1990
COMPONENT TOTAL	**5094**	**7000**	**10250**	**14400**	**15200**
ACTIVE	1444	2190	3643	6268	6159
ELECTRON TUBES	786	1378	2688	5027	4921
DISCRETE DEVICES	525	284	642	715	703
INTEGRATED CIRCUITS	133	231	312	526	535
PASSIVE	1218	1518	2010	2267	2571
RESISTORS	278	343	517	502	561
CAPACITORS	693	857	1102	1310	1414
CRYSTALS	37	48	62	64	64
MAGNETS	213	270	329	411	492
ELECTRO-MAGNETIC	754	915	937	1169	1095
ELECTRO-MECHANICAL	394	489	634	808	984
CONNECTORS	117	160	252	248	380
RELAYS & SWITCHES	233	268	339	497	525
OTHERS	44	41	43	63	79
PCB	448	587	698	1072	1165
OTHERS	836	1301	2329	2796	3226

Source : DoE Annual Reports

several well equipped, well staffed design laboratories. Inspite of this, most of ITI's turnover comes from equipment built to collaborators designs.

2.9.62 The CDOT is an independent development agency under DOT. It licences its designs to private or public sector units. So far, it has licensed production of EPABX, RAX 128, RAX 256, and RAX 512. In course of time, larger exchanges will be licenced. Figure 2.18 lists some of the technologies that CDOT will be licensing in the next 3-4 years.

2.9.63 The private sector has only recently been allowed a limited entry into the Telecom sector. Present role of R&D is restricted to component indigenisation in collaborators designs. The future may see development of variants on collaborators designs.

2.9.64 Software is India's strength. India has a flourishing software industry and many international companies have set up in India to take up development of software here. The entire software for CDOT equipment has been developed indigenously. India can be claimed to be fully self sufficient in software capability.

FIGURE : 2.18 TECHNOLOGIES FROM CDOT

A. SWITCHING EQUIPMENT

1. 128 port RAX
2. 250 port RAX
3. PABX
4. Automatic Call Distribution Eqpt.
5. MAX-M (400 - 1400 lines)
6. MAX-L (1000 - 10,000 lines)
7. MAX-XL (>10,000 lines)
8. RLU
9. ISDN Units

B. **TRANSMISSION EQUIPMENT**

1. 215 MARR
2. 600 MHz 10Ch Eqpt.
3. 400 MHz 10 Ch. Eqpt.
4. Single Ch. VHF Eqpt.
5. TDMA Pt Mutlipt.
6. 34 Mb Dig. Mw Eqpt.
7. 134 Mb Dig. Mw Eqpt.

C. **SATELLITE BASED EQUIPMENT**

1. SBRTN
2. VSAT
3. TDMA (60 Mb)
4. Speech Codec

D. **OPTICAL COMMN. EQUIPMENT**

1. 2Mb OLT
2. 8Mb OLT
3. Synchronous Digital Hierarchy (Long Term)

Note - 1. Above technologies are already on offer or will be by 1993.

APPENDIX : A DETAILED REQUIREMENT OF COMMUNICATION EQUIPMENT

	USER	QTY	VAL.(RS M)
SWITCHING EQUIPMENT			
Local Switching Eqpt.			
a) Small cap. (L Lines) [illegible] lines	[illegible]	[illegible]	[illegible]
	Rlys	[illegible]	[illegible]
b) Larger capacity (L lines)	DOT	[illegible]	57100
	Rlys	[illegible]	140
Trunk Switching Eqpt. TAX ('000 line	DOT	306	4590
Elex. Transit Switch for [illegible] workin	DOT	[illegible]	1350
Telex Equipment ('000 lines)	DOT	[illegible]	960
	Rlys	[illegible]	15
Electronic PABX PAX (sel.type)	DOT	N.A	N.A
	Power	[illegible]	300
SWITCHING EQUIPMENT TOTAL			70595
TRANSMISSION EQUIPMENT			
Digital UHF System			
a) 30 Chl. Tmis.	DOT	1200	600
	Rlys	250	125
	Power	125	63
b) 120 Chl. Tmis.	DOT	600	300
	Rlys	145	73
Digital Microwave System			
a) 2 GHZ Digital M/w Tmis.	DOT	400	320
	Power	360	288
	DOT	250	300
b) 4 GHZ Dig. M/w Tmis.	DOT	1600	1920
c) 6 GHZ Dig. M/w Tmis.	DOT	850	680
d) 7 GHZ Dig. M/w Tmis.	Rlys	1250	1000
	Power	11	88
	DOT	100	120
e) 11 GHZ Dig. M/w Tmis.	Power	55	66
	DOT	900	720
f) 13/15 GHZ Dig. M/w Tmis.	Rlys	360	288
g) 18 GHZ Dig. M/w			
Satellite Communication Eqpt.			
a) Dig. Earth Station using TDMA/DSIDOT		16	410
b) VSATS using AA-TDM tech. with hub TDMA	DOT	500	1200
	Rlys	134	300
	DOT	50	500
c) Extended C Band/KU Band Earth Stn			
d) High power Amplifier (HPA)			
i) 20W HPA (1+1)	DOT	73	80
ii) 100W HPA (1+1)	Total	19	28
iii) 400W HPA (1+1)	Total	4	8.0
iv) 3KW HPA (1+1)	DOT	2	9.0
e) SCPC Modem	DOT	1900	190
	Power	100	10
f) CFM SCPC Bays	DOT	74	133
	Power	11	20
g) Low Noise Amplifier	DOT	75	30
i) (90 deg.K(1+1)	Power	9	3.6
ii) ..40 deg. K	POwer	1	1.2
h) Sat[illegible]lite Antenna			
i) 14[illegible]	DOT	1	10

ii) 11M	Total	3	15
iii) 7.5M	Total	73	131
iv) 4.5M	DOT	22	11
Digital Co-axial System			
i) 140 mb/s Tmls	DOT	14	21
ii) 140 mb/s Regenerators	DOT	256	46
iii) 34 mb/s Tmls.	DOT	88	33
iv) 34mb/s Regenerators	DOT	350	64
Optical Fibre System			
a) 565 mb/s Tmls	DOT	30	20
565 mb/s Regenerators	DOT	10	2
b) 140 mbs Tmls.	DOT	1120	383
140 Mb/s Regenerators	DOT	200	24
c) 34 Mb/s Tmls.	DOT	430	74
	Rlys	32	6
	Power	43	7.4
34 Mb/s Regenerators	DOT	22	2.6
	Rlys	76	9.0
	Power	32	3.6
d) 8 Mb/s Tmls.	DOT	850	85
	Rlys	40	4
	Power	43	4.5
8 Mb/s Regenerators	DOT	10	1.0
	Rlys	420	42
	Power	60	6
e) 2 Mb/s OFC Tmls.	DOT	100	10
	Power	19	2
2 Mb/s Regenerators	Power	30	3
f) 12 Fibre optical cable in KM	DOT	14300	872.3
8 Fibre optical cable in km	Rlys.	3350	148
h) 6 Fibre optical cable in km	DOT	2650	117
i) 4 Fibre optical cable in Km	DOT	3000	105
j) 8 Fibre self supporting non-metallic cable for spans 300 500m in Km	Power	3229	646
k) 8 Fibre composite cable power comprising earth wire built in optical fibre OPGW in Km	Power	3229	646
Multiplex Equipment			
a) FDM Mux (Group Ends)	DOT	1500	1000
b) Digital Mux			
1st Order Mux	DOT	8580	441
	Rlys	1050	48
	Power	1000	47
2nd Order Mux	DOT	21476	988
	Rlys	650	30
	Power	190	9
3rd Order Mux	DOT	6838	314.4
	Rlys	160	7.4
	Power	95	4.4
4th Order Mux	DOT	1596	73.4
5th Order Mux	DOT	16	NA
PCM Systems	DOT	39300	5895
Underground Tel. Cables (in L CKM)	DOT	790.36	47400
- Accessories	DOT	NA	NA
- Gas pressurisation equipment	DOT	NA	NA
Carrier & VFT Systems			

a) 3 Ch. Open wire System	DOT	2000	150
b) 3 Ch. Open Wire System	DOT	750	90
c) Time Division Multiplex /FT Sys	DOT	3000	1170
d) 3 + 4 Dx	DOT	1500	82.5
Rural Transmission System (06-10-30 Ch., UHF or SDM or Optical Fibre)	DOT	13045	16827
TRANSMISSION EQUIPMENT TOTAL			87919.9
TWO WAY RADIO COMMUNICATION EQUIPMENT			
(a) HF Transreceiver	DOT	500	125
i) 1000	DOT	500	40
ii) 15W	Power	145	10
(b) UHF Station	Rlys	90	18
i) Base	Power	1520	15
ii) Termina.	Rlys	900	10
iii)Mobile	DOT	15000	300
(c) UHF Station			
i) Base	Rlys	240	70
ii) Mobile	Rlys	9900	99
(d) Cordless Telephone	DOT	2500	350
(e) Multible Access Rural Radio	DOT	500	1000
TWO WAY RADIO COMMUNICATION EQUIPMENT TOTAL			2057
PLCC EQUIPMENT			
PLCC Equipment Terminals	Power	3300	363
PLCC Coupling Device	Power	3650	55
Protection Signalling Eqpt.	Power	650	29
PLCC EQUIPMENT TOTAL			447
TERMINALS			
Telephones (in lakhs)	DOT	88.25	5300
	Rlys	0.6	30
	Power	1	6
Teleprinters (in thousands)	DOT	72	2520
	Rlys	0.96	35
	Power	0.9	32
Facsimile Eqpt. (in nos) Rlys	DOT	170	85
	POwer	140	7
	DOT	100000	10000
Payphones (in thousand)	DOT	75	1120
Modems (in nos)	Power	4450	60
	Rlys	4000	50
i) Baseband Modems	DOT	2500	54
ii)Voice Band Modems	DOT	5000	65
PC Facsimile	DOT	25000	1375
Videotax Terminal	DOT	50000	500
Economic Message Terminal	DOT	100000	1000
TERMINALS TOTAL			22162.5
DATA COMMUNICATION EQUIPMENT			
a) Packet Switch Exchanges			
i) Medium Size	DOT	10	120
ii) Concentrator	DOT	90	20

iii) [illegible]	[illegible]	[illegible]	30
[illegible] Master Computer	[illegible]	[illegible]	[illegible]
DATA COMMUNICATION EQUIPMENT, TOTAL			132
EQUIPMENT FOR TELEGRAPH SERVICES			
a) Store Forward Message Switch - 128 ports	DOT	3	90
b) SPMS _ 64 Ports	DOT	10	60
c) SPMS _ 32 Ports	DOT	15	45
d) Message Handling Sys(X400 Switch)	DOT	4	80
e) Electronic Key Board	DOT	5000	120
f) Electronic Key Board Concentrator	DOT	1000	100
g) Phonocom Concentrator	DOT	1000	15
h) Electronic Cash Machines	DOT	600	50
EQUIPMENT FOR TELEGRAPH SERVICES, TOTAL			520
Computerisation for telephone billing, fault control, directory enquiry, office automation	DOT	100	350
a) Float Rectifier	DOT		
i) 800 Amp		340	60
ii) 400 Amp		828	110
iii) 200 Amp		2001	200
iv) 100 AMp		2200	154
v) 25 Amp		585	23.4
b) Battery Charger	DOT		
i) 600 Amp		170	30
ii) 300 Amp		633	88
iii) 150 Amp		2765	276.5
iv) 75 Amp		1070	59
v) 25 Amp		585	17.5
c) Switching Cubicle			
i) 4000 Amp	DOT	170	36.7
ii) 2000 Amp		195	18
iii)1000 Amp		438	33
iv) 500 Amp		3196	195
v) 100 Amp		585	11.7
d) Float - battery charger 6/12 Amp DOT		11800	212.4
e) Battery			
i) 5000 AH	DOT	340	353
ii) 3000 AH		390	239
iii)1000 AH		769	154
iv) 600 AH		4012	410.2
v) 400 AH		2339	145
vi) 120 AH		25770	
f) Invertor			
i) 1 KVA		200	8.8
ii) 6 KVA		300	163
iii)24 KVA		2	2
iv) 35 KVA		1	1.2
POWER PLANT EQUIPMENT, TOTAL			2992.4

CHAPTER : 3 INDONESIA

3.1 GOVERNMENT POLICY

3.1.1 Regional Linkages

3.1.11 With an area of over 1.92 million sq.kms: Indonesia is located between the South East Asian & Australian mainland. On sea-route it is situated between India & China. The country consists of some 13,667 islands extending in an archipelago for over 5000 kms.

3.1.12 Vegetation of the country ranges from mangroves & swamps along the Sumatra & Kalimantan coast-lines. Of the total area 8% is arable land & over two-thirds is forest or wood-land. Between the two ocean shelves of Sunda (Malaysian & Indo-chinese extension)& Sahul (emanating from northern Australia), the Lesser Sundas, the Maluku & Sulawesi form the island summits of subaquatic mountain ranges flanked by sea trenches. The Kapuas & Barito rivers dominate the Indonesian hydrological profile.

3.1.13 The Indonesian population of 177 million (1989) is spread within one metropolitan district (Jakarta Raya), two special autonomous districts & 24 provinces. About 25% of the population live in urban areas. In 1988, Jakarta had a population 7.3 million & Surabaya, Bandung,Medan & Semarang had population exceeding over 1 million.

3.1.14 The inland transport covers road length of 220,000 kms & rail length of 6600 kms of which only 110 kms are electrified. Indonesia is connected with other parts of the world by sea (has 8 ports) & by air having 6 international airports.

3.1.2 National Objectives

3.1.21 Indonesia is a republic headed by Executive President with two legislative houses -- House of Peoples Representatives' & 'Peoples' Consultative Assembly. The President rules with the assistance of an appointed cabinet. The members of the cabinet formulate & implement various socio-economic policies. The planned development in the republic of Indonesia has been implemented in steps based on 'Five Year Development Plans' (Repelita).

3.1.22 Indonesian planning comprised 5 plans of 5 years each to cover 25 years of Stage I when the objectives were to establish the groundwork for a just and prosperous and unified society in a peaceful & orderly way. The thrust to attain this was through economic growth with increasing reliance on own resources. The government assumed an all embracing role during this stage by investing in all aspects of the economy, especially infrastructure. In the early plans the establishment of surface transport took precedence while telecom attracted priority only in the IV & current V plan ending 1993/94.

3.1.23 Under a Presidential government most resources and decisions rested with Government. With tourism being a major forex earner, a Ministry of Tourism, Post & Telecom guides the policies and investments in these three sectors. However, each maintains its

separate subsidiaries through the establishment of several independent parastatals handling their own outputs under the ministry. **Figure 3.1** summarises the organisation structure. The allied electronics industry, however, is but a section in the Directorate of Metals, Machinery & Electronics under the Ministry of Industry. Directorate of Electronics (DOE) guides the private sector though smaller units go through a separate Directorate.

3.1.24 Electronic industry started in Indonesia some 24 years ago with assembly of consumer electronics equipments. The manufacturing activity till recent past is heavily dominated by assembly of imported kits. With the drop in oil-prices & oil-exports in 1980's Government has emphasised on exports of non-oil items -- electronics topped the priority list.

3.1.3 Industry & Technology

3.1.31 On national policy on industry & technology Badam Pengkajian dan Penerapan Teknologi --- BPPT (Agency for the Assessment & Application of Technology) is the responsible government agency. It advises the government concerning national policy for development & application programs. Additionally, it also provides advisory & consultancy services for implementing technology development programs. The agency has a crucial role in evaluating industrial sectors, in preparing & supervising Indonesian parastated companies in various stages of development.

3.1.32 In the early plans, role of industrial development lay in the hands of the government (especially in telecom). The V Plan (1988-89 to 1993-94) has seen movement of industrial policy to enable increasing participation of private sector not only in supplying ancillaries and sub-assemblies but also complete equipments, systems (and sometimes even turnkey installations) to the operating agency. Recent moves towards private operating agencies with "revenue sharing" agreements are expected to add new resources needed for faster growth of telecom.

3.1.33 With the Rupiah now freely convertible, the inflow of plant & technology is loosely controlled (reportage only) except where the entrepreneur wants special concessions and benefits calling for government to qualify his project for the same. We are informed that import duties are low & steply graded from 40% for end-equipment, 30% for technology; 20% for sub-assemblies, to 5% or less for most components and materials needed in electronics. The parastatal telecom operator (PERUMTEL) is however free from import duties & taxes but has to pay VAT on local items.

3.1.4 Local R & D Approach

3.1.41 Research, Development and Engineering proceeds in a low key in Universities, Parastatal Laboratories and Producing Entities in a varying mix along with inflow of foreign technology as needed. Monitoring, Assessing and Recomendatory role rests with BPPT, which comes under the Ministry of Research and Technology. This assessment is mostly at times when Parastatals wish to import technology. Private sector often makes its own arrangements for technology flow.

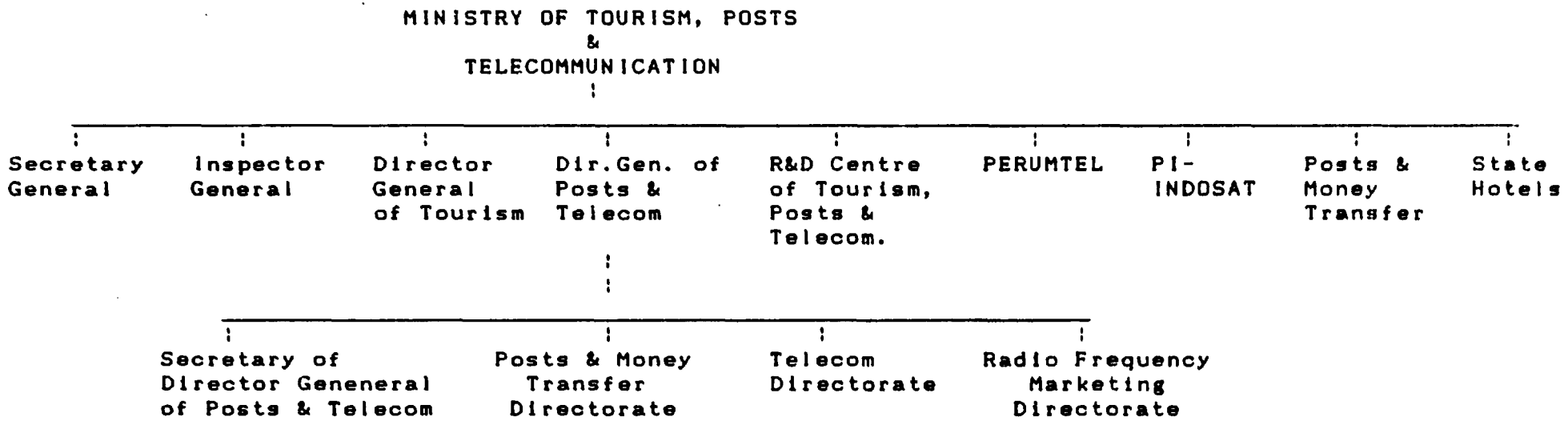


FIGURE : 3.1 ORGANISATION STRUCTURE OF MTPT

3.1.42 Research projects in co-operation with Siemens, Thomson, RCA, and other corporations had been undertaken mainly in the area of Radio Equipments at LIPI (Indonesian acronym for Electrical & Electronic Research Institute). Several of the results have been prototype stage and custom supply. While LIPI continues with its research programs its engineering facilities are separated out into an organisation for production of Professional Electronic Items.

3.1.43 The LEN (Lembaga Elektronika Nasional)- National Electronics Institute-- is a government research institution that has been responsible for research into technologies in electrical & electronics fields. LEN also supplements local electronic industry to supply equipments to the government primarily in areas where the private sector does not have capabilities. As an electronics research institution , LEN also supports industry by conducting research & development & providing results to be used by industry for the national betterment.

3.1.44 There is limited research & development performed by private sector units who concentrate instead on assembly. The industrial electronics sector's R & D efforts have been limited to designing equipment & systems.

3.1.45 Co-ordination between the government research & private sector industry is carried out by the industry associations that are members of Indonesian Chamber of Commerce & Industry (KADIN-Indonesia) to encourage, create & develop industry. Among the associations related to electronics & telecom are :

a. APNATEL -- the Indonesian Association of Telecom.

b. The Gabungan Elektronika -- Electronic Association.

in addition to serving as a liaison between entrepreneurs & the government; these associations also undertake various programs for training of entrepreneurs.

3.2 ROLE OF TELECOM

3.2.1 Socio-Economic Impact

3.2.11 As the economy has grown and modernised, telecom has not been able to keep pace with its exponentially urgent role. Firstly in the functioning of the government itself, its reach, power and developmental efficiency especially to the far flung islands is greatly attenuated. The spread and reach of even essential infrastructures outward from main cities as to that extent more difficult.

3.2.12 Thus, major services such as railways, power, oil and of course the security apparatus have had to make their own investments in telecom. The result of this fractionation is the less efficient scattering of equipments, consequent non-co-ordination, considerable duplication. It is estimated by World Bank that simple coordination; balancing and management of existing plant could cheaply add another 15% to 20% more lines and substantially better service for existing lines.

3.2.13 Service is largely concentrated on the island of Jawa which contains 6 of the most prosperous cities (Indonesian Telecom Circles IV to VII). In 1988 these consumed 470,000 out of 830,000 lines in service. Other islands though aggregating much larger in area have but the remaining lines and poor service. Need and scope for rural telecom is indeed high for spreading new development to the outlying islands.

3.2.14 Even in the well-served areas, connections to government and next to business take precedence over residential service. Thus waiting lists and years of waiting are especially arduous for residential lines. In Circles VIII & IX for example, the wait list is 4 times the lines in service.

3.2.15 In the recent years of national development: Indonesia's high economic growth rate was obtained partly as a result of much improved telecom facilities. The high- quality transmission through the international telecom satellite (INTELSAT) system, the PALAPA domestic satellite system & the international submarine cable systems were the major contributing factors to an accelerated growth of the industrial sector.

3.2.2 Effect of Country Characteristics

3.2.21 The archipelago structure of Indonesia presents an especially intricate problem for telecom planners, the concentration of power and to some extent urbanisation on the island of Jawa has pre-empted, all the planners attention in the past. Current plans however have addressed the need for new modes or transmission to economically reach all parts of the country.

3.2.22 Thus satellite-based communications to various islands form an increasing part of the transmission network. In view of the linear stretch of distances along the narrow archipelago, microwave routes are essential for the ground sector. Long distances and intervening seas, make cables highly investment intensive.

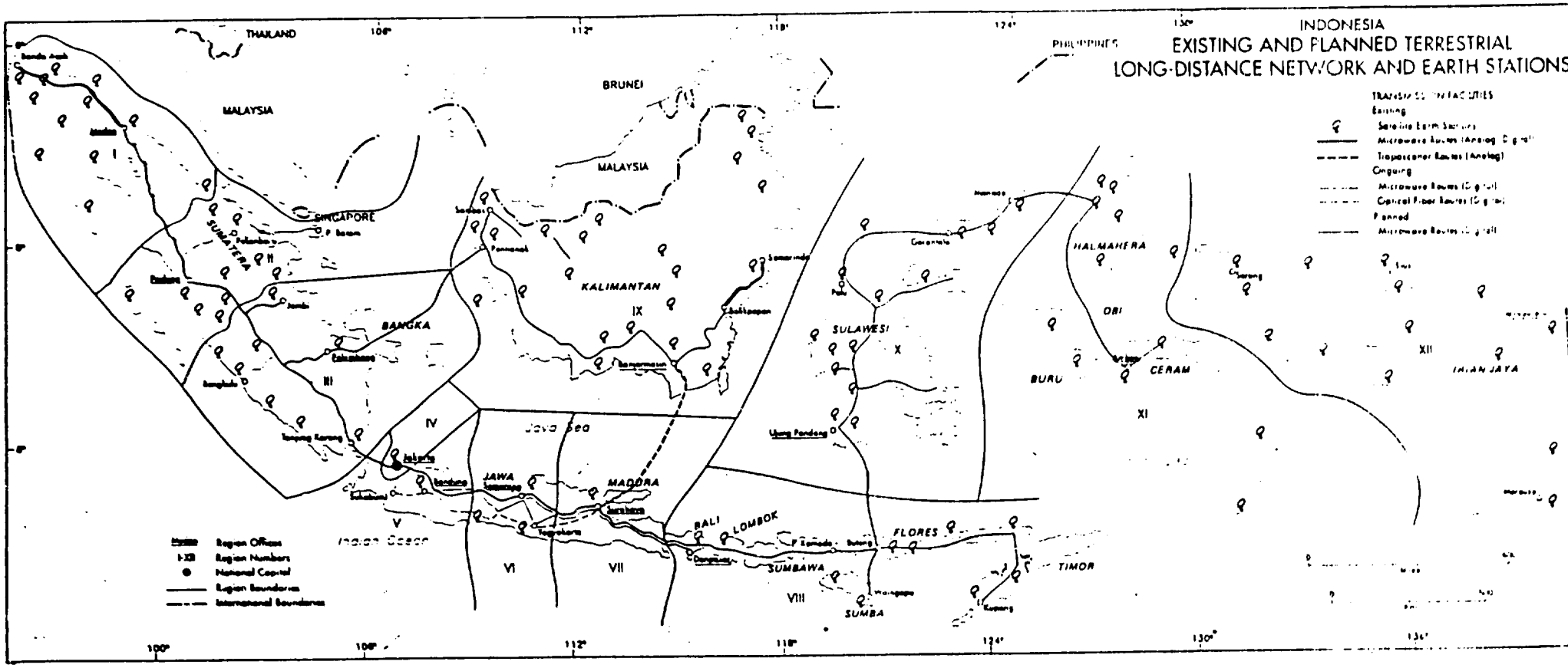
3.2.23 Another factor having a major say is that the rich resources of Indonesia lie in the less-populated regions. Thus new projects and new territories can be opened up more rapidly when telecom reaches them adequately --- another factor strengthening the need for satellite-based telecom for Indonesia. **Figure 3.2** shows a telecom map of Indonesia with current & future coverage.

3.2.3 Organisation & Management

3.2.31 Under the MTPT, the telecom operating agencies are two parastatals --- PERUMTEL for domestic public network and INDOSAT for international traffic. The latter was nationalised by Government in 1980 from a private entity. PERUMTEL is the dominant element with revenue approaching USD 500 Million while INDOSAT earns less than USD 200 Million.

3.2.32 In recent years two other operating agencies have been permitted -- PT Rajanansa Hazanah Perkasa for a small but expanding segment of cellular-mobile; and PT CSM for domestic data network

FIGURE : 3.2 TELECOM MAP OF INDONESIA



VSAT mainly concentrating in metros. Both are private companies but with revenue sharing arrangements with PERUMTEL. Both are microwave based.

3.2.33 In addition, as mentioned earlier, there are private networks owned & operated by the separate parastatals for oil (PERTAMINA) railways (PJKA), electricity (PLN) and, through-leased lines by large business houses. Operationally; however PERUMTEL is the dominant entity having major say in routes allotted, tariff setting, expansion and so on.

3.2.34 Over the years there have been several organisational changes in the operating and producing bodies. Management of PERUMTEL itself has been often reviewed, adjusted and modified with help of bilateral and multilateral agencies in view of various aids and loans it receives. Such funds are however made available after due consideration by MTPT in consultation with Ministry of Finance.

3.2.4 Injection of Technology

3.2.41 As PERUMTEL has grown & modernised, it has received inputs of consultancy along with financial facilities from Belgium, France, Germany, Holland, Sweden, Japan and multilateral agencies like UNDP, World Bank, Asian Development Bank. Such assistance is in form of extended consultancies ranging from planning to training as well as thorough evaluation of the whole sector from time to time.

3.2.42 In addition, various major expansions have been executed on basis of turnkey projects from various foreign suppliers. This includes not only supplies and installation of plant but also extensive training of staff locally and abroad in the newer technologies.

3.2.43 Producers of equipment (parastatal & private) also acquire new technology as they move from one generation to another of required equipments. Other than the role of BPPT, there is no specific restriction to the injection of technology nor is there any preference as to the source thereof. With a convertible currency, the manufacturer is free to reach any agreement suitable for his work provided he can raise the resources. A tax of 35% on know-how fees applies. For telecom projects (which are large) the constraint of funding leads to use of bilateral aid which in practice (if not in theory) closes the option of wider procurement and greater contribution by local entities. Unbundling of such bilateral packages becomes difficult in view of concessional funding offers.

3.2.5 Available Modes of Communication

3.2.51 While the Indonesian network includes most of the modes of communication, the availability and performance to different segments of the public varies. As may be expected, Jakarta (capital city) along with its corridor to Surabaya (the next populous city) has the maximum facility. Many islands on the other hand have little or no telecom contact.

3.2.52 The basic services of voice and telex have been established over a long time, of course. However, their performance has been a subject of criticism even in the capital city. This results not only due to different generations of equipments but also from management of the "outside plant" (OSP) and its maintenance. The quality of service has been reported extensively by a World Bank study which concludes that considerable improvement needs to be achieved (with balancing of plant, computerised management system, organization and training) as the first step even as further expansion through new plant takes place.

3.2.53 About 70% of the connections are in the island of Java (40% in just Jakarta city). Area of Java is only 7% of total land areas. However, due to faster development 60% of population is concentrated in Java. If telecom and other infrastructure could reach the other 93% land mass, development could be more spread out and remote resources better exploited. Government is hard put to find the enormous resources required to have a more equitable distribution of development over the far flung country.

3.2.54 Satellite communication has helped to reach distant and remote islands and unexploited territories on a spot basis where small earth stations have been installed. Such coverage is nowhere near enough. Under consideration is Multi-Access Radio Relay (MARR) for locally supplementing the area around each small earth station.

3.2.55 The more modern modes of facsimile and datacom are presently considered "non-essential services" and are left to the private resources to append to existing DEL. Use however, is limited to areas having adequate quality of transmission and also to business entities and affluent homes. The shared revenue approach is expected to assist in extending newer modes of communication such as cellular, packet switching etc.

3.3 NETWORK USAGE PATTERN

3.3.1 Domestic Traffic

3.3.11 The Operating agency PERUMTEL has undergone several structural changes. Once a department within the Ministry of Tourism, Post & Telecom (MTPT); it was separated out from Post in 1965 and set up as a parastatal corporation in early 80's. Very recently it has been restructured again as a limited company (renamed PT-Telekommunikasi). It is in essence the monopoly operator of the public network. The monopoly however is slowly getting breached.

3.3.12 Aside from the special private and closed networks for oil, power, rail and military, there are now "revenue sharing" arrangements with private bodies for "non-essential" services of cellular and data-packet communication. To this may later be added Electronic Mail and other value-added services. The investment for the extra equipments needed for these services is provided by the private party, the revenue will be shared on agreed basis. It is expected that after the private investor recovers his capital with agreed return, the whole will revert to the monopoly operator at the end of certain years.

3.3.13 There are also in Jakarta some Wide Area Networks (WAN) owned by large organisations who wish to have much enhanced services over and above the quality and scope of public services. In such cases permission has to be obtained from PERUMTEL alongwith payment of fees.

3.3.14 The past & future growth in capacity of telephone and telex is shown in **Figure 3.3.** Also shown is the growth of public telephones and kiosks which are growing at an even faster rate. Actual usage by subscribers is summarised in **Figure 3.4.**

3.3.15 Plan IV has resulted by 1988/89 in 1.1 million DEL with 80% of them in service. About 30% of the lines are digital while 20% of them are obsolete manual types which will have to be replaced with the coming decade. availability of STD service is to the extent of 90% of subscribers ..... though quality varies from place to place. Call charges are at Rs. 1.00 per pulse.

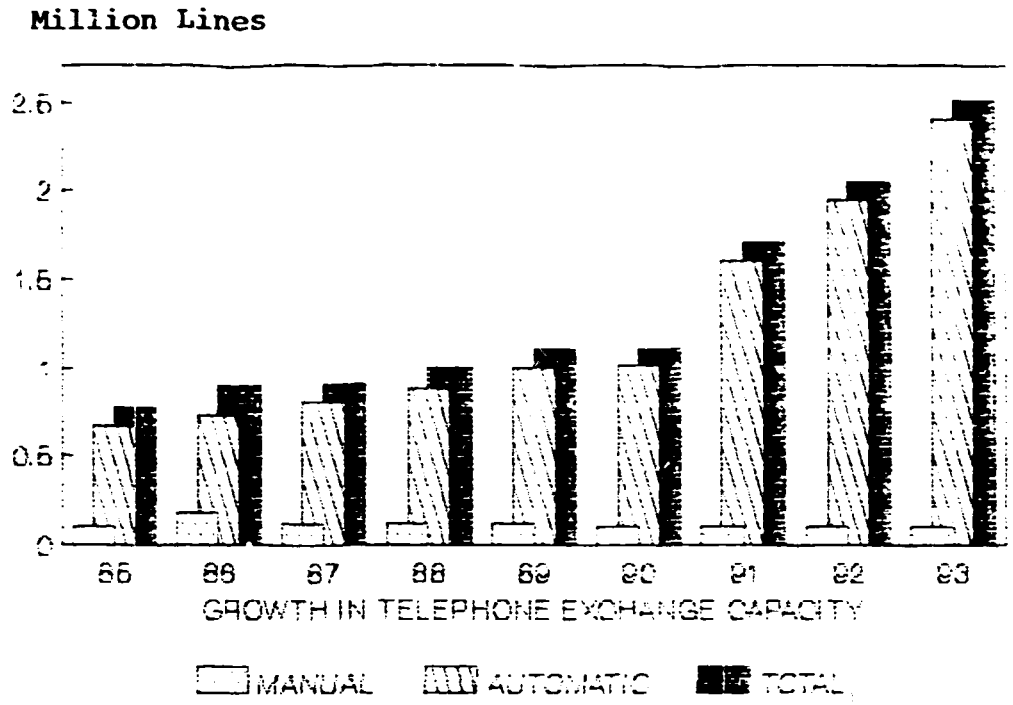
3.3.16 Indonesia was one of the earliest investors in domestic satellite systems (termed PALAPA) for wide public use in mid-70s. The first two satellites are life-expired and two new ones are under positioning but are having orbit problems. At present 16 transponders are in use and 6 more are leased out. The satellite network comprises a Master Earth Station, and about 140 Earth Stations of various capacities scattered all over the archipelago.

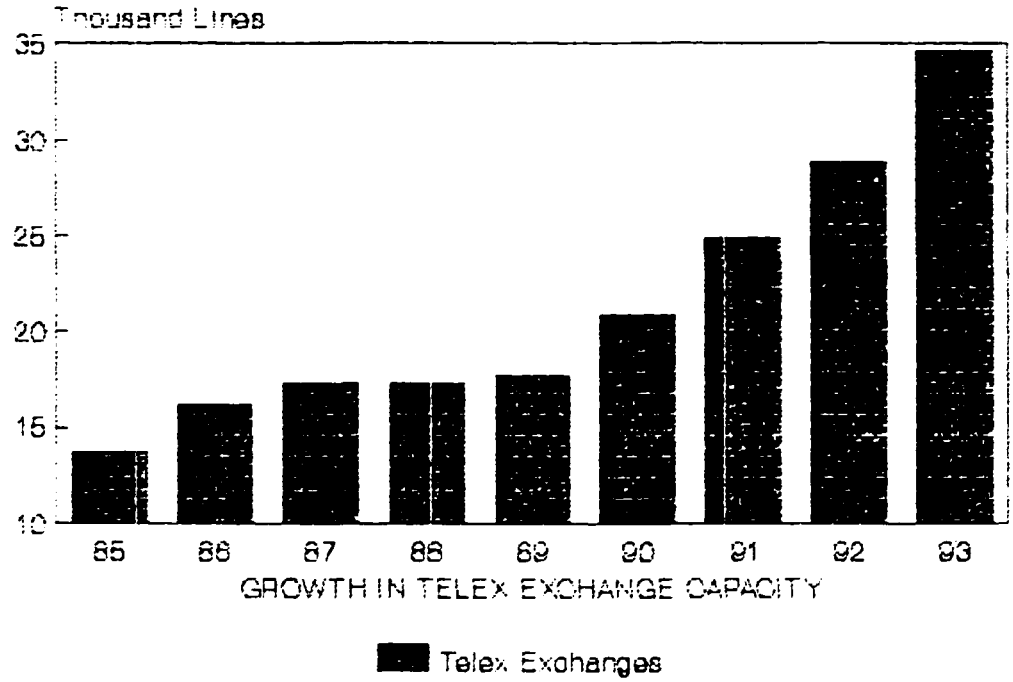
3.3.17 It is felt that telex service will saturate (in view of the more modern modes of communication) but will go through a stage of modernisation and digitalisation. For covering non-urban areas, telegram service continues over a network of nearly 700 offices & tele-text services is increasingly used by business subscribers. Data Packet Services started in 1984 and serves about 300 users in the 7 major cities also linked to international centres. Connection of Facsimile (FAX) to telephone line is freely permitted: many imported models are available in the market via imports: wide use however awaits the improvement of quality of lines and communication.

3.3.2 International Traffic

3.3.21 Operating authority, now termed PT INDOSAT, was acquired from private hands and converted into a parastatal monopoly. Two gateway exchanges at Jakarta and Medan are the entry points of neighboring countries. Here too, a major fibre-optic link to Singapore is underway.

3.3.22 Access through both cable and satellite links in 1990 is to 182 countries (up from 127 in 1987) as shown in **Figure 3.5** which also shows the fast increasing number of subscribers (66500, in 1990). Though small, the growth has been 40-50% annually as also has been the rise in units of international conversations. This indicates the need felt by the global community to stay in touch with the liberalising and growing Indonesian Economy. Tariffs however are high .... in the range of USD 3 to 5 per minute.


Million Lines
2.5
2
1.5
1
0.5
0
85
86
87
88
89
90
91
92
93
GROWTH IN TELEPHONE EXCHANGE CAPACITY
MANUAL
AUTOMATIC
TOTAL


Thousand Lines
35
30
25
20
15
10
85
86
87
88
89
90
91
92
93
GROWTH IN TELEX EXCHANGE CAPACITY
Telex Exchanges

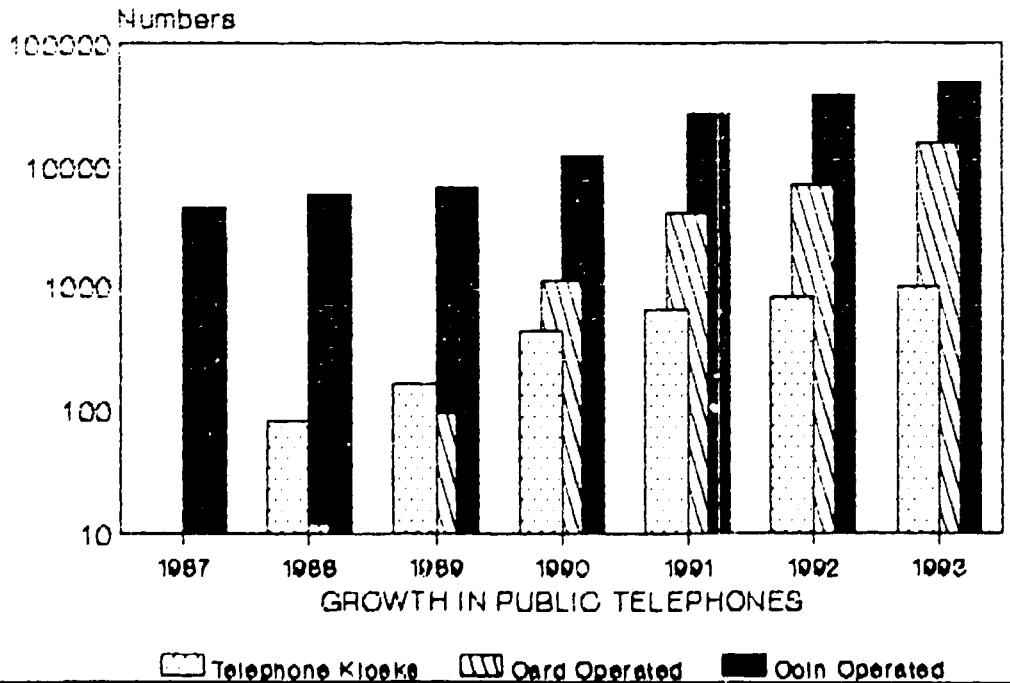
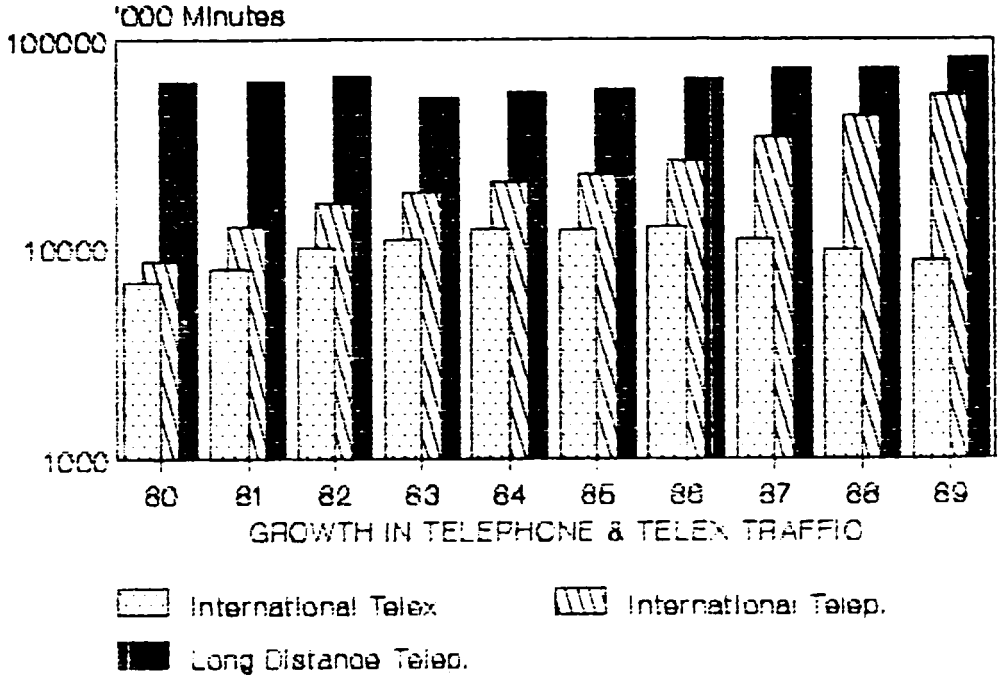

Numbers
100000
10000
1000
100
10
1987
1988
1989
1990
1991
1992
1993
GROWTH IN PUBLIC TELEPHONES
Telephone Kiosks
Card Operated
Coin Operated

FIGURE : 3.4 GROWTH IN INTERNATIONAL & DOMESTIC TELECOM TRAFFIC



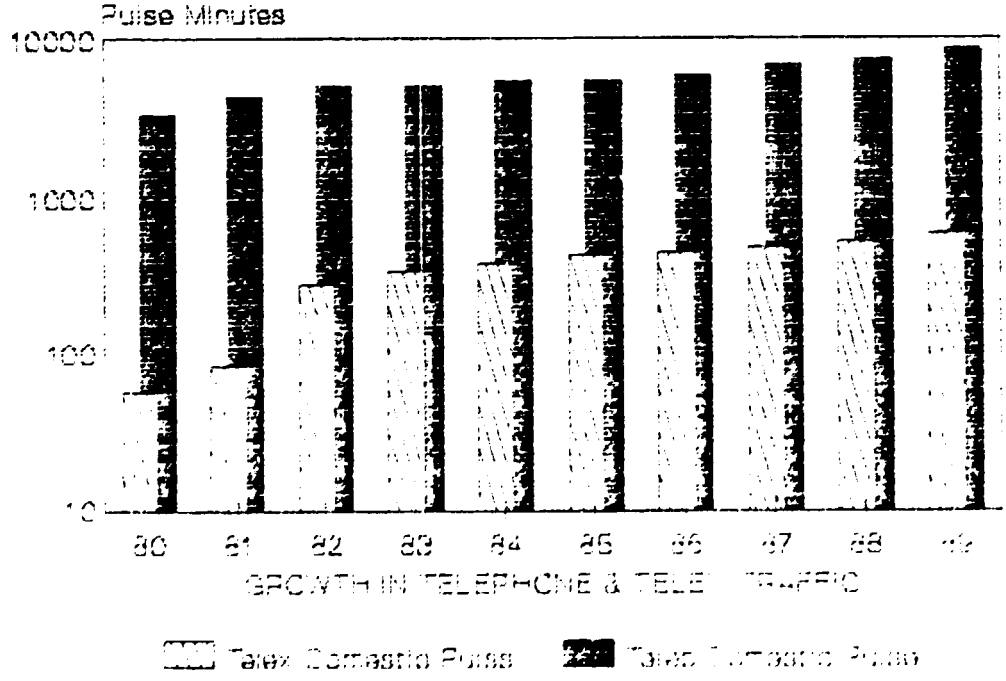
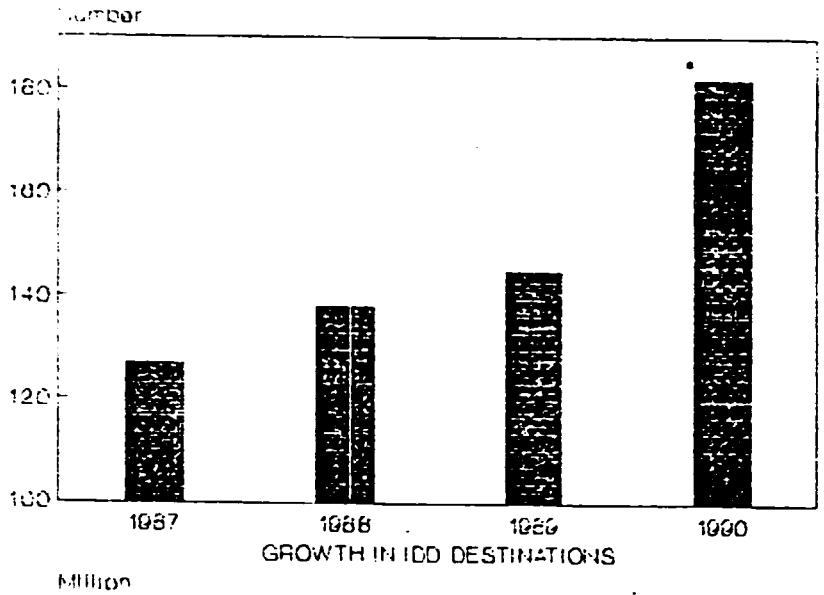
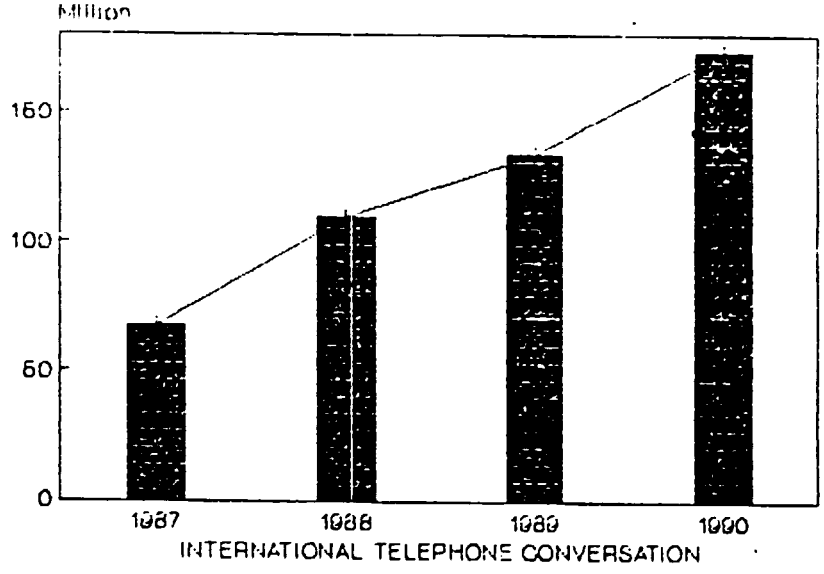


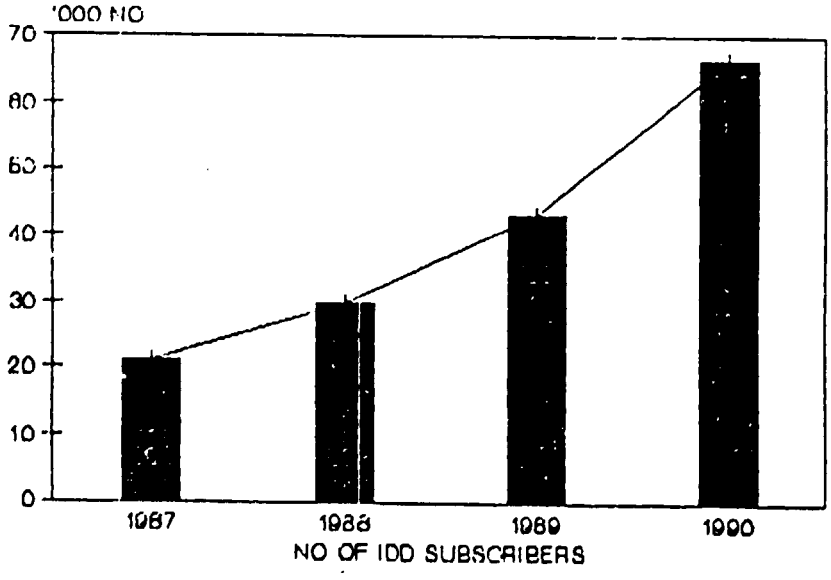
FIGURE : 3.5 GROWTH IN IDD FACILITIES



GROWTH IN IDD DESTINATIONS



INTERNATIONAL TELEPHONE CONVERSATION



NO OF IDD SUBSCRIBERS

3.3.3 Private Users

3.3.31 Subject to government permission, private users are setting up networks for their own internal use. The equipment used has to be within specifications approved by PERUMTEL and INDOSAT. Registration fee has to be paid according to the network requested. If access to the public network is sought, the rentals and user tariff has also to be paid.

3.3.32 With the arrival of "Revenue-sharing" operators and the so-called "Non-essential" modes, the presently limited private use is expected to spread rapidly. Specific data and projections are not available. It would be a useful exercise to understand the situation of a developing telecom system in the early process of opening out.

3.3.4 Rural Coverage

3.3.41 Telephone density averaged over the whole country stood at 0.47% at end 1988. However, this varied drastically according to location. A picture of distribution over the 12 telecom districts is shown in **Figure 3.6**. In the various telephone districts, it ranged from 0.22% in rural areas to 3.81% in the key telecom district around Jakarta. It is to be noted that the most populated districts (V, VI, VII) are the least served.

3.3.42 Remote areas, at present, with low population are receiving some attention in and around small satellite stations. However, if the resources of these vast areas are to be tapped, considerable investment in spreading out the services will be required on which the returns will be very long term.

3.3.43 Over 50000 villages (Population over 2000) remain to be served even by one public telephone. A separate loan has been arranged for rural network development.

3.3.5 Network Performance

3.3.51 According to the annual report of MTPT, domestic revenues doubled over five years to Rp. 1.3 trillion (1990) but profits grew at only 4% to reach Rp 219 billion. The much smaller INDOSAT on a small revenue base of Rp 445 billion doubled its profits over 5 years to Rp 250 billion --- an astonishing performance. One may attribute this to relatively higher tariffs especially on international routes. PERUMTEL however has been investing heavily and will continue to do so and its profitability is expected to grow with expansion and efficiency.

3.3.52 Encouraging has been the faster growth of modern services since 1988 --- Card & coin Public Phones; mobile phones; cellular; Earth stations; Packet Switching. **Figure 3.7** shows the trend.

3.3.53 However, the "quality" of existing service continues to be a problem. Call success ratio ranges between 30% and 50% (latter for international calls). For long-distance calls noise, echo often are a problem. Faults are as high as 9% per month. Repairs take several days as they are mostly in the "outside plants".

FIGURE I 3.4 REGIONAL DISTRIBUTION OF TELEPHONE SERVICES

Regions etc.	Lines in Services	% of Total Lines	Population '000)	No.of DELs per 100 pop.	Waiting List.	Waiting List as % of Working Lines
I	64233	7.75	13355	0.48	26248	40.86
II	26673	3.22	6663	0.40	17061	63.96
III	38803	4.68	15818	0.25	32513	83.79
IV	335472	40.48	6804	3.91	248511	74.08
V	82277	9.93	33064	0.25	63307	76.94
VI	67802	8.18	31341	0.22	44269	65.29
VII	110766	13.36	32516	0.34	76679	69.23
VIII	26289	3.17	9988	0.26	27622	105.07
IX	25198	3.04	8445	0.30	25848	102.58
X	37547	4.53	12288	0.31	21453	57.14
XI	5979	0.72	1766	0.34	1659	27.75
XII	7773	0.94	1511	0.51	1786	22.98
Total/Avg.	828812	100.00	175578	0.47	586956	70.82

Source : World Bank report on Indonesia Telecom - Feb. 1991

FIGURE : 3.7 GROWTH IN TELECOM SERVICES

No.	Descriptions	Units	1986	1987	1988	1989	1990
1.	Telephones						
	a. Automatic						
	- Exchange	Number	195	211	223	289	364
	- Capacity	Lines	728.000	794.978	909.221	1.003.685	1.328.841
	- Subscribers	Number	580.454	649.964	731.162	772.228	965.428
	b. Manual						
	- Exchange	Number	509	503	496	480	419
	- Capacity	Lines	110.555	117.046	121.230	116.950	101.463
	- Subscribers	Number	77.887	87.624	97.650	91.594	86.797
	c. Public Telephones						
	- Coin	Number	4.106	4.636	5.724	6.653	12.395
	- Card	Number	-	-	12	95	1.123
	d. Mobile Phones						
	1. INTI						
	- Capacity	Lines	x)	x)	3.024	3.452	3.302
	- Subscribers	Number	2.022	2.122	2.504	3.386	3.896
	- Cities	Cities	x)	x)	3	3	3
	2. Cellular						
	- Capacity	Lines	10.000	10.000	10.000	10.000	15.000
	- Subscribers	Number	2,491	4,199	6,504	9,620	12,000
	- Cities	Number	1	1	2	2	2
	IDD						
	- Originating Cities	Cities	-	-	35	51	95
	- Destination Countries	Countries	-	-	138	145	182
	- Subscribers	Lines	-	-	29,833	43,141	67,638
2.	Telecom Service Centres	Centres			84	174	386
3.	Radio Paging						
	- Cities	Cities	6	9	14	17	17
	- Operators		9	14	18	23	23
	- Subscribers		12,814	19,184	22,274	28,518	40,160
4.	Telex						
	- Exchange		34	36	36	36	35
	- Capacity	Lines	16,200	17,300	17,300	17,700	20,850
	- Subscribers	Lines	11,738	13,733	15,441	14,880	16,222
5.	Earth Stations		-	-	141	143	229

TABLE : 3.3.5 Contd.

No.	Descriptions	Units	1986	1987	1988	1989	1990
6.	IDDC						
	- Destination Countries	Countries	-	-	-	6	12
7.	TOLL FREE						
	- Consumers		-	-	3	152	-
	- Destination countries	Countries	-	-	-	-	6
8.	Electronic Mail						
	- Subscribers	Terminals	-	-	-	6	166
9.	Packet Switched Data Service						
	- Dial-Up		-	-	-	-	665
	- Leased Circuit		-	-	-	-	89

Source : MTPT Annual Report

3.3.54 Studies by ITU and World Bank call for concentration on upgrading human resources even as the tasks of growth and complexity of management increase with the arrival of new and expensive technologies.

3.4 GROWTH IN SERVICES

3.4.1 Telephone

3.4.11 Despite acceleration of provision of connections (from 10% in Plan III, to 13% in Plan IV), registered waiting lists continue to grow at over 15% (revealed demand). As in all developing situations, provision of services brings out even further suppressed demand. This too despite high connection charges and tariffs. Hence the task of catching up grows more difficult until demand satisfaction can be reached. During Plan IV annual investments ranging from USD 700 million to USD 900 million were made.

3.4.12 Future growth of long-term demand has been forecasted by various bodies at various times as shown in **Figure 3.8**. While the most optimistic one is using the CCITT model, it probably includes suppressed demand. The various Plans (Pelita) are targetting a doubling to 3.6 million DEL by 1994 and nearly tripling to 7.1 million by 1999 (as informed to us in PERUMTEL interviews): indeed a very substantial task for which private operators (revenue-sharing) are hoped to contribute 50% in the coming decade.

3.4.13 Public access through coin phones, card phones and manually attended phone booths, is to be increased many fold from about 7000 in 1989 to over 65000 by end of Plan V. Public phones can satisfy subscribers having lower level of demand who would then not need to ask for their own connection.

3.4.14 Rural coverage is to be segmented in Plan V by installation of 5000 radio communication sets in the more populated villages. The first chain of cellular communication is to be attempted in the Jakarta-Bandung corridor. Though mainly intended as a delux service for people on the move, only benefits which could be derived for rural coverage will be carefully monitored.

3.4.2 Text & Data

3.4.21 Text transmission services via telegrams and telexes have decelerated from a high of 18% to below 8% on an average. This ofcourse, transfers the load to the other more modern services where already availability and quality are a problem. There could be a case for lowering the cost and tariff on telex and telegram to divert some of the excess demand to telex mode.

3.4.22 Telex lines, which were stagnant upto 1989 at around 17000, are expected to be doubled by end of Plan V and modernised to cover store-and-forward facility thus handling faster traffic.

3.4.23 Text and image transmission by way of FAX is presently favoured by large businesses and will grow in its natural way unplanned by PERUMTEL. What the subscriber attaches to the DEL is

FIGURE : 3.8 TELEPHONE DEMAND FORECAST BY VARIOUS MODELS

(Scale : Mill. ...)

MODEL	1984	1989	1994	1999
KENAIKAN RATA-RATA SEBESAR 7% SETIAP TAHUN SEJAK (FUNDAMENTAL PLAN 1972)	720	982	1.494	2.302
LOG DT = -.5 + 1.68 LOG X (C.C.I.T.T.) MODEL	1.247	2.452	4.856	8.780
4 TELEPON US $ 100.000 (ESCAP) TARGET	1.104	1.736	2.726	4.286
BTM (1977-1979) BELGIAN CO.	892	-	-	-
KENAIKAN RATA-RATA SEBESAR 11% SEJAK 1972	713	1.202	2.026	3.415
A.T.M. (1975)	625	-	-	-
MODEL KORELASI DENGAN INDEKS EKONOMI (CORRELATION MODEL WITH ECONOMIC INDEX JICA)	493	787	1.367	(2.845)
TOTAL INSTALLED DEL DURING PLANS IV, V & VI	0.8	1.2	2.6	7.1

unlikely to be in the control of the operating body. As in all countries its growth is expected to be fast but will be elastic to the cost of the installation.

3.4.24 Packet Data Services have started in the "revenue sharing" sector and are expected to grow rapidly. In Plan V, 1100 additional ports are going to be provided. As Indonesian economy becomes increasingly global, this service will become an important "information highway" for enhancing efficiency.

3.5 EQUIPMENT REQUIREMENTS

3.5.1 General

3.5.11 As with all developing countries, the existing network is a mix of various generations of equipments starting with the earliest. As their network spreads in response to demand, the older equipment gets pushed out to rural areas. In areas where no service existed before, even such obsolescent equipment is welcome.

3.5.12 While this makes possible some expansion within the limited resources at hand, it aggravates maintenance problems and of course provides a low quality of service. Older equipment is discontinued only when its life is far beyond redemption.

3.5.13 Key targets to be met over Plan V include 1.4 million new DEL (of which 0.75 million STD); over 1500 new telexs. Public phones to comprise 3% of DEL: 300 Telecom Centres: 1100 Data Ports: 3 major microwave routes, one new satellite: 6 sea-cables to connect islands.

3.5.14 The past development of the network has been with considerable imported content. At the end of Plan IV, the aggregate netwrok equipment was 100% local for cables, 55% for switching and only 40% for transmission equipmets. Even in 1990 about USD 250 million worth of communication equipments were imported, about half for the telecom network.

3.5.2 Switching Equipment

3.5.21 While reducing rapidly as a proportion of the network, manual switches still exist to the extent of 100,000 lines constituting about 6.7% of switching capacity. These are small exchanges averaging below 200 lines each operating on local battery supply.

3.5.22 Mechanical or "step-by-step" exchanges also exist covering nearly 235,000 lines and constituting perhaps 15% of the capacity. Similarly, cross-bar versions cover about 155 000 lines or 9-10% of that capacity.

3.5.23 High speed relay crosspoint exchanges have given good service and constitute 380,000 lines or 25% of the switching capacity. Average exchange capacity is large around 10,000 lines and hence are used in some of the densest traffic. Being stored program controlled, they enable a number of facilities not possible with earlier cross-bar. Introduction of these exchanges will

continue until full scale digitalization can be done with local manufacture.

3.5.24 Since Plan IV, emphasis has been on digitalising the exchanges. Thus far, about 670,000 lines have been installed raising the proportion of digital lines from none in 1983 to almost 45% currently. Emphasis on digital will continue into Plan VI so that nearly 90% digitalization is likely by turn of century as ISDN gradually enters the network in future.

3.5.3 Local Distribution

3.5.31 Cables are the major medium of distribution to subscribers. Open wire has been done away with in populated areas though it still continues in rural areas of lighter traffic. However, such items of "outside plant" have been the major source of faults and a substantial maintenance problem leading to 70% of the failures of service.

3.5.32 Experimental optical fibre distribution has just started. The program is being monitored to understand the particular problems that appear during use. It is clear that maintaining the more expensive & sophisticated optical fibre plant will have to be properly organised to avoid the problems that are already occurring with the present cable network.

3.5.33 A few dedicated networks of businesses where heavy internal traffic is involved are based on small microwave links but these are privately installed and not available to the public networks.

3.5.4 Long Distance Transmission

3.5.41 The terrestrial transmission network is based as Trans-Sumatra, Java-Bali & East Indonesia microwave system routes and on the Surabaya-Barjarmasir Troposcatter system. In addition, there are open wire carrier systems, VHF & HF radio links.

3.5.42 The environment for transmission is very difficult. Geographic conditions and long distance make the use of terrestrial co-axial cables most expensive and use of microwave difficult. However, the country needs terrestrial transmission facilities over shorter distances for cost effeciveness and over longr distances for security with alternate routing to guarantee services provided through the satellite system.

3.5.43 **Figure 3.9** gives details of various transmission media installed on July 1991 and proposed addition during plan V.

3.5.5 Multiplexing Equipment

3.5.51 The present multiplexing equipments are based on FDM, TDM & PCM techniques. Out of the total 30,107 channeling circuits installed; about 86 % are of PCM type We have been informed that additional 5,432 TDM channeling circuits will be installed during plan V.

FIGURE : 3.9 INSTALLED CAPACITY OF DIFFERENT TRANSMISSION EQUIPMENT

ITEM	UNIT	INSTALLED UPTO JULY.91	PROPOSED IN PELITA V
Open Wire	CCT	771	-
Pressurized Cable	(000'KM Pair)	900.75	16.99
Jelly Cable	(000'KM Pair)	1663.11	1682.20
Optical Fibre	(000' KM)	1.46	532.02
Analog Microwave	CCT	8475	-
Digital Microwave	CCT	3670	3 Routex
Satellite Earth Stns.	SITE	230	150
FDM Channelling Eqpt.	CCT	3360	-
TDM id	CCT	960	5462
PCM id	CCT	25787	25000

SOURCE : PT TELEKOMUNIKASI INDONESIA

3.5.6 Ancillary Equipments

3.5.61 With each installation, whether switching or transmission, require power supplies of various ratings and specifications according to the particular station being installed. Need for uninterruptible supplies is a major market and becomes more important as equipment of greater sophistication enters the network.

3.5.62 In a network comprising different technologies and brands of equipments, certain interfacing facilities have to be provided to enable one type of equipment to "speak" to the next. These interfaces are specific to each situation and are developed and programmed accordingly.

3.5.63 Testing, Monitoring, Supervision and Maintenance equipments are also an important requirement at each installation as well as at supervisory centres. It is understood that this need is fulfilled to a minimum extent in Indonesia leading to limitations in managing the network more efficiently. Though few in numbers, these equipments are sophisticated and expensive. Sources for such special equipments are also limited.

3.6 LOCAL PRODUCTION

3.6.1 Overall View

3.6.11 Electronics industry overall output is planned to grow at a hectic pace of nearly 40% a year if the hopes of Directorate of Electronics are realised (see **Figure 3.10**). Telecom which had a share of 23% at end of Plan IV will increase its share to 29% by end Plan V. PT> INTI which is the largest producer of telecom equipments (accounting more than 90 % of total telecom production) has preponed production program for plan V as given in **Figure 3.11.**

3.6.12 While production in the consumer electronics segment is essentially in private hands, the telecom segment has been dominantly with parastatals. As explained earlier, private sector is planned to increase its contribution even to the telecom sector as the economy is opened out.

3.6.13 In the consumer electronics segment, we are told that the activity is largely based on SKD/CKD assembly in conjunction with known foreign brands. This situation is unavoidable since the duty protection to components is less than 5% and the local components industry has not had a chance to develop to be competitive.

3.6.14 Based on the records of the Directorate of Electronics, a listing of the major telecom units has been prepared along with details which are shown at the end of this report in **Annexure B.** They comprise private as well as public production units. Some of the main ones are covered in the sections that follow.

3.6.2 Capacities in Public Sector

3.6.21 As a consequence of the monopoly in operation of telecom network, it was natural that a great part of the production is undertaken in the public sector. Thus, PT INTI, formed out of the

FIGURE : 3.10 GROWTH IN ELECTRONICS PRODUCTION

(Scale : Bill. Rp.

BRANCH INDUSTRY	PLAN				
	REALIZATION		PROJECTION		
	1989	1990	1991	1992	1993
ELECTRONICS	656.03	1026.16	1259.54	1784.67	2460.09
CONSUMER ELEX.	360.68	501.26	601.69	1021.75	1351.48
COMMUNICATION ELEX.	156.25	289.95	343.39	432.30	707.23
DATA PROCESSING. INSTRUMENTATION & CONTROL	27.44	67.52	74.27	85.41	98.33
ELX. COMPONENTS SUB-ASSEMBLIES & COMPONENTS.	111.65	167.42	240.19	245.21	303.05

FIGURE I 3.11 PRODUCTION PROJECTIONS OF PT.INTI

ITEMS	UNIT	1990	1991	1992	1993	1994
A. SWITCHING TERMINAL						
- STDI	000' Lines	193	388	402	389	402
- Telephone Inst.	000' Nos.	193	388	402	389	402
- Public Telephone	000' Nos.	6.9	13.8	17.5	20.2	22.5
- PABI	000' Lines	4.97	5.00	42.0	62.0	72.0
- PTUS	Sets	52	75	90	100	100
B. TRANSMISSION						
- PCM	000'Channels	26.88	27.8	29.10	31.4	34.0
- Digital Microwave	Set	100	60	75	75	-
- SBK 2 Channel	Set	-	5	5	5	5
- SBK 12 Channel	Set	13	5	5	5	5
- Subc. STKB (Cellular)	000' Sets	1.00	1.5	2.0	2.5	2.5
- STKB Base Stations	Sets	-	5	5	5	5
- INMARSAT	Sets	-	6	8	10	5

Source : PT.INTI Planning Documents

assets of PT PERUMTEL, poised to be the dominant telecom producer. In 1989, however, its reportage was shifted from MTPT to the Agency for Strategic Industries which now holds 10 essential parastatals including PT INTI.

3.6.22 A summary of the capabilities of PT. INTI is given in **Appendix B** to this chapter. Its products range from simple telephones (now de-emphasised) through public phones to a variety of switching & transmitting systems. It has benefited from "technical assistance arrangements" for several of its past products; including Siemens where digital switching technology is being transferred. In addition, INTI undertakes its own developments based on its accumulated expertise by improving & modifying its product range according to local requirements.

3.6.23 Production process is essentially assembly oriented. In-house capability covers mechanical parts, cabinetry, harnessing, wound parts, double sided PCB capacity. Components and materials are almost entirely imported. Local subcontracting is of minor nature only. As a consequence, local value added is stated to be below 40% on average and even lower for the recent digital products. Increasing onset of of Surface Mounting may deteriorate Value added still further.

3.6.24 A second unit in the public sector is PT. PUSAT LEN, a unit which has been born out of restructuring of an earlier electronics arm of Indonesian Institute of Natural Sciences (accronym LIPI). Historically, LIPI has been dedicated to development of advanced communication systems beginning with design & engineering of radio & TV transmitters and moving to more advanced needs of security forces, opto-electronic communication, etc.

3.6.25 Out of these efforts, LIPI developed capability of small-quantity supply where requirements were limited. Realizing the advanced nature of the work and wanting to put it to wider use, the engineering equipments and competence were shifted to form a separate corporation --- PT. PUSAT LEN with the objective of transforming local scientific effort into usable products in quantity. To this end, joint development projects with Siemens, Philips, BTM are in process expected to result in actual products. A summary of LEN is at **Appendix B.**

3.6.26 In its new garb, LEN is supplementing its substantial equipment assembly capability with a set up to develop and make micro-electronic components. Its PCB (double-sided) facility has been augmented to cover thick and thin film hybrids. LEN is in the process of installing semiconductor equipment (including a sophisticated ion-implanter) for gaining expertise in designing and executing devices and later integrated circuits. The attempt of LEN is to increase self-sufficiency in the products that it undertakes. As the restructuring has been recent, it is to be seen if these hopes can prove successful.

3.6.27 The directive to LEN is to aim for professional products not yet undertaken by other main producers with the added provision of maximising self-reliance to the extent possible.

3.6.3 Private Sector in Telecom

3.6.31 With increasing liberalization in the economy, private parties have also been able to offer telecom products to some extent. It is to be kept in mind that import protection is not excessive and currency is convertible. Hence items needed in wide use can be imported even through traders. Local competitiveness relies on the lower manpower and brainpower costs and of course on the generally declining currency.

3.6.32 Smaller factories produce telephone instruments, key phones, small EPABX, power supplies and various accessories needed by general and wide market. Assembly from SKD kits is a common practice. Designs and brands are borrowed from abroad. As a result of this competition, larger manufacturers have de-emphasised these products.

3.6.33 Medium-sized manufacturers have entered the area of radio communication through product ranges like Handy-Talkie, Low Power Transreceivers (HF & VHF), and more recently TVRO Satellite Receivers. In these products, local efforts seem to be higher and serve as a focus of competence for professional products further down the line.

3.6.34 In the more advanced areas of telecommunication, the private company PT Radio Frequency Communication (RFC) has made a mark for itself having started in 1969. With VHF Transreceivers, the company has broadened out and upgraded its products continuously to cover many types of Telecom Transmission Equipments and Multiplexers right into the microwave region. A greater detail of this pioneering company is given in **Appendix B.**

3.6.35 The design and production capability of RFC has enabled it to be a supplier to the critical sectors of Oil (PETROMINA), Power, Security Forces and even Defence. It has been selected by the army to handle the technology of Rapier Missile System in its complete form as a turnkey from production to maintenance.

3.6.36 PT Electrindo Nusantara is a more recent private company (1983) permitted into the field of advanced telecom equipment. A broader profile is given in **Appendix B.** The company first made its mark by actively participating as a contractor in the integration, installation and testing of earth stations for the Indonesian satellite communication network and its system enhancement. In the process it has brought in qualified experts on its staff and recruited bright young engineers who are trained up on a broad front. Its staff has risen in quantity (from 15 to 370) and quality and new products have been brought on line.

3.6.37 By buying in a stake into a small Silicon Valley Company, it has obtained access to some of the latest methods & techniques. By undertaking joint development programs at both ends, their product capability attempts to make available upto-date systems not only to Indonesia but also neighboring developing countries. While small earth stations have been their area of speciality, they are now setting up to offer products in multiplexing systems, modems, special test equipments, and recently small digital switch. In the

least item technical assistance is being arranged with NEC to upgrade to future exchanges where much of the system and software work will be done in Electrindo.

3.6.38 With its turnkey expertise, Electrindo is entering the field of cellular communications firstly along the Jakarta-Bandung corridor. It will invest, build, install, operate and eventually transfer the cellular system on basis of a "revenue-sharing" arrangement with PERUMTEL. It is expected that, with this experience, cellular will spread not only to other corridors but also broaden out into a "rural band" on both sides of the corridor.

3.6.39 Another new-comer worth noting is PT.CITRA who will build digital communication equipment with technical assistance from the giant MNC AT&T.

3.6.- Depth of Manufacturing Capability

3.6.41 With the efforts of public and private sectors and with liberalization of central control, quantum of productive capacity may be less of a problem than the extent of local value added. With a relatively low level of protection (compared to other developing countries), the opportunities and temptations to import must weigh on those who have to get on with their system needs. Depth of local manufacture will then suffer.

3.6.42 Further, to the extent that Indonesia needs to rely on bilateral and multilateral assistance, the tendency for global supplies would exist. While there is a 15% price preference for local suppliers, this must be affected by technical differences and user preferences. Orders on local manufacturers are assured however, to the extent that Rupiah funds are available.

3.6.43 Locally procured equipment is frequently made with parts and components obtained from the technical collaborator. There are reasons why this happens :-

a. Specification & selection of components is proprietary to the design and deviations could lead to performance deterioration.

b. In the realm of VLSI, custom & semi-custom integrated circuits make it impossible to procure from other sources.

c. Even for simpler items, low quantities and requirement for high reliability militate against any other source.

d. Periodic improvements in design by the collaborator make it difficult to establish stable sources.

3.6.44 It is therefore mainly in equipments where the design technique is locally mastered that alternate & economic sourcing has been possible. For foreign based designs, manufacture is mainly of cabinetry, mechanicals, PCB, harnessing, transformer winding, etc.

Discussions reveal that even in these activities the raw materials may well be imported.

3.6.45 Use of sub-contracting is rather rare and each producing unit tends to add value in-house. Part of the reason given is the need to ensure quality and adherence to specifications.

3.6.5 Further Local Scope

3.6.51 Telecom equipment involves variety, customization and small lot sizes. Thus physical capacity in terms of space and machinery are not limitations but rather the support services of design, engineering, materials procurement, approvals, etc. One interviewee informed that cycling a product through all its steps takes well over 6 months.

3.6.52 We were informed that local telecom markets were rather small and impact of imports continued. Thus we are led to believe that, given wider market acceptance and more efficiency, output could be doubled.

3.6.53 Each producing unit has also been introducing new products from time to time and has capability of modifying these products as may be needed for wider regional markets. As example we were informed of small earth stations designed, produced and installed in Malaysia.

3.6.54 There is also scope for indigenization and creation of sub-contractor base so as to enhance capacity if needed. This would require training and encouragement of entrepreneurship among technically qualified and experienced executives.

3.7 REVIEW OF INPUTS

3.7.1 Overall Picture of Components Base

3.7.11 Discussions with telecom equipment manufacturers leads one to the view that components for telecom are entirely imported. This is also reinforced by the low tariff applicable on imports. It is necessary to see however the capability of the local components manufacturers since components from an important element for adding local value.

3.7.12 We tabulate in **Figure 3.12** a summary of various electronic components for which capacity had been sanctioned by the Directorate of Electronics. In several cases, the capacity has been structured to reasonable scale but in many more cases, the sizing of the units is so small as to raise doubts about technical and economic supply of professional grade components from such units. It is likely that their attention is directed to supplying the consumer appliance markets.

3.7.13 In view of the numerically small Indonesian market for components, we are told that the units having larger scale of operation are export-oriented and hence should be able to supply proper quality of components at competitive prices for imports. Our following comments are directed at such units.

FIGURE : 3.12 SUMMARY OF CAPACITIES FOR COMPONENTS

	Components	No. of Units	Total Capacity (Mill.Nos.)
1.	Poly Variable Capacitor	1	9.6
2.	Ceramic Capacitors	1	360.0
3.	Speaker	5	42.-
4.	Computer Cable	4	10.0
5.	Resonator Crystal	1	30.0
6.	Rod Antenna	4	70.0
7.	TV Antenna	1	25.-
8.	Tuner TV	1	..0
9.	Flyback Transformer	1	..5
10.	Variable Resistor	1	1.-
11.	Fixed Resistor	-	90.-
12.	Semiconductor (IC)	1	360.0
13.	Video Head	1	50.-
14.	Coils	5	107.0
15.	Shield wire	1	17.1

Note: 1. These are registered capacities & not necessarily installed.

2. Capacities for export are included.

Source : Buku Pandaan Industri Elektronika - June 199.
Direktorat Industri Elektronika - Indonesia

3.7.1 By and large, the supply of components is very limited in variety and reliance of the telecom industry on imports is very substantial. Since many equipments are assembled under collaboration, the pressure to use imported components is high as explained in 3.5.+3.

3.7.2 Passive Components

3.7.21 Printed Circuit Boards (PCB), a key component in all electronic equipment is made in-house by PT INTI and independently by some other manufacturers. Prominent among them are two huge capacities (around 350.000 sq. mtrs.) presumably for exports. Such large capacities can, besides exporting, serve also telecom requirements.

3.7.22 Electrolytic and ceramic capacitors also have large export-oriented capacities registered. Capability to supply domestic markets should be available. Relatively smaller capacity exists for fixed resistors which are one of the commonest passive components for electronic circuits.

3.7.23 Quartz Crystals, a key component for telecom also have an export-based unit having a huge capacity of 50 million pieces. Telecom requires crystals custom tailored to specific frequencies and other specifications which should be possible on a well set up crystal production plant.

3.7.3 Micro-electronics

3.7.31 An export-oriented factory for 360 million semiconductors has been operating in Indonesia for some years. Its product range includes standard and commodity IC's which form only a small part of telecom requirements. Telecom equipments however also need semi-customer and custom IC and other specialised semiconductors which therefore have to be imported.

3.7.32 Hybrid IC, as mentioned earlier, are in-house activity of PT LEN. The set up is run more as an experimental than as a production-unit and has yet to make a dent in the needs of Telecom industry.

3.7.4 Capital Goods

3.7.41 Sophisticated machinery & test equipment needed for telecom production are all imported. A few specific and dedicated test set-ups may be developed in-house but such cases are few.

APPENDIX : B MAJOR TELECOM EQUIPMENT PRODUCERS

PT.INTI (Industri Telekomunikasi Indonesia)

Jl. Mohamad Toha 77 - Bandung 40253 Phone : (022)-471501
Telex : 28141 INTILPF BD . Fax. 022.87096

PT.INTI was originally founded in December 1974 as one of the state owned companies under the Ministry of Tourism, Posts & Telecommunications. Since Oct. 89, this company is under the Executive Board of Strategic Indus: chaired by the Minister of Research & Technology. Due to its capabilities & capacities, INTI pioneered production of digital telephone exchange in 1954 with technology from Siemens. Recognised as the market leader (nearly 90% market share) in Digital telephone switching, transmission & advanced fiber optic systems, the current manufacturer range covers:

* Digital Telephone Switching Equipment -- Desk Telephones
* Digital PABX -- Public Payphones
* Multiplex Transmission Eqpt -- Mobile Telephone Systems
* TDMA Subscriber Radio Systems --
* Small Satellite Earth Stations -- Marine Radio Equipment
* Data Communication Systems -- PCB's

The Company currently employs about 1850 people & has technical co-operation agreements with many foreign manufacturers including Siemens AG Germany, BTM of Belgium, TET/Philips of Finance & JRC and NEC both of Japan. Plans for the period 1990-94 include manufacturer & installation of nearly 1.4 million line of digital telephone exchanges in the country. Production targets in Plan V are given in Fig. 3.11.

PT.LEN INDUSTRI (PERSERO)

Jl. Soekarno-Hatta 470/205A Bandung 40254 - INDONESIA
Phone (022) 472682. Tlx 28415 LEN BDG IA. Fax(022) 472695

Originally established (1965) as the National Electrical Research Institute (Lembaga Electronic Nasional: LEN) the scope of activities grew rapidly till in the 1980's, the role of LEN was further enhanced by Presidential Decree to encompass engineering & small scale production of Professional Electronics Products. The new facility at the present location, inaugurated in mid-1983 boasts of 10000 sq.mtr of space equipped with state of the art facilities for research as well as production. Continuing the growth of R&D activities, LEN has been divided into 3 R & D and 1 production unit in 1986. In 1990, this production unit was formally established as PT.LEN INDUSTRY.

In its earlier forms, LEN has to its credit the production and installation of over 100 Television stations & 35 small earth stations in the period 1980-83 above. Thereafter, LEN in association with International Companies like Philips, Thomson, Siemens etc. has produced/assembled and installed a variety of

switching, Microwave & TV systems all over Indonesia. Current activities range from pilot production of electronic components (IC's & Hybrics), five mecnanical components to production of professional & defence equipments, switching systems, Broadcast equipment, Power electronics etc. The Co. also extends electronics training facilities & programs to other companies

PT. RADIO FREQUENCY COMMUNICATIONS

Jl. Ir. H Juanda NO. 474, PO Box 70, Banding 40135, INDONESIA
Ph. (022)-81235 Tlx : 28236 RFCBD IA Fax (022) 87714

Founded in 1969, PT Radio Frequency Communication (PT RFC) is an Indonesian private company whose capability is backed by extensive laboratory facilities for both software and hardware), and 350 highly skilled and experienced engineers and technicians.

Starting it's manufacturing activity in producing Single Channel VHF-FM Transreceiver for mobile and fixed station, a present the Company manufacturers wide range of Professional and Strategic Electronics Equipment like HF-SSB Transreceivers, VHF/UHF-FM Transreceivers, Analog/Digital Microwave Radio, Micro Earth Station (V-Sat), Small Earth Station with SCPC type transmission, Earth Station for Medium Traffic and for Large Traffic, also Time Division Multiple Access System (TDMA). The Company also provides a wide range of accessories such as Selective call, telephone interface, Telex interface, FSK Modem, and various types of Antennas.

Thousands of units from PT RFC's product range have been installed and operated throughout Indonesia today. Some of the products are manufactured under license agreement with various companies from USA, Japan, West Germany, England, Australia and Belgium. The main Customer for professional equipment is Perumtel, the State Telecommunication Company, Department of Defence, Armed Forces, Army, Air Force, Police, Regional Government, Oil Company etc.

PT ELEKTRINDO NUSANTARA

Jl. Kebon Sirih 17-19, 4th Floor, Jakarta-Pusat.
Tel. 353 093, 353 197 Telex : 46 505 Eltara Fax . 353 697

Jl. Yos Sudarso 55, Sunter, Jakarta-Utara
Tel. 49 141, 492 567 Telex. 640699 Eltara fax. 492 726.

PT Elektrindo Nusantara was established in April 1983, as part of the private sector BIMANTARA GROUP comprising nearly 40 diversified comapnies, it developed itself strategically by acquiring and mastering three basic technologies , namely LF to RF technologies, Digital Signal Processing Techniques (DSP) and software capabilities.

Technology acquisition was done by hiring experts at the initial stages, recruitment of young engineers, training them locally and abroad, setting up R&D teams and facilities and drawing up development plans. Research and development activities have been done jointly in Indonesia and in the USA and Canada. The

establishment of a sister company Battel Technologies Inc.under the US law is part of the attemot to gain from the advanced technological environment in those countries.
The total number of employees grew from 15 at its establishment in 1988, to 150 in 1988 and 373 in 1990. About two third of the employees are technical and out of that, approximately 20% are university graduates. The factory has a 5000 square meter built up space on 9000 square meter land. At another location land has been reserved for later expansion. Electronic test gear and modern production machineries constitutes a big part of the company assets. Modern communication facilities have been installed, and a local area network (LAN) with currently 32 work stations is operational.

The Company's product range comprises :

- Sscc modems, analog, digital
- Up-Down converters (4GHz)
- Echo cancellers
- PCM systems, FDM systems
- Small digital Telephone Exchange (STKE)

The Company has been very actively involved in the modernisation & upgradation of the countrys telecom infrastructure having built and installed earth stations, fibre optic systems, Antennas, Switching equipments etc all over the country as well as neighbouring countries.

CHAPTER : 4 CHINA

4.1 Government Policy

4.1.1 Regional Linkages

4.1.11 China's location is in the Asia-Pacific Region of the UN including of developing countries. While it has an enormous coastline looking East onto the China Sea, it borders in the North with Mongolia; on the West with USSR and Afghanistan; and South with numerous nations including India, Nepal, Burma, Hong Kong.

4.1.12 China's topography divides into three major regions : the South-Western mountains (including Tibetan Plateau); the North-Western uplands (enclosing the vast Tarim Basin, Takla Makan Desert and the smaller Dzungarian Basin) and the eastern region predominantly low-lying and divided by the Yangtze and Huang rivers.

4.1.13 With its enormous population of 1.1 billion (1989), resources and particularly its unique political structure, China stands as an entity by itself. Of the total population, about 4% population live in cities having population over 2 million. Although, only 11% of the land is cultivated, the majority of the workforce is engaged in agriculture.

4.1.14 China has total road length of 963,000 kms. of all types. The rail track covers a distance of over 65,000 kms. of which over 5000 kms. are electrified. Domestic and international aviation services are provided by General Administration of Civil Aviation of China. There are 4 international airports.

4.1.15 China is a member of UN as well as most-specialised agencies such as IMF, World Bank, etc.

4.1.2 National Objectives

4.1.21 Since 1949, China has had a centrally planned economy. In Dec. 1978, CCP's Eleventh Central Committee launched a decade of reform and modernization of the economy became a priority. China opened out to foreign trade and investments. Special Economic Zones (SEZ) were established to attract investors. Industrial reforms were further announced in Oct. 1984. In April 1985 policies were introduced to streamline and professionalize the industrial structure.

4.1.22 The announced national objective is that by 2050 the nation will be a "middle developed country" with an annual per capita income of $ 4000. The government will continue to "manage" the economy, liberalizing and controlling as may be felt appropriate sector by sector from time to time.

4.1.23 China is determined to be self-sufficient technologically in the long term. Two years ago, China's technology strategy in the areas of electronics and telecommunication called for foreign collaborations. China expects five-fold expansion of telecommunications in next 15 years --- number of telephones to grow from 6 millions in 1986 to 30 million in the year 2000.

4.1.3 Institutional Framework

4.1.31 Though all important economic activities (except small and informal enterprises) are under state control, Chinese institutions are a careful blend of centralised and decentralised bodies with liberalization increasing progressively in the interest of faster development and finding an important place in world commerce. While National Government retains ultimate control, decision-making is increasingly undertaken at the level of provinces, autonomous regions, special economic zones, and even municipalities of major metropolii.

4.1.32 This situation also applies in telecom matters where there is a "Combined management system". There are presently 23 provinces, 5 autonomous regions, 3 special economic zones, & 3 metro-municipalities involved in the "combined management" of telecom in China. The local network operatives are the Provincial Administration of Post & Telecommunications (PAPT) and have major say in plans, procurement, installation, operation & maintenance in their geographic area. Ministry of Post & Telecommunications (MPT) develops, owns & operates the domestic trunk and international traffic and is also responsible for policy, plans, regulation & supervision on overall national basis.

4.1.33 Within both MPT and PAPT there are the Directorates of Post & Telegraph as well as about 10 functional departments responsible for Regulation, Planning, Finance, Personnel, Technology, and so on. In each provincial matter the PAPT has the executing responsibility so long as they stay within the bounds laid out by MPT. These bounds are day by day reduced starting with experiments in Special Economic Zones (SEZ) where market forces are given much more leeway and many of the regulations are relaxed for more productive activity.

4.1.4 Industrial Policy

4.1.41 In principle, the state is the prime force in ownership and management of the productive apparatus. This is all the more so in telecom which is considered a high-priority since 1980. However, here too different forms of "combined managements" apply. At the national level, production responsibility for telecom equipment is taken up under the Ministry of Machinery and Electronics Industry (MMEI);also by MPT through its Post & Telecom Industry Corporation (PTIC); further by PAPT's through manufacturing subsidiaries set up for this purpose; and in Special Economic Zones (SEZ) where any of the above bodies may set up joint ventures with selected foreign parties.

4.1.42 Each of these entities have set up, funded and supervised a host of producing units varying from small to large factories in parts, components,equipments and systems. These subsidiaries may be entirely owned by MMEI or PTIC; may be joint by between central & provincial bodies; or may even be foreign joint ventures with offshore participation (aimed largely at export market).

4.1.43 While self-reliance used to be a keystone of policy in the past, since 1980 there has been "opening out of the economy" -- especially in telecommunications (and such hi-tech areas) where it is not possible to catch up without reliance on foreign technology and capital and some extent of globalization.

4.1.44 Protection is given only to items which are in local production in sufficient quality & quantity. Otherwise import tarrifs in the range of 10% to 30% apply where imports are considered essential. For items considered to be in adequate production (say TV sets or automobiles) the protection may rise as high as 100%. Of course, the whole apparatus being under government control such protection is only a matter of principle.

4.1.45 Prior to 1980, industry was concentrating on provision of basic products, employment creation and social objectives. Profits being secondary, the non-economic performance often led to high prices, poor quality and subsidization from government funds. Any improvement, renovation or expansion called for fresh funds from government. Resources both at the center and the provinces began to deplete rapidly.

4.1.46 Since 1980 however the trend has been to call upon each major unit to sustain itself and justify its existence in economic terms. This was termed the "contract" or "responsibility" system whereby in certain enterprises, ownership (ie. government) was separated from management which then had to be responsible to an agreed long-term plan including expected profits, proposed investment of surplus, upgrading, etc. It is stated that this led to a dramatic turn-around, profitability & growth.

4.1.47 Another innovation was "group formation" whereby enterprises (which were often quite small) were encouraged to join together into synergetic groups for encouraging common brands, larger scale, better integration, cross-financing and lower overheads. Stronger market & finance position resulted in less drain on government subsidies.

4.1.48 In the last few years, several coastal areas (near to Macao, Hong Kong and Taiwan) have been developed rapidly into Special Economic Zones (SEZ) where enormous investments are made into infrastructure and liberal policies are implemented. Such zones have essentially emulated a market economy. Foreign technology, inputs and investments have poured in and an upsurge in output, exports & expansion has taken place. Visibly SEZ (such as Shenzen) are different in all respects from the traditional activities still going on in the North.

4.1.5 Approach to R & D

4.1.51 Major thrust in research bodies is towards applied research aimed of import substitution of systems, equipments and components. Investigations are carried on not only at some of the larger telecom factories but also in separate "Institutes" devoted to special areas of research where new locally-designed products are brought out. Admittedly, the pace and quality of research has been insufficient to provide many upto-date products for the telecom

network. [illegible]

4.1.52 [illegible] institutes under the control of PTIC and devoted to the needs of Post & Telecom. In addition MMEI has over 200 institutes which of course cover the wider field of machinery and electronics. Certain ones are doing developments directed towards telecom and allied accessory products such as peripherals, power supplies etc.

4.1.53 The drive is presently to upgrade the telecom technology from its analog past into fast-moving digital stream. Substantial efforts are going to to digitalize all apparatus of switching, multiplexing, transmitting and terminals so as to convert the whole network by year 2000 when ISDN will become widespread in major cities.

4.1.54 Realising the technical & financial limitations and the widening gap with advanced countries, most of the parties visited seemed to welcome and even invite programs from abroad aimed at transfer of such technologies with some form of multi-lateral funding.

4.2 ROLE OF TELECOMMUNICATION

4.2.1 Socio-Economic Impact

4.2.11 The opening out & liberalization reforms have crated a huge upsurge of economic activity in all respects with consequent industrialization and urbanization. The telecom infrastructure, which was already lagging behind the needs, is under great pressure to keep up with the demands placed on it. Imports of equipment through bilateral and multilateral loans does help to some extent but clearly has its own limits and constraints in terms of resources.

4.2.12 Being still a command economy, the need for governmental, provincial and rural information flow is a big load in itself. This is especially true as reforms are under implementation and thus execution, monitoring and adjustment call for copious flow of information & orders. The government itself is facing costly limitations in its functioning for which telecom infrastructure needs to be upgraded very substantially.

4.2.13 The security and defence apparatus have established & operated their own dedicated network for quite some time. It is nation-wide and largely based on wireless (rather than wired) configuration. Use of MPT lines however is made by leasing arrangements with MPT. Similar mixed operation also exists for the Broadcast Network which strives to reach remote populations in the aid of national & cultural integration.

4.2.14 Power, Rail, Airways, Oil//Mining, News Agency, Meteorology, and so on have to reach into areas not covered by public network and hence each have their own dedicate networks which they separately operate. In all, 34 dedicated networks operate in China. Such networks cover 60,000 km of wired, 5000 shortwave, 5000 UHF, and 10,000 km of microwave links. About 5500 lines of automatic and

2000 lines manual switching serves dedicated customers.

4.2.15 Along with the development of SEZ (such as Shenzen) has come the possibility of such new zones setting up their own network with the latest and most modern equipments and advanced services (Fax, teletex, data, even cellular). These needs are in line with rapid growth of foreign business and joint ventures operating in conjunction with their headquarters.

4.2.16 Socially, household connections have the least priority including from the point of affordability (ie personal income). Connections are paid for by business and government bodies and even their needs do not seem to be met especially when moving away from urbanised and industrialised areas. Impact on the remote and sparsely populated areas of the center and west have been negligible.

4.2.17 While telecom traffic grew at 22% per annum (average from 1985-1989), subscriber growth was at a lower rate of 19%. Aware of the mutual interaction between development and telecom facilities, the government has given special benefits for telecom entities such as 15% income tax rate (10%), retention of 80% of non-trading export earnings; moratorium on repayment of government loans; increase in tariff rates. Development rather than competition or efficiency has been the social impact of telecom activities in the past. Opening out of the economy and increasing decentralization is expected to change all that.

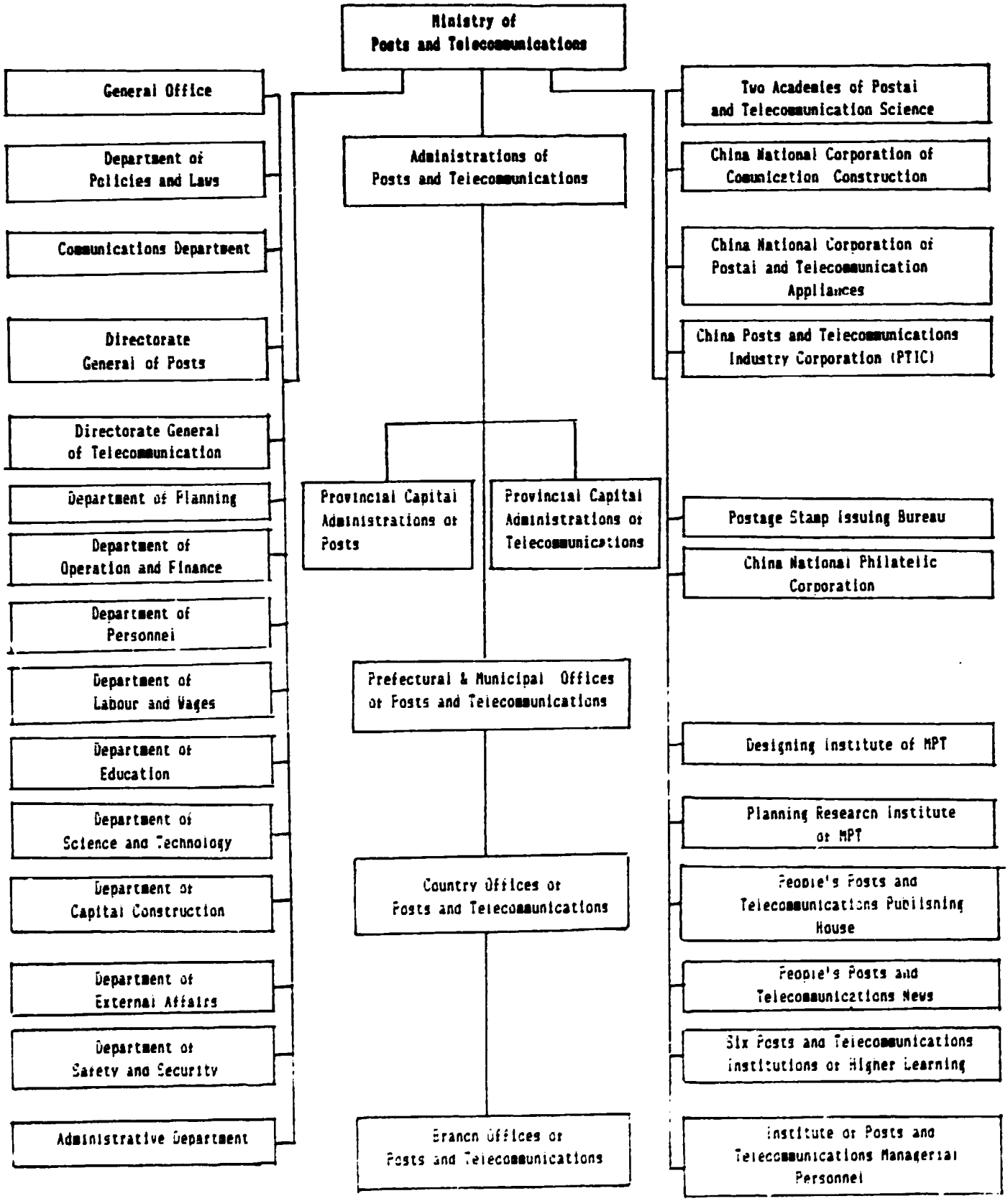
4.2.2 Organisation & Management

4.2.21 Ultimate supervisory authority rests at the national level with MPT from where the bulk of nationwide funding is derived for new projects. For the VIII plan, MPT will invest 10 billion yuan and extend a loan of further 10 billion yuan. Final approval of plans, tariff setting and foreign loans also rests with MPT. On the operating side, MPT handles the international traffic and first-order national trunk traffic. Relations with international technical and regulatory bodies are also handled by MPT.

4.2.22 Through its production arm (PTIC), the MPT is also a very major supplier of physical plant. PTIC is a separate holding corporation under MPT responsible for production, supply, installation of a great deal of equipments needed not only by the network directly operated by MPT but also the needs of PAPT's and the large range of private users mentioned in 4.2.1. PTIC guides 28 factories, 5 Institutes, 8 joint subsidiaries with provinces, 10 joint venture units with foreign partners. **Figure 4.1** gives a picture of the main organisation tree.

4.2.23 In the provinces, PAPT's are the primary operators (supervised by MPT) picking up from the trunk network of MPT and being responsible for provincial operations. This includes urban as well as rural and also coordination with private users in their provinces. PAPT's have substantial control over their own affairs & expenditures within the policies & plans set by MPT. As of now, Post & Telegraph operate under the same administration and hence Post works in conjunction with Telecom at all levels and in all

FIGURE : 4.1 ORGANISATION CHART



SOURCE : REPORT ON UNITED NATIONS DEVELOPMENT PROGRAMME
(SEPTEMBER 11, 1991.)

functional organisations, separation of these two entities has yet to be established.

4.2.24 The organisation is under continuous review and changes are made from time to time in view of changes in technology, economic policy, user needs. The general direction is towards decentralization of decision-making and responsibility. The process is however slow except in SEZ where the pace of liberalization is rapid. Results of SEZ will be the pointers to changes in other areas that will follow.

4.2.3 Injection of Technology

4.2.31 While emphasis on self-reliance and self-development has been high in the past and continues in principle even today, China has not been able to avoid import of technology in various forms at any stage. Each generational change brings with it the compulsion for quick changeover to the new techniques. It is at such times that technological imports, at least for some period, become unavoidable. The period around 1990 has been such a period calling for moving from analog to digital and to higher levels of integrated circuits. At such a time injection of foreign technology cannot be avoided.

4.2.32 Technology injection takes place first through importation of turnkey systems to establish newer & more modern apparatus and gain experience in the operation of advanced systems. Turnkey contracts and Joint-Ventures have been forged with many European companies --- Siemens, Alcatel, Philips, Plessey, Ericsson --- involving substantial parts of the network. Several of them are in the form of joint local assembly. This is followed by equipment import along with purchase of corresponding know-how and manufacturing set-up. For some time, the component parts continue to be imported until Chinese engineers have unravelled the designs and substituted local components to the extent possible and /or found second sources for the collaborator's components in the global markets.

4.2.33 Parallely, the Chinese development Institutes are carrying on their own experiments to catch up with the technology being imported. At some point the local efforts are expected to converge with the imported knowhow and mastery of the technique is properly absorbed (for example : analog microwave links). If this process takes a long time , another generation of technology may be born abroad and the process of catching up starts afresh.

4.2.34 The Chinese scientists & technologists informally expressed a strong need for some interim assistance programs which could speed up this catching-up process and put them in line with current technologies so their research may stand closer to par with others and they may rely increasingly on themselves for further advancement.

4.2.4 **Available Modes of Communication**

4.2.41 China is not uniformly covered in terms of telecom facilities. Along the south-eastern seaboard (the doorway to world trade), up-to-date modes of the fast digital communication are established --- voice, fax, high-speed data-packets, paging and cellular (mobile and hand-carried). Density of connections, traffic capacity and quality of service in these areas are a cut above anywhere else with the country. This results from the creation of special economic zones where global market conditions are emulated.

4.2.42 The corridor running from Beijing to Shanghai (via Tianjin and Nanking) is next served with telephone, telex and data-links but less endowed with fax or cellular activity (these being import items at this time are more readily permitted in the export-earning South). In the main cities of Beijing, Tianjin & Shanghai (as also at Guangzhou) the average telephone density stood between 7% to 8% as compared to the national average of 1%.

4.2.43 The matrix of rural areas surrounding cities & towns are served mainly by the spill-over from the main trunk corridors and register connection densities well below 0.5%. The truly remote areas (low in population) have negligible density. In both these areas the "plain old telephone" is about all one gets. Newer services are yet to penetrate.

4.2.44 Surprisingly, there is little emphasis on "public call offices" or outside coin/card operated telephones. These could have been a way of providing wider telephone access to people whose need is occasional as for example in low-income localities or in rural villages.

4.3 NETWORK USAGE PATTERN

4.3.1 International Traffic

4.3.11 The entire responsibility for international traffic rests with MPT. Planning, importing, local procurement (to the extent possible), construction, operation and maintenance is in the ministry's hands. As international tariffs are kept high, this activity shows higher profit compared to domestic and is a major source of capital formation for network expansion.

4.3.12 While operator-assisted calls to foreign countries can be originated from many parts of the national network International Direct Dialing (IDD)to about 180 countries could be availed from nearby 300 Chinese cities and towns in 1990. Connection to Hong Kong provides a major link. An optical fibre cable from Hong Kong connects to 10 cities in South China. About 75% of international calls are destined for Hong Kong. About 10% of the subscribers availed of IDD facilities.

4.3.13 There are two earth stations and gateway exchanges (Beijing and Shanghai) and a third one is imminent at Guangzhou. Digitalising the Satellite Services and building submarine optical cables are in VIII Plan and should improve the quantity and quality of world-wide communication thus assisting in national development

and a richer global presence.

4.3.2 Domestic Network

4.3.21 The progress of domestic network of China is indeed impressive. Current level of telephones (1990 over 12 million) growing at 15% each year makes it the largest among developing countries and about 12th largest worldwide. Growth during the 40 years of independence is pictorialised in **Figure 4.2**.Each year revenues of USD 2 Billion and investments of the same order place China's efforts (especially during the last decade) at the head of developing countries list, particularly Plans VII, VIII and IX chalking out the strategies upto year 2000.

4.3.22 Related to its size, population and basic resources,however, the position looks less impressive. The growth of traffic and usage is rushing ahead of expansion of physical plant as can be seen in **Figure 4.**.. This is clearly due to the headlong pace of economic development with which the infrastructure of telecom is unable to keep up placing parts of the network under great stress.

4.3.23 Local exchange capacity is less than **10%** manually switched (in rural areas); about 65% electromechanical; and about 25% stored program controlled (in main cities). Long distance transmission has grown to more than **100,000** circuits only **40%** of which were connected to automatic exchanges.

4.3.24 The long distance transmission network is predominantly analog with newly imported digital equipment being less than 20% of the coverage. Direct distance dialing (DDD) subscribers by 1990 rose to 1.2 million, though an enormous growth over 625 thousand in 1989. DDD covers but a small proportion in this vast country. Besides the congestion and the delays, use of advanced services like FAX, Data, Paging, Mobile, Cellular are only for the most urbanised cities. Subscriber base for each of these services is in the range of 1500 to 2500 each and that too in the busiest of metro-cities.

4.3.25 Post & Telegraph activities operate in tandem with telecom and to a large extent are subsidised by it. These services are also being modernised --- for example by automated sorting or store and forward telegrams. An indicator of their continued importance is that telegrams carry 30 times more messages than telex and telex 40 times more than FAX.

4.3.3 Dedicated Networks

4.3.31 During the early stages of development, the telecom network was miniscule and its importance as an infrastructure had yet to be realised and resources deployed. Important services and projects started setting up their own networks from their own resources. This happened not only for defence/security forces and essential services but also in case of certain distant administrations which were developing away from main power centers. Networks by private parties are of course not permitted.

FIGURE : 4.2 GROWTH IN TELECOM SERVICES

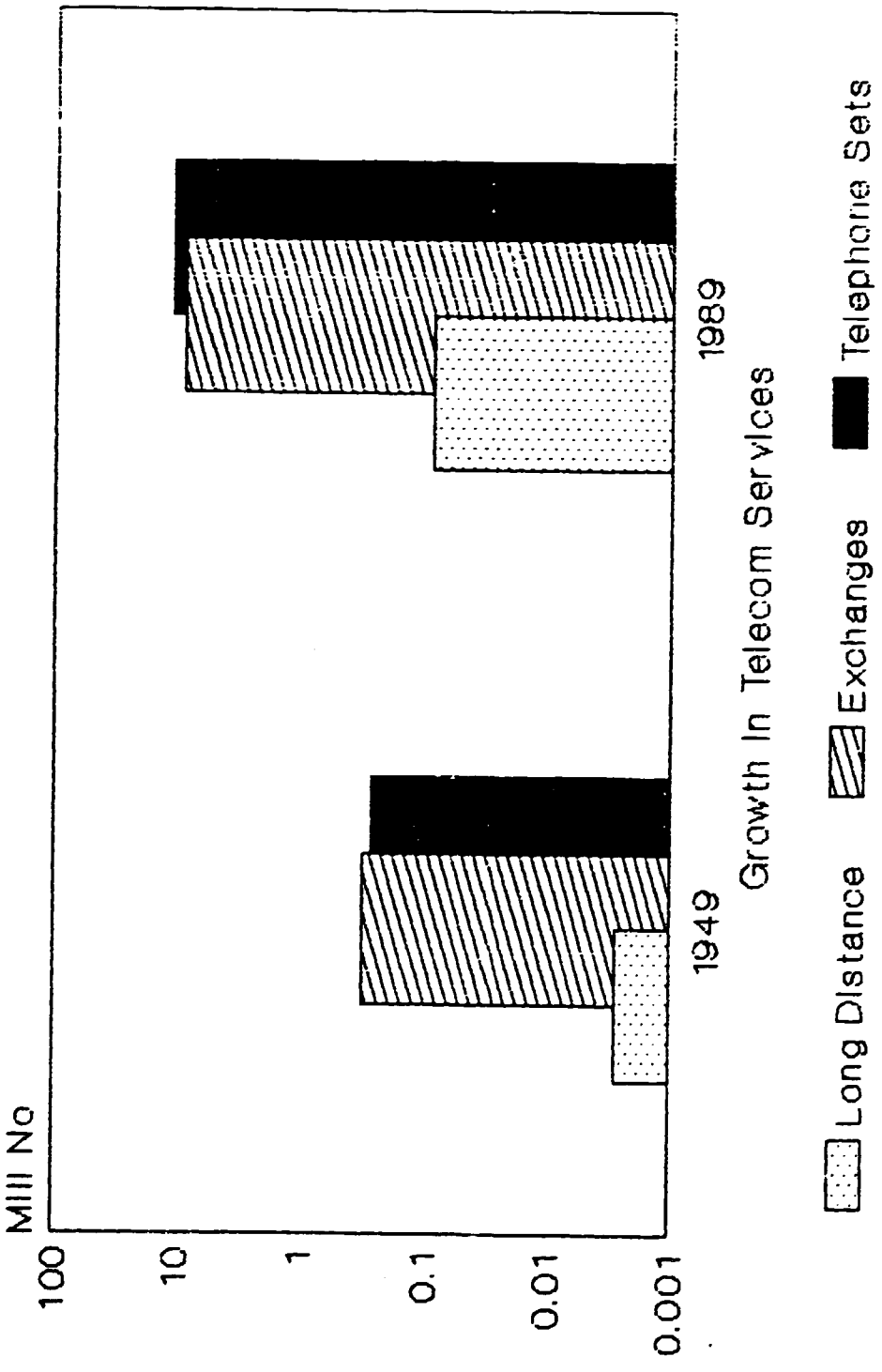
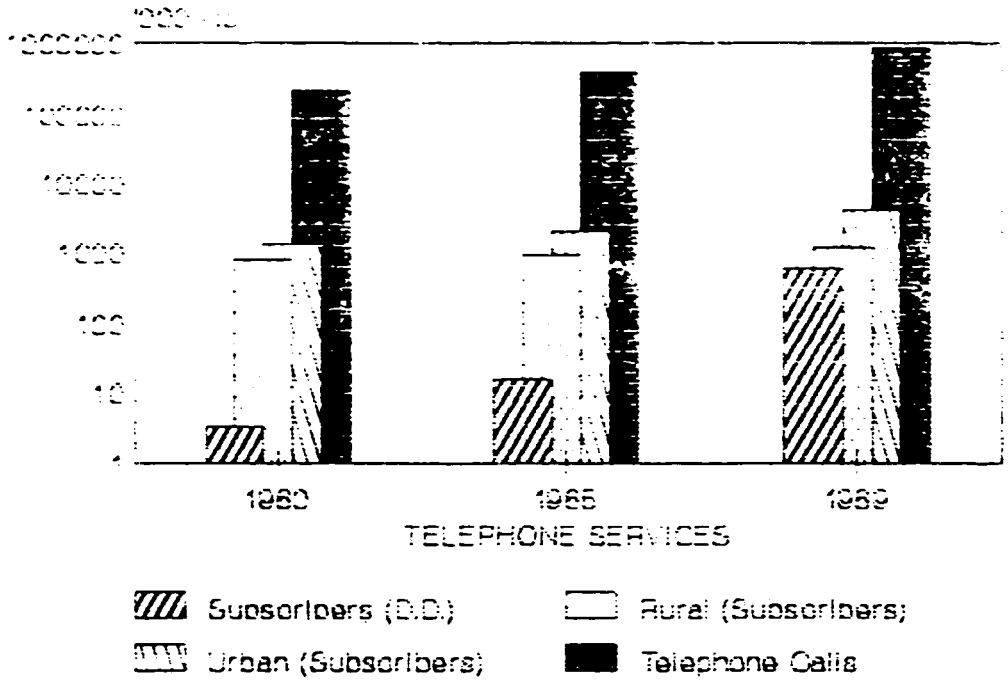
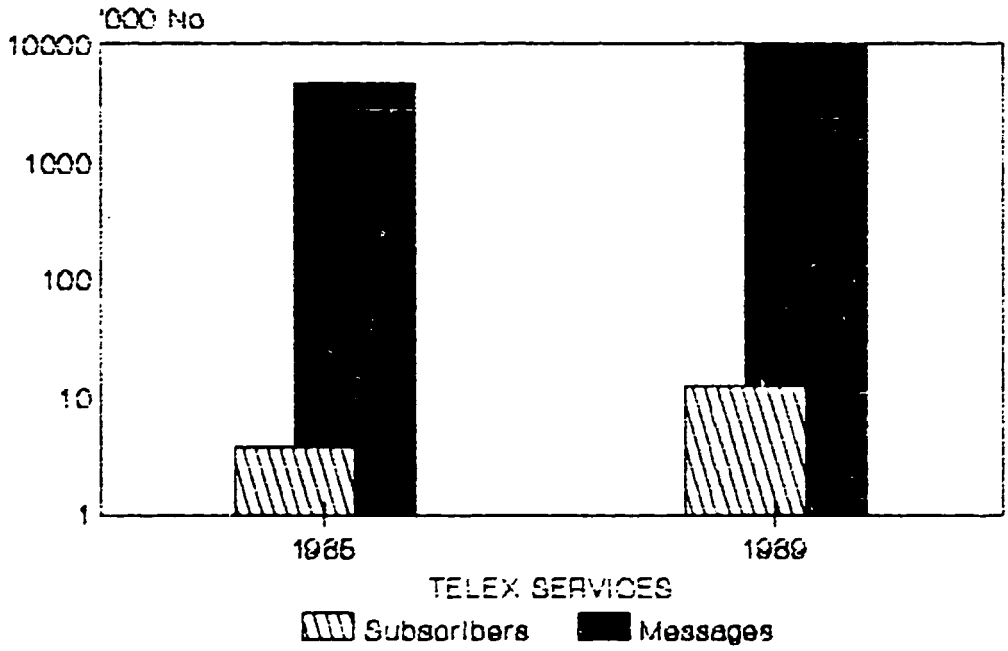
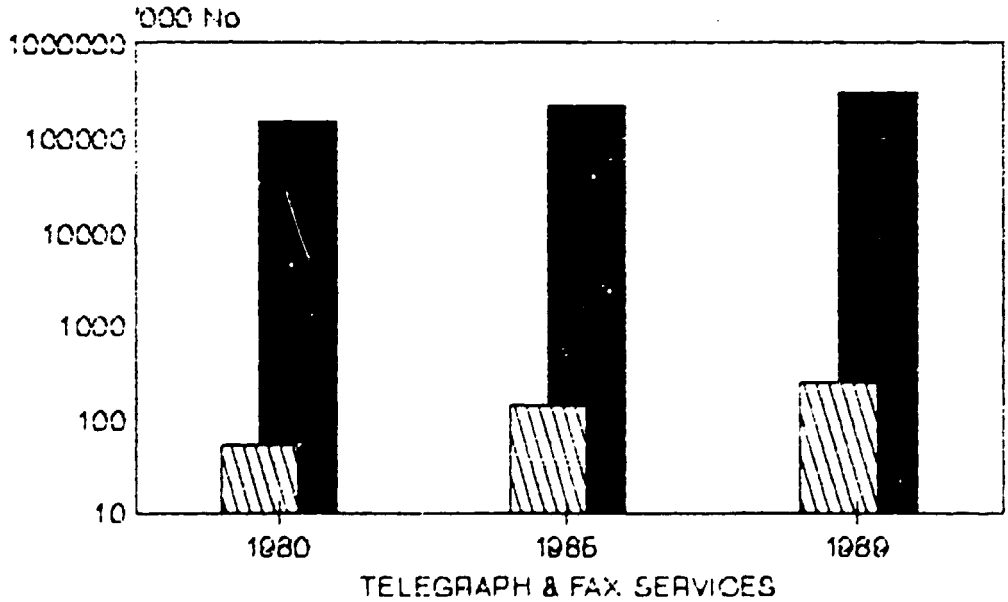


FIGURE : 4.3 GROWTH IN TELEPHONE & TELEX TRAFFIC







4.3.32 Each authority made its own plans allocating its investment and local requirements. Deployment of resources and procurement procedures were done independently. There should be provincial, national network was needed. this was tossed out. Requirements being largely internal, costs and shares accepted loosely decided.

4.3.33 The aggregate of dedicated point-to-point network is not small. It is estimated that there are 60,000 wired circuits; 10000 microwave; 5000 VHF and 5000 shortwave circuits. Switching is automated to the extent of nearly 60%, the rest being manual. As development spreads to unserviced areas, it is felt that pressure for private circuits will grow further.

4.3.34 The technology and equipment mix of such dedicated networks were decided desparately as needs arose and local resources become available. Inadequate consideration as to compatibility, interfacing, matching and obsolescence is now getting the attention of MPT and strong efforts are being made to bring about consideration of overall system optimization. Efforts are on to integrate some of these networks into the main organizational structure of MPT which requires fresh legislation.

4.3.4 Rural Services

4.3.41 Rural Services are handled by PAPT organizations. Resources of PAPT are often deployed towards capital and industrial cities. Especially in the new atmosphere of opening out to global forces, urban infrastructure gets high priority at the expense of rural requirements & telephone densities in cities are sometimes as high as 10 times the average density in the PAPT.

4.3.42 While urban network doubled between 1985 to 1989, the rural coverage rose by less than 40% in the same period. To some extent this is ascribed to the tilt at the provincial levels in favor of export development. MPT reports that farming areas embodying 80% of the population are served by less than 0.2% of the overall telephones.

4.3.5 Network Performance

4.3.51 Efforts during Plan VII have turned MPT from frequently losing into a profit-making body (within the meaning of accounting methods used in China's government accounts). Despite re-investment of surpluses, government & foreign loans, investment in telecom remains below 0.5% of GNP (low end in the Asia-Pacific Region) and below 1% of developmental investments.

4.3.52 For the VII Plan the State Council decreed that various telecom operating authorities will "not only use state appropriations but also funds from the efforts of state, provincial, local, collective and even individual resources". At the provincial level devices such surcharges on centrally approved tariffs and connection fees were introduced; customers who were given connections on newer automatic systems with more facilities were charged differentially and so on. As a result, the fixed assets which aggregated 12.6 billion yuan in 1985 almost doubled by 1989 to 23.6 billion yuan.

4.3.53 Despite doubling its telephone density from 0.4% in 1985 to 0.8% in 1990, it is expected to reach only 1.1 by end 1995. China's telephone coverage belongs to the group of less developed countries. Registered waiting lists continue to grow (6.5 million in 1989). Hidden demand may be several times this figure because small business, residential, public-call and rural requirements have hardly been tapped in China's largely government-based economy. The growth rate of subscribers continues to lag behind the growth rate of the national economy being at 50% in VI Plan and 80% in VII Plan as compared to the growth of the economy.

4.3.54 The additional investments were of course aimed at installing the most recent equipment that the country could produce: this included mostly crossbar and semi-electronic equipments and analog transmission mode. Beginnings were also made to import digital switching and transmission equipments for the densest and heavily loaded parts of the network. These remained limited within the resources available and bilateral loans which the supplier could arrange.

4.3.55 Improvement in performance of the network is displayed at **Figure 4.4.** It should be noted that Toll and Urban successful calls remain at low levels as compared to more efficient networks elsewhere. Also the productivity of labor rose about 2.5 times during the VII Plan as a consequence of adding more modern (relatively speaking) equipment to the network.

4.4 GROWTH IN SERVICES

4.4.1 Basic Services

4.4.11 In keeping with the opening out of the economy and the enhanced overall growth objectives, the State Council has decided that the telecom infrastructure should grow at a rate which is double of the out put of the economy. This calls for an eight-fold rise in telecom traffic volume and capability by year 2000 as compared to 1980. During the VIII Plan there a compound growth rate of 12% has been targeted to bring the turnover of MPT to over 13-14 billion yuan in 1995 as compared to over 7-8 billion yuan reached in 1990.

4.4.12 In terms of telephone density, the national average of 1.1% reached in 1990 should increase to 1.8 - 2.0% by 1995 and further 2.8 - 3.0% by 2000. Provincial capitals should be covered to the extent of 10% and the four metropolii to the extent of 15% by 1995. Special attention would be given to rural distribution to achieve at least 1% rural density. Even so, China will be well behind the performances achieved in smaller European countries even today.

4.4.13 One may then consider the demand for telecom services to be more restricted by the supply side. As telecom facilities are provided along with the growing economy, incomes will rise and the suppressed demand will emerge to keep running ahead of any supply that can be arranged. A picture of the growth of basic services is shown at **Figure 4.5.**

FIGURE : 4.4 NETWORK PERFORMANCE

		1990	1995	2000
1.	Telephone Density	0.42	0.60	0.88
2.	Successful Call Ratio (%)			
	- Toll Telephone			
	- Automatic	-	-	42.54
	- Manual	-	85.49	87.45
	- Qualified Circuits	80.24	86.76	90.50
	- Urban Local Telephone	67.00	70.50	80.42
	- Rural Telephone	-	87.81	95.38
3.	Telegraph			
	- Service Error (%)	0.01	0.0024	0.0038
	- Overdue Delivery (%)	0.91	0.527	0.289
	- Qualified Circuits (%)	-	93.29	95.56

FIGURE : 4.5 GROWTH IN BASIC SERVICES

		Position at the end of Plan			
		VI	VII	VIII	UNIT
1.	Investment in Telecom	5.9	20	35	Bill.Yuan
2.	Total Telephone Exchange Capacity	N.A	20.45	35.45	Mill.Lines
3.	Automatic Toll Exchange Capacity	12.31	165.00	465.00	000 Lines
4.	Long Distance Telephone Circuits	37.55	108.00	258.00	000 Nos.
5.	Trunk Transmission Network				
	- Microwave	N.A.	33625	48125	Kms.
	- Optical Fibre	N.A.	3304	23334	Kms.
6.	Satellite Earth Stations	N.A.	22	34	Nos.
7.	Telephone Sets	6.0	12.6	[illegible]	Mill.Nos.
8.	Telex	5.0	12.0	17.64	000 Nos.

4.4.14 The aggregate switching capacity during the eighth plan will increase by 15 million lines (4 million central exchange subscribers and 1 million in rural locations. This will enable aggregate switching capacity to rise to 35.5 million and telephone sets to nearly 25 million.

4.4.15 Efforts will be to increasingly automatise the long-distance network by adding 150,000 new toll circuits using automatic equipments. The national automatic network will then cover not only the main metropolii and provincial capitals but also prefectural towns in the east and west and even down to county seats in the fast moving coastal areas.

4.4.16 New fibre optics based digital switching and transmission equipments will create a 20,000 km linkage between the major cities starting from Beijing in the North and down to Guangzhou in the South with cross connections to smaller cities along the route. This will be assisted by 14,500 km of digital microwave to serve as alternate and branch routes.

4.4.17 For initiating a domestic satellite telecom activity, twelve earth-stations and 50 VSAT will be distributed in remoter areas having resources or political significance. Their deployment will certainly add to the poor level of rural telecom.

4.4.18 International communications will be further strengthened with Japan, Hong-kong and Macau to serve the fast moving trade with these regions. Optical submarine cable to Japan and augmentation of the gateway exchanges will aid this process.

4.4.2 Text and Data

4.4.21 Thus far telegraph has been a major mode of text communication especially for families and individuals who have no access to the main telecom network. Thus telegram traffic has been growing steadily throughout the last decade but shows signs of leveling off at 250-300 thousand telegrams per year. This may be due to the gradually increasing access being available to more modern telecom services.

4.4.22 Use of telex has not been a major load on the telecom system. Despite 15,000 telex lines being available in 1986, less than 5000 subscribers ventured to use the service. Even in 1988 the combined production of telex, teletype, facsimile and data equipments were reported at only about 20,000 all told. These are abysmally low figures for an enormous country like China. However it must be remembered that the Kanji script creates an enormous barrier leaving the use of telex to Latin script users only.

4.4.23 Facsimile machines, which are replacing telex machines in the advanced countries, are essentially imported or brought in as kits for local putting together. Plans to acquire the technology of manufacture remain in limbo partly in view of some difficulty in negotiating Japanese technology and partly due to the substantial investments which would have to be made for a presently small market. In the long run however the ease with which Chinese

character text can be conveyed should promise a very substantial market for facsimile machines.

4.4.29 Data networks are not as yet widespread in China even for major bodies such as banking. Quality of the lines being very variable at various points on the route and computer activity being rather subdued .production of PC was less than 55,000 in year 1988 the scope for data transfer seems at the moment small.

4.4.3 Advanced Services

4.4.31 During the VII Plan, the compulsion to modernise led to the import of large quantum of advanced equipments. In the main these were digital and SPC controlled version of exchanges, multiplexing equipments, fibre-optics, microwave (140 MBs) and so on. These were installed in the densest parts of the network, namely within and between the major traffic centers.

4.4.32 This has opened the way for initiation of more advance services to take shape through import and trials in use. Places like Shenzen,Guangzhou and others near to the free market centers of ASEAN are the most active in this respect. Packet-switching, digital paging, cellular mobile, and some electronic mail has started being used by large businesses.

4.4.33 Expansion of these services will depend firstly upon export earning of the globally active southern region and will spread from there mainly when locally produced digital systems become common. Technology-acquisitions and joint-ventures are already initiated to increase the local content of the advanced equipments.

4.5 EQUIPMENT REQUIREMENTS

4.5.1 Present Situation

4.5.11 Existing network, evolved over several decades through local production as well as imports from time to time, is a mix of First to Fourth Generations of telecom equipments (see 1.3). As newer and newer equipments have been inducted, it has not always been possible to give up the earlier generations mostly because the demand continued to grow beyond supply.

4.5.12 As and when major trafric centers could no longer use the older equipment, it would be passed down the line to sparser trafric.There have even been occasions when provinces purchased or were gifted earlier generations of equipments from abroad and these were incorporated into parts of the network.

4.5.13 Upto the year 1985 from the data available it seemed that the rural telephone service comprised entirely of older telephone instruments, manual switchboards, open wire lines---in short equipments left over from the First or Second generation. Urban networks however were inducted locally made equipment of the Third Generation based on analog technology.

4.5.2 Switching Equipment

4.5.21 To give some estimates, at end of VI Plan, manual switching comprised 35%; step-by-step 35%; cross-bar 25% and "semi-electronic" only 5%. Clearly this was all analog equipment except for some digital systems developed by research institutions for experimentation.

4.5.22 It was in the VII Plan that the modernization drive of the 80's had its effect on the modernization of the network. Resources were mustered by the reform movement (locally as through foreign sources) and massive imports of digital equipment were arranged in all aspects of the main trunk network. From verbal inquiries, the mix of Analog to Digital by 1990 would perhaps stand at 75:25. In switching for the urban/suburban traffic, a knowledgeable source estimates: manual 15%; step-by-step 20%; cross-bar 25%; semi-electronic 15% and SPC digital 25%. This would be the position by 1990.

4.5.23 Though there is a resolve to induct the maximum amount of the latest SPC digital equipment from now on, this may be difficult to achieve as past investments in factories making earlier equipments have not yet paid for themselves. Further, import of the latest equipment has already put a strain on the balance of payments making imports of large magnitude difficult.

4.5.3 Transmission

4.5.31 Microwave and UHF transmission (analog type) have been a strong point of development and production by MPT factories; so also the capacity to produce cables. Other modes of transmission (satellite, MARR, mobile, cellular) have not yet made serious impact in the Chinese network. Rough proportion between wired and wireless transmission by circuit kilometers may be approximately in the ratio 60:40 in the public network.

4.5.32 A broad picture of the valuewise annual investments in various parts of the Chinese telecom network can be pictured as shown in **Figure 4.6.**

4.5.4 Supporting Equipment

4.5.41 Along with the various types of systems and sub-systems developed /produced in China, the R & D institutes have in some cases developed customised equipments for exercising and testing the functioning of the system. Similarly, monitoring and supervisory equipment is also required to keep tabs on the working of the network or sub-network and compiling mal-function statistics. As SPC digital equipment has now entered the network, newer designs of such equipment have become necessary.

4.5.42 Since the Chinese network comprises such a wide variety of equipments of different generations, different technologies and varying sources, a major problem centers around the need for interfacing the newer equipment with the older one. This may be less of a problem for totally new turnkey installations but when existing installations are expanded with new equipment, intervening racks are

FIGURE : 4.6 BROAD PICTURE OF ANNUAL INVESTMENT

(Scale : $ Million)

	Telecom Equip. Expenditure		
	1984	1989	1994
TOTAL Expenditure	1100	1800	2800
- Switching	308.6	464.4	722.4
- Transmission	251.9	368.4	588.2
- Cable	100.1	151.2	226.8
- Satellite	34.1	57.6	81.2
- Mobile	57.2	160.2	257.6
- Data Comms.	73.7	176.2	330.4
- PBX & Key	83.6	151.2	215.6
- Consumer Premises	104.5	156.4	232.4
- Others	91.3	113.4	146.4

NOTES : 1. Expenditure baseed on Arthur D. Little Inc. Estimates.
2. Expenditure by equipment type is based on average world expenditure proportion in various types.

necessary to match one equipment to the other. We note the capability of Chinese scientists and engineers to meet up with this requirement both at R & D institutes and at factories.

4.5.4 Supporting equipments along with the more prosaic needs like power supplies constitute a respectable part of the system investment amounting to over 5% of the total. In general these would be made and supplied locally even in cases where the main system has been imported.

4.6 LOCAL PRODUCTION

4.6.1 Overall View

4.6.11 Electronics industry in China comprises almost 3500 enterprises whose regulation and guidance is the responsibility of the Ministry of Metals and Electronics Industry (MMEI). The ownership of all except small industries is under the state apparatus. These units may be owned and operated by a variety of parastatal bodies built up under MMEI, MPT, other Ministries, Provincial Authorities, even major Municipalities. However, overall policy-making, monitoring, recording comes under MMEI.

4.6.12 Locationwise, three areas dominate electronics production---Jiangsu, Guangdong, Shanghai---accounting for 40% share of output of nearly 60 billion yuan in 1988. Employment in the industry exceeded 1.7 million of whom over 200,000 were engineers and technicians. The industry has grown nearly seven-fold in the decade 1980-90. It exports almost 12% of its output which is nearly 2% of the overall national export.

4.6.13 Breakup of the output shows 30-31% as components, about 55% as consumer equipment and the balance around 15% professional equipment. One might consider this as quite a lopsided distribution in favor of the consumer sector. Production of professional equipment in recent years is shown at **Figure 4.7.**

4.6.14 The industry imported USD 5.2 Billion worth of goods in 1989 of which about USD 0.5 billion was communication equipments. Additionally, over USD 1.6 Billion worth of components other than picture tubes and audio components were imported presumably for professional equipment production.

4.6.2 Public Sector Factories

4.6.21 As covered earlier, production for telecom is entirely controlled by the state through numerous parastatal factories organised either by MPT, MMEI, Provinces or certain Municipalities. Recent reforms have resulted in the transfer of majority of centrally owned factories to be passed on to the the provinces in which they are located.

4.6.22 As of the statistics of 1988, telecom factories numbered about 200, set up by MMEI and another 30 set up by MPT (through its holding subsidiary PTIC). Employment exceeded 200,000 of whom about 35000 were technical personnel. Communications equipment production (inclusive of specialised equipment for navigation and communication

FIGURE : 4.7 GROWTH IN PROFESSIONAL EQUIPMENT PRODUCTION

Scale : '000 nos.

Products	1985	1986	1987	1988	1989
1. **Communication Equipment**					
- Radio communication and navigation aids.	137.8	12.9	155.8	256.3	234.8
- Multi-channel communication equip.	4.1	9.8	23.5	15.1	15.4
- Wire communication Telephone Set	1598.5	1317.8	2863.5	6558.3	7187.5
- Telephone Exchange	912.8	527.1	1521.4	2948.3	2286.5
- Telegraph Equipment	5.7	4.8	16.3	16.3	23.3
2. **Broadcasting Equipment**					
- Broadcast & TV Eqpt. Broadcast & TV m/wave equipment.	0.042	0.155	0.345	0.162	0.122
- Broadcast Transmitters	0.539	1.028	3.672	0.325	0.371
- TV Transmitters	0.236	0.321	0.431	0.396	0.266
- TV Transposers	4.098	3.728	4.434	5.322	4.383
3. **Computers & Peripherals**					
- Computers Computer in various sizes	0.286	0.280	0.239	0.502	0.628
- Micro computers	35.7	39.1	47.4	53.3	75.4
- Peripherals	67.5	65.8	164.7	166.7	253.4

Source : China Electronics Industry Year Book - 1990

in the air and sea well exceeded 5.5 billion yuan in 1985. Table 4.11 **Figure 4.8** lists the trend of production of key items for 1981-85.

4.6.24 Indications show that growth rates vary drastically, even point negative from item to item and from year to year. Under these circumstances, it is hazardous to predict the increase in telecom equipment output. However, plan targets are to aim for 17% growth in telecom services. One could then estimate the output in 1990 to be in the vicinity of 7 billion yuan.

4.6.24 Regarding the technology of equipment being produced, reports of 1986 show that 30% of telephone sets were still mechanical type; 10% of exchanges were still manual; about 50% were crossbar; 35% were semi-electronic and less than 5% were SPC digital, for which projects were recently started. Production of telecom cables seems to have stabilised at less than 200,000 kilometers per annum including all types. Optical fibre cables having just made a start with around 2500 kilometers.

4.6.25 Wireless transmission equipment remained entirely analog. Emphasis remained on UHF and Microwave links while the satellite stations which were produced were largely for TV relaying into distant areas. Satellite earth stations for telecom were not evident in production in 1985.

4.6.26 A Directory of main public sector telecom producers is attached at the end of this report (**Annexure B**). From the large number of factories it was possible to get adequate information on selected places only by visits and through official information provided. A sample description of some of the better-known enterprises is given at **Appendix C** .

4.6.3 **Joint Ventures**

4.6.31 Shanghai Bell Telephone Equipment Manufacturing Corporation Limited July 1983 saw the signing of Sino-Belgian contract on the co-ordination of SPC telephone exchanges (S-1240). The MPT Belgian government and ITT (now belonging to Alcatel) provide the capital. This corporation began its production in 1985 and by 1990 it has altogether manufactured 1.01 million lines. Its original manufacturing capability was 0.3 million lines per year and this corporation will be able to turn out over 0.55 million lines in 1991.

4.6.32 Beijing Municipality and the Siemens Corporation of the former West Germany will set up a joint venture in managing an assembly line to manufacture EWSD SPC exchanges. When put into operation, this assembly line can produce 0.3 million lines per year. Now the joint corporation has been established and can produce 0.95 million lines during the 6th Five Year Plan according to the contract. Another assembly line will be managed by a joint venture between Tianjin Municipality and the NEC of Japan to manufacture NEAX 61 SPC exchanges. Now this joint venture has not yet come into being and therefore no estimation on its production during the 6th Five Year Plan can be offered.

FIGURE : 4.6 TRENDS IN PRODUCTION OF KEY COMMUNICATION EQUIPMENTS

Products	Unit	1983 Production volume	1987 Production volume	1988 Production volume
Telephones	1000 sets	1795.3	3163.3	6556.3
Telephone Exchanges	1000 lines	2211.3	1853.7	2400.3
Telephone Command Equipment	sets	485	186	112
Telegraph communication equipment including facsimile, teletype writers & data transmission eqpt.	Units	16.981	16.812	28.343
Carrier Communication Equipment	Units	28.195	27.766	38.987
Large & medium power communication equipment..including chiefly fixed shortwave single side band radio-station with power above 2000)	sets	1.173	639	135.1
Land based mobile communication eqpt. incl.. chiefly VHF & UHF band pocket, portable vehicular and base station communication equipment.	1000 units	96.-	186	171
Microwave communication eqpt. incl. microwave relays and tropospheric scatter communication eqpt.	Units	2.467	4.147	5.280
Satellite earth station equipment (chiefly T. broadcast station receiving eqpt.	sets	1.375	817	1.648
Aircraft communication equipment	Units	333	334	382
Shipborne communication equipment	Units	1.586	759	8.338
Communication & navigation vehicles	Units	189	144	295
Aircraft directing navigation eqpt.	Units	475	2	113
Marine directing navigation eqpt.	Units	667	439	987
Ground directing navigation eqpt.	Units	68	96	69
Communication navigation complement and accessory equipment.	Units	6.681	9.882	14.357

4.6.33 January 1989 witnessed the beginning of the production of 1000 PABX by the Shanghai Telephone Equipment Factory and the British GPT. Now the production capacity of this enterprise is 30-40 thousand lines per year and will ultimately be 100 thousand lines per year.

4.6.34 The Wuhan Yangtze Optical Fibre and Cable Company has introduced an optical cable production line which every year can manufacture 450 thousand kilometers optical fibre and 4.5 thousand kilometers optical cables . It is expected that this production line will begin operation at the end of 1991. This project is a joint venture between the city of Wuhan and the Dutch Philips Corporation and the MPT is one of the share holders (in terms of shares, the Netherland accounts for 50%, the City of Wuhan 25% and the MPT 25%).

4.6.35 The Shanghai Communications Equipment Factory and the US AT & T have established a joint venture to manufacture optical communications terminal equipment and now production has begun. It is planned to signed a memorandum with the AT&T on the co-production of subscriber loop carrier multiplexing equipment.

4.6.36 Besides the case of introducing manufacturing technology and equipment in the form of joint ventures, the Changging Communications Equipment Factory has used grant aid from the Italian government to pay for the technology transfer fees for introducing from the Italian Italtel company PCM equipment production lines which have already begun batch process. Its products can be used together with the S-1240 production lines and the digital microwave equipment manufactured by the Beijing Communications Equipment Factory. The MPT has also made use of the Belgian grant aid for the project of EPC digital exchanges in Lhasa, which is expected to begin operation in 1991.

4.6.37 The above overview show that what the foreign loans and joint ventures have covered normally are the batch process of telecommunications equipment (exchanges transmission and terminals etc.), the introduction of equipment and the putting into forts in these areas can make profits and earn back the investment in comparatively shorter time and also can directly meet the urgent demand for telecommunications services.

4.6.4 Depth of Equipment Capability

4.6.41 Manufacturing of telecom equipments for various generations has been going on in China for several decades. Also, production in consumer electronics equipments has been an even larger activity. Since numerous projects for equipment assembly have been set up (many in a big way), there is an ample capacity for assembling of all types of equipments .

4.6.42 Due to the insistence of earlier governments to maximise indigenous capability, technologies of the earlier generations of equipments have been thoroughly absorbed. Various institutes (at major factories, academies and independent laboratories) have added their efforts to build up reasonable capability to improve, change (for local conditions), and even design a wide variety of equipments. One may then say Chinese engineers have mastered the

technology of 70's generation Telecom equipments.

4.6.4 Despite massive effort in this direction, the advanced coastal states have taken their toll in terms of time to reach this level. In the last decade, telecom technology has undergone a sea change and wave after wave of new products have swept out from the highly developed economies. Switchover to digital and VLSI technologies have resulted in a generational change in the equipment needed. Production technique is in the process of shifting to Surface Mount Technologies (SMT) which will make the high manual approaches presently used in developing countries obsolete.

4.6.5 Chinese scientists and engineers realise that this quantum jump will be hard to accomplish without taking substantial help. The government has accordingly in the 80's initiated reforms to move towards a competitive situation and also to selectively open doors to the inflow of desired technologies. However, hard currency resources remain a major hurdle and bilateral aid as a solution is far from perfect.

4.7 REVIEW OF INPUTS

4.7.1 Overall Picture of Components Base

4.7.11 Thanks to a large production base of consumer apparatus (especially TV), China has developed a very substantial components industry producing a wide variety of electronic components. There exist over 1200 enterprises and 10 research institutes devoted to components production. Employment exceeds half million of whom nearly 40,000 are technical.

4.7.12 The overall output of the components sector reached a value of 10 billion yuan in 1989 of which semiconductors approximated 3 billion yuan. Variety of components covered all basic types and classes except IC above the SSI level where there is a clear gap.

4.7.13 Grades and types of components are however aimed at the huge production of consumer apparatus. Telecom engineers have to carefully select, approve and use only the most reliable out of these. As a result portion of telecom component requirements need to be imported. In case of equipments in which technology is under the process of transfer, certain components have to come from the collaborators for quite some time.

4.7.2 Passive and Electro-mechanical Components

4.7.21 Production of these components as recently reported is shown at **Figure 4.9**. Though the aggregate output shows very respectable physical volumes, the scale when averaged over 1200 enterprises does not look all that impressive (15 million per factory). While certain of the major factories may perhaps have adequate scale, it does seem that a restructuring of the segment to result in fewer consolidated enterprises may be advisable.

FIGURE : 4.6 PRODUCTION OF PASSIVE & ELECTRO-MECH. COMPONENTS

Scale : Million Nos.

	1986	1987	1988
A. PASSIVE COMPONENTS			
1. Capacitors	3756.1	5247.0	5789.5
2. Resistors & Potentiometers	[illegible]	[illegible]	[illegible]
3. Magnetic Materials & Devices	743.5	1134.9	1663.6
4. Transformers & Coils	236.4	362.6	464.6
5. Quartz Crystals & Devices	16.0	17.6	24.5
6. Piezo-Ceramic Components	28.6	44.0	101.1
7. Sensors & Transducers	31.4	37.0	44.4
B. ELECTRO-MECHANICAL			
1. Electric Connectors	317.5	544.6	738.6
2. Control Elements	23.9	27.6	75.5
3. Micro & Special Motors	17.1	10.4	12.9
4. PCBs (in 1000 sq.mtrs.)	56.0	955.0	12586.0
5. Electro-acoustic Devices	143.2	228.3	259.5

Source : China Electronics Industry Year Book 1990

4.7.22 Such consolidation could also be accompanied by upgrading of [illegible] reliability than what is currently used for TV industry so that the needs of more professional equipment producers could better be met. Many of the local components seen in locally produced equipments appeared outsized and relatively crude.

4.7.3 Microelectronics

4.7.31 In physical terms the output of the microelectronics industry also seems impressive---in 1985, 1.9 billion discrete devices, 100 million IC and nearly 10 million hybrids. However, data indicates that there are over 300 discrete device makers, 24 IC factories, and about 10 hybrid units. One is again left with a sense of scattered capabilities. A sample factory visited had in fact closed down its IC production line after it was called upon to become self supporting under new reforms.

4.7.32 It is understood that efforts are on to encourage grouping of synergetic factories and closing of those which seem unviable or have not been able to modernise. A handful of larger-sized units are emerging who have brought the technology up to the capability of medium scale integration (MSI) using 5 and 3 micron technologies and 75mm wafer size. Their efforts are aided by the government decision to provide protection for those IC's which are made in the country. A picture of the microelectronics output is shown in **Figure 4.10**.

4.7.33 In terms of product range, the government has adopted the policy of standardising the specifications of a set of IC's and discrete devices for some of the very major applications in all items of consumer electronics,microcomputers and so on. Standardisation is expected to achieve genuine volumes per type of device with consequent improvements in yield, quality, cost.

4.7.4 Capital Goods

4.7.41 China's Electronics specialised technological equipment industry was originally under that of Microelectronics Bureau & Component Product Bureau, Ministry of Electronics. In 1988, it was transferred to the control of Microelectronics & Basic Product Bureau, Ministry of Machinery & Electronics Industries.

4.7.42 Measures such as efficiently digesting & absorbing the imported production equipments, are being adopted to realise the replacement of imported equipments by domestic capital goods aimed at reducing the foreign currency out-flow. These efforts have also resulted in an element of mastery over production processes as well as increasing the local industry out-put with reduced capital expense.

4.7.43 At present capital goods industry is composed of 88 enterprises & research institutes with a total personnel pool of about 60,0000 of which around 12% are the technical personnel. The total production of capital goods stood at 600 million yuan in 1985. The export valued at USD 10 million in total.

FIGURE : 4.10 MICRO-ELECTRONIC OUTPUT

(Scale : Mill.Nos.)

	1986	1987	1988
A. ICs Total	45.7	76.7	92.8
- Bipolar Digital ICs	2.3	3.7	3.5
- MOS Digital ICs	6.5	10.0	12.3
- Interface ICs	1.1	0.5	0.6
- Linear ICs	2.0	2.9	3.2
- Voltage Regulator ICs	1.1	2.6	1.6
- Specialized ICs for Consumer Electronics and others.	33.0	57.0	71.1
B. Hybrid ICs Total	2.1	3.8	7.9
- Thick Film	1.0	2.2	5.3
- Thin Film	0.4	0.3	0.5
- Other micro devices	0.7	1.3	2.1

Source : China Electronics Industry Year Book 1990

[illegible] Scientific research & new developments are [illegible] through the joint efforts of enterprises & research institutes. Many new equipments have been successfully developed & some of the technologies have approached sophisticated level. In addition, more industry in this country is being pushed to become more self-sufficient in future.

APPENDIX : F MAJOR PRODUCERS OF TELECOM EQUIPMENTS

BEIJING TELECOM EQPT FACTORY

5, Jiangtai Lu, Beijing, China, 100016
Ph: [illegible]; Cable: [illegible]

One of the oldest factories in telecom (50 years), under Ministry of Posts & Telecommunications. The factory employs 1700 people, 35% of whom are technical. Their product range include various analog & digital microwave communication equipments. They are the largest producer of analog UHF & Microwave links having supplied over the years 40-45% of the cumulative installations of radio transmission & channeling equipment in the national network, about 25% is supplied by one other factory & the remaining 30% was imported over the years. Their annual output of about 220 systems is valued at 100 million yuan.

Having improved existing equipment & imported the production line of NEC digital microwave equipment of large capacity from Japan; the factory becomes the first one able to produce 960 channels becomes the first one able to produce 960- channels & 1920 channels PCM digital telephone microwave equipment.

The equipments produced by BCEL confirm to China's national standard, CCIR etc.

GUANGZHOU TELECOM EQPT FACTORY

139 Zhong Shan Road, Guangzhou, China, 510630
Ph: 5151186; 518888; Tlx: 44705 GFTTF CN; Fax: 511096

Convinientiy located not far from the center of the bustling city of Guangzhou, this is a well set up factory of over 100,000 square meters of production floor space. Employment is 1600 people of whom 25% are engineers.

Sagem teleprinter is made here in a totally integrated fashion covering all its parts and components (including the delicate printing head). Major products are analog versions of channeling, multiplexing and transmission racks the output of which is growing at 15% each year. Here too the technology has been sufficiently absorbed resulting in almost total indigenisation of the equipment. The factory goes to the extent of making its own mechanical filters, quartz crystals, and many other subparts. Critical IC are however imported when not available in the country.

To this date, there is need for substantial analog equipment since the rural network remains analog, radio links are analog, and we were informed that even in the main transmission chains almost half the installations are analog. Nevertheless, since analog and digital equipments will for considerable time exist together, interface equipment prepared on custom orders is a specialty of this factory.

At the county not desired to have the digital route. The R&D are in the factory in consumption with other research institutes and universities has an ongoing effort to develop digital versions of all its equipments. However, this is an onerous task, and the factory is looking for technical assistance or cooperation of any kind to speed up this process.

Manufactures a channeling, interface and transmission equipment and also of Sagem electronic teleprinter. this is is a factory of 1600 people of whom 15% are engineers.

SHENZHEN PEACE TELECOM CORPORATION

R & D Unit, 11 F Construction Bank Building, Shenzhen
Fax: 246119, 246169; Tlx: 420204; Cable:3DFTIC

Basically the company is a manufacturer of telecom cables holding 10% share of local supply. It also manufactures electronic push-button telephones. It has embarked upon the custom development and supply (to the Shenzhen P&T and FTIC) special testing and supervisory equipment. Having carefully studied most of the imported and local brands of transmission equipments, they have established the capability of fulfilling any need for a reasonably localised network.

Other special purpose instrumentation is also under development and finalisation. Testing and monitoring of pressures in gas-envelope cables has a large requirement if this parameter is to be tested and monitored to speed up maintenance procedures. Similarly exercising and testing of fast digital switch has be made into an instrument.

These will form the basis of the additional products of the factory. However, they seek to compress the time element of development since the Chinese network is modernising at a fast rate. They are looking for technical and funding assistance for independent organisations to this effect.

STATE RUN CHANGDE TELECOMMUNICATION EQUIPMENT FACTORY

No. 2, the East People Road, Changde.
Hunan Province China - 15000
Phone : 22995 . Cable 6016

It is one of the 10 state approved factories manufacturing digital programme control exchanges. It was established in 1974 & has a capacity to produce 60,000 lines of cross-bar telephone exchanges & 30,000 lines of digital program control exchanges each year. Their capacity is proposed to be expanded to produce 100,000 lines each of cross bar & digital exchange lines by end of 1991.

Their output value has recorded an annual average increase of 37.9%.the enterprise is focusing on technical advancement, making the crossbar telephone exchange as its base & program control exchange as its production orientation. Training is imported to develop new products with high technology.

The production technology of EDPMI-3 series of digital program control exchange, imported from Philips Co., Holland is turned out for production. The first product was put into market in 1985, with exchange capacity upto 20-2000 lines.

CHANGDE TELECOMMUNICATION EQUIPMENT FACTORY

No.2, The East People Road,
Changde, Hunan Province 415000,
Ph : 415000 Cable : 6018

Established in 1974, it is one of the ten state approved factories manufacturing digital program control exchanges and also a state appointed specialized manuracture for automatic telephone exchange.

It can produce 100,000 lines of crossbar telephone exchanges and another 100,000 lines of digital program control exchanges. Annual average increase in the total output value since last few years is 37.9%. The enterprise is focusing on technical advancement: making the crossbar exchange at its base, and the program control exchange as its production orientation. A scientific research institute and a department of program control engineering is started to train the employees for developing new products with high technology.

TIANJIN ELECTRONIC WIRE & CABLE CORPORATION

No. 63, Jingjin Highway, Hebei District,
Tianjin 300231
Ph : 262807 Cable : 2233

Tianjin Electronic Wire & Cable Corporation, a large state run manufacturer for wire and cable which was directly under the administration of the former Ministry of Electronics Industry, was transferred to be under the administration of Tianjin.

The company covers an area of 126,000 sq.metres and the total personnel employed are more than 3000 out of which 13% are technical.

The main products of the company are - RF cable, installation cable, military used cable, all kinds of cable for household appliances, wire & cables for computers and other specialised cable. The output of the company is growing at an average growth rate of 1.86%.

At present, the company is engaged in developing telecommunication optical cable with the introduction of advanced production equipment and testing equipment and presumably, it would be an important base Ofor optical cable production.

SHANGHAI NO. 6 RADIO FACTORY,

No. 419, Guangfu Road (Western)
Shanghai. CHINA 200063
Ph : 536310 Cable : 5867

Shanghai No. 6 Radio Factory is a specialised factory for manufacturing various non-polar fixed capacitors and hybrid thick film integrated circuits with "Sanya" brand which is one of the large & medium-sized enterprises in China.

The company employed about 2000 personnel out of which 16% are technicians. The factory occupies an area of 38,000 sq.metres. The fixed assets of the company are estimated at 22.50 million RBM Yuan. The total output value during 1986 was 58.2 million RMB Yuan. They have been awarded the prize for their product quality. In order to make further improvements and product developments, the management has put an emphasis on Research & Development

WUXI MICROELECTRONICS CORPORATION

Dawangji. Wuxi. Jingsu Province.
CHINA 214061
Ph : 661123 Cable : 0534

Wuxi Microelectronics Corporation is the largest R & D and production base for ICs and discrete device in China with advanced technology & equipment. WMC is a joint venture between former Ministry of Electronics Industry and Jiangnan Semiconductor Device Factory.

It has more than 5000 staff & members of which 2400 are technicians & engineers. It is built on an area of 180,000 sq. mtrs. and occupies an area of 320,000 sq.mtrs. Total fixed assets value is about 400 million RBM Yuan.

WMC has one state of art bipolar IC production line with an annual output of 30 million pieces and one discrete device line with an annual output of 300 million pieces annually. It also has two-chip color TV IC assembly line capable of producing 2.5 million pcs. per annum. It has renovated a MOS pilot line for Research & Development.

During the 7th Five Year Plan period the WMC has been listed as the key project construction unit in China. Based on their earlier experience, they will continue to import the advanced technology from abroad & carry out the production, research & development of LSI and VLSI. After expansion, WMC will have capability of developing 1 - 1.5 micro technology.

CHAPTER : 5 REGIONAL COOPERATION

5.1 SUB REGIONAL CO-OPERATION

5.1.1 Limitations of Country Efforts

5.1.11 To achieve acceptable levels of telecom network performance, each country has set ambitious targets. On the one hand implementation of their plans requires installation of a vast variety of equipments & systems to spread & upgrade the network. On the other hand, adequate capability in terms of technology and / or production capacity may not exist in each and every aspect. Each country has different areas in which gaps exists in fulfilling their own requirements. **Figure 5.1** gives a qualitative overview of the existing capabilities as revealed from our visits.

5.1.12 Common constraints among the three countries for optimal upgradation of telecom are identified as follows:

a. Most countries have resolved to go the digital way to the maximum extent possible. Gaining mastery over several technologies required by modern networks requires extraordinary efforts and substantial investments.

b. Such new equipments have components which are not yet made in the country (especially VLSI), leading to hard currency outflow.

c. Progressively reducing requirements of equipments of earlier generations whose technology may have been mastered and substantial investments made in setting up production capacities (including components) cannot be abandoned.

d. Practical difficulty of rapidly mustering sufficient resources (including revenue collection) to import modern equipments especially the hard currency component.

e. Local R&D efforts are not at levels which will enable catching up through their own development programs.

f. Enhancement of human resources in keeping with the new technologies now emerging

5.1.13 Sub-Regional cooperation has to aim at mutual action for reducing the effects of these constraints for benefit of all sides. Such action may be evolved at the product, technology or at human resource levels. Subsequent sections will discuss these possibilities in more detail. However, there is a possibility of readier cooperation between each of these large countries and surrounding small countries in the region which can be accomplished with minimum constraints as discussed in the next section.

FIGURE : 5.1 MANUFACTURING STATUS FOR REGIONAL COOPERATION

		CHINA		INDIA		INDONESIA	
		Capacity	Tech.	Capacity	Tech.	Capacity	Tech.
A. SUBSCRIBER							
Telephone	- Mech.	A	C	A	C	A	I
	- Elx.	A	C	A	Y	A	I
Teleprinter	- Mech.	D	-	A	C	A	I
	- Elect.	B	C	A	Y	A	I
FAI		C	-	C	C	C	-
Paynones	- Mech.	C	Y	A	C	D	-
	- Elx.	C	Y	B	Y	C	I
Modems		A	C	A	C	B	Y
EPABX		C	Y	A	C	C	I
Teletext		D	-	D	-	-	-
VSAT for Telecom		C	I	C	I	A	Y
B. TRANSMISSION							
Cable	- Copper base	A	C	A	C	A	C
	- Optical	C	I	B	I	D	-
M/W Sys.	- Analog	A	C	B	Y	A	I
	- Digital	C	I	C	Y	C	I
Satellite System	- Ground	C	-	B	Y	B	Y
C. SWITCHING							
Manual		A	C	A	C	A	C
Strowger		A	C	A	C	B	C
Crossbar		A	C	A	C	B	C
Semi-electronic		B	I	D		B	I
Digital		C	I	C	I	C	I

A = Excess Capacity B = Adequate Capacity C = Insufficient Cap. D = No Capacity

I = Ind. Ckt. Assy. Y = Partial Mfgr. C = Total Mfgr. Excl. VLSI

5.1.2 Technical & Commercial Unbundling

5.1.21 One of the first steps towards successful cooperation should be an effort towards unbundling of the offers. Packages offered to developed countries or the developing nations, one part relates to sustaining the commercial part of the package from the technical part. As mentioned earlier, attractive financial assistance on attractive terms often clouds the decision of the purchaser away from offers of developing countries which cannot match such terms. A way of unbundling this aspect of the package is suggested in a later section where development banks can help counter this biassing.

5.1.22 Unbundling of the technical part of the requirements can be done firstly by deseggregating the system by levels of technical excellence involved in producing the individual item. A typical technological breakup into sophisticated, high, medium & low levels is shown in Figure 5.2. The analysis is qualitative and broad and should be further refined in great detail while analysing each packaged offer.

5.1.23 Even a relatively less developed country could undertake low levels of technology on its own, thus eliminating such items from the package. Medium and high levels may be considered for supply from within the sub-region by a larger and better developed neighbour subject to checks on quality, performance and cost. Only the sophisticated and latest parts of the package would call for competitive bids from developed countries.

5.1.24 In case of packages relating to transfer of technology for local production, it is often the case that the technology is bundled along with the kit of components constituting the equipment. Once again, the concerned components can in specific cases be deseggregated into various grades. Only those which are sophisticated (and perhaps proprietory) need be part of the technology package while the rest can be considered for procurement from global markets provided specifications are conveyed by the purveyor of the technology. Procurement within the sub-region may also be possible.

5.1.25 It is admitted that the unbundling needs to be done with due care and expert knowledge. In this respect, suitable programs/projects by UNIDO or UNDP or ITU could be created to help the lesser developed nations to understand the technicalities involved.

5.1.3 Cooperation with Smaller Developing Countries

5.1.31 The countries reviewed in this Report are the largest in the Asia-Pacific region leading to substantial telecom markets within their own borders. To satisfy these needs they have set up telecom production facilities of substantial scale. Smaller developing countries within the region having smaller markets would find it unviable to produce their own limited telecom requirements and could greatly benefit through cooperation with one or more of the large developing countries in fulfilling their telecom requirements.

5.1.32 The lower levels of requirements of these smaller countries in technological & economic terms could be adequately met by the technologies already in place in larger developing countries. Further, because of the globalisation of telecom., these smaller countries generally have close interlinks with the networks of nearby larger countries resulting in compatibility.

5.1.33 Shortage of hard currency is a major constraint limiting regional cooperation. Due to this, developing countries (especially smaller ones) smaller countries are forced to depend on aid or other bilateral financing from developed countries which often forms a part of the total package offered to them. If a mechanism for minimizing and funding the hard currency in such transactions could be worked out (suggestions are made later), there are prospects of regional alliances being developed in telecom.

5.1.34 When smaller countries buy equipments and systems from developed countries substantial quantum of hard currency, to the full value of the package is to be paid. In the case of regional purchasing the systems cost itself is likely to be much lower. Further, through a suitable financial arrangement, the hard currency requirement need only be to the extent of the unavoidable inputs for production of the system by the large countries in the region.

5.1.35 Further hard currency savings at the stages of installation, testing, training and operation can also be achieved. Supplies through regional cooperation could thus substantially reduce the need for hard currency as compared to procurement from developed countries.

5.1.36 In aggregate, small country requirements add up to a lot. A study by Arthur D. Little Inc. projects annual expenditure on telecom equipments by smaller Asian countries reaching US $ 5.3 Billion by 1994. This will be 20% of the total Asia-Pacific region (including Japan) investments in telecom. In absolute terms, this will equal the combined investment in that year of India & China. It makes good sense to cooperate regionally and reduce this outflow of hard currency from the region.

5.1.37 Thus to the extent that the small regional countries have hard currency resource constraints, they could still develop their much needed telecom infrastructure through regional cooperation. To the larger countries, regional co-operation will provide access to markets of the surrounding countries, offering ample scope to improve utilization of investments made in their existing [illegible].

5.2 PRODUCTION COMPLEMENTARITY

5.2.1 Similarity of Technological Direction

[illegible] of the countries surveyed the main [illegible] between technologies is to shift from [illegible] ultimately towards [illegible]. All countries share the common problem of [illegible] and [illegible] telecom systems and a common desire to

materials and export their surplus.

5.2.12 Common to these countries (and in contrast with developed countries) is the uneven distribution or distribution of telecom sources. While there is demand concentration in metro regions, rural requirements have yet to be met for achieving social and developmental objectives. The latter are presently less revenue generating and more expensive to provide using conventional technologies. Wide geographic spread & coverage of varying terrain necessitate development, adaptation and interfacing of a range of technologies to resolve these problems which are different to those in developed countries. The developed countries --- which have hitherto been the main source of telecom technologies --- design products suited to their own telecom conditions and these are often not the most suited solutions for others.

5.2.13 Such commonalities provide common ground for meaningful and mutually beneficial sub-regional cooperation between these three countries in production as indicated below.

5.2.2 Complementarity in Subscriber Equipment

5.2.21 All three countries have ample market and appropriate capabilities to produce the essential apparatus viz. telephone instruments, teleprinters, modems, etc. all of which are increasing their electronic content adding features, as compared to earlier mechanical versions. However, prospects of competitive cross-trading should be examined.

5.2.22 In the areas of digital EPABX and Public Telephones, India seems to have, with its own efforts, progressed several steps ahead of the other two countries. More importantly, the equipment is developed for rugged conditions and with standardised components which are readily available. There is distinct room for complementarity in this product range. The other countries could consider working closely with India to absorb Indian EPABX technology for establishing their own production.

5.2.23 None of these countries have made much progress towards mastering the technology and productionising of Facsimile --- increasingly becoming the preferred mode of international communication. It is especially attractive for national communication in these countries also on account of unique scripts in their languages. The key parts of this technology are closely held. There is a good case therefore for these three large countries to take a joint approach to the acquisition & further development of fax technology and to enhance their bargaining position in joint acquisition of critical parts of this technology.

5.2.3 Complementarity in Transmission Equipment

5.2.31 All the three countries have established facilities to meet their own present needs of copper based wires & cables. They are equally capable of expanding the same as may be needed in the future. In the case of fibre-optic cables, the long-term requirements especially of India & China are going to be enormous. India has already acquired the basic technology for the drawing of

the optical fibre as well as making the cable. Two units are already in production, China is in the process of negotiating acquisition of the technology. Indonesia and other developing countries, who presently import their needs would do well to incorporate requirements into the plans of the other two.

5.2.32 Communication through optical fibres requires a number of specific equipments and components like interface equipment, multiplexers, regenerators, etc. to be incorporated for utilising this technology in the telecom network. India has procured technology for manufacture of some of these products. The prospects of expanding this arrangement to meet the needs of China and Indonesia who are yet to start, needs to be investigated. Technology for such equipments, being opto-electronic, is completely different to existing technologies with network operators and equipment manufacturers.

5.2.33 Rural communication is an area of great importance in all the developing countries. In the case of India & China, development and production of reasonable depth exist whereas in Indonesia manufacture is more assembly oriented. Considering future needs in this area, regional co-operation by standardisation and model-wise sharing of production of VHF/UHF communication equipment is another area of complementarity, which can lead to substantial economy for all.

5.2.34 Microwave technology is utilised for both analog and digital transmission. All three countries have installed this technology in the network, to a lesser or greater extent. Production capability exists in India & China for microwave analog and, to a much lesser extent, for microwave digital. The future will increasingly use digital microwave. Therefore this is another area for potential regional cooperation in acquiring/developing the technology for the entire spectrum of equipments used in digital microwave.

5.2.35 Increasingly, national and international communications use satellite links. Geographic imperatives have forced Indonesia to develop much further in this direction among the several aspects of satellite communication. Since satellite and launch vehicle technology has military and national security implications, each country is likely to proceed on its own. However, cooperation for operating a satellite based communication network for the Asia region with interconnection to international networks is certainly an area that should be considered for regional cooperation. India's strength in satellite design, China's strength in satellite launching and Indonesia's strength in satellite ground equipment could be suitably dove-tailed to provide world class satellite based communication networks for this region.

5.2.36 In the above cases, we have discussed only technologies that are presently in use, at least to a reasonable extent, in all the countries. New telecom services like cellular telephones (mobile & static), paging systems, etc. have not become significant in any of the countries. Such services would be required in course of time in all the countries and a long term view for joint planning, cooperation jointly to develop suitable these technologies would benefit all the countries.

5.2.- **Complementarity in Switching Equipments**

5.2.41 Digital networks require small PAX or below 500 line capacity, main exchanges of MAX or above 10,000 capacity and medium exchanges or intermediate capacity. In small and medium digital exchanges, India is well ahead of the other two countries having developed and deployed its own exchanges. To the extent that this technology is particularly suited for developing countries and is less expensive (though with fewer features) than imported versions, this is an area for regional cooperation in setting up large manufacturing facilities using this technology.

5.2.42 MAX exchanges are of various kinds but interest for the future is in digital. All the countries have well established facilities in mechanical and electro-mechanical exchange production which are in declining demand. New investments (in production facilities) will be made for digital exchanges for which India and China / Indonesia have acquired European technologies. The exchange of experiences could benefit all countries greatly in this area. Since Indonesia is doing kit assembly of these exchanges, cooperation would benefit them also in establishing indepth manufacture. It should be appreciated that it is the software which really optimises the use of the digital exchange for different traffic conditions. It is both difficult and expensive to obtain specially developed software from the international manufacturers who are not fully aware of telecom traffic conditions in the acquiring countries. Regional cooperation in this area can be fostered by combining the acknowledged software skills of the region.

5.2.44 China and Indonesia continue to manufacture what can be described as semi-electronic exchanges --- analog exchange of an older design using reed relays. India has leap-frogged this technology and though unlikely to **acquire** this technology for manufacture, it might be willing to buy products (on regional cooperation or barter basis not involving hard currency) for use in non-critical parts of the network. This would have to be determined after more detailed study covering suitability for interfacing, cost-effectiveness, etc.

5.2.5 **Complementarity in Allied Equipment**

5.2.51 In addition to the main sub-systems there are several areas of allied equipment which show potential for regional cooperation. Operation and maintenance of the network requires a variety of test equipments which would be economical to manufacture indigenously. Test instruments, especially for optical communications, Microwave digital, digital main exchanges, etc. require technologies which can be developed through regional cooperation.

5.2.52 Another possible area for regional cooperation is in the production of modern batteries and power plants for exchanges. These are basic technologies and could be readily absorbed by each country.

5.2.6 Complementarity in Components

5.2.61 China & India have well established conventional component manufacturing facilities while Indonesia has virtually none. China has large capacities, mostly in public sector producing mainly consumer grade components. India has a broader base of professional grade components though individual capacities are somewhat smaller. Both India & China need to and will improve this component base in the wider context of their overall electronics industry and Indonesia could source such requirements from them.

5.2.62 Surface Mount is the assembly technology of the future and none of the countries has a base in this area. SMT enables more reliable and more compact equipments to be made and has completely changed the way components are made, packaged and used. No country professing to have a telecom industry can afford to be left behind in this area. Regional cooperation would be desirable, for developing this technology, both in the manufacture of components and in their application. The long term advantages of cooperation in this area cannot be overempnasized. This technology will have benefits for the manufacture of other types of electronic equipments also.

5.2.63 ASICS have become the preferred semiconductor component used in telecom equipment. They introduce an element of proprietorship in equipment design by which the equipment manufacturer could be tied forever to the collaborator for supply of ASICS. This technology needs to be acquired urgently by all the countries. ASICs involve design as well as fabrication. Design Centres at several locations within the region are an important begining to absorb this technology. Silicon foundries to process wafers could be contracted from many sources as a start. Regional cooperation to acquire design and fabrication technology and facilities could thenbe conceived on an overall basis for the sub-region.

5.2.64 In all aspects of telecom, the share and importance of software is increasing and mastery in this area is of paramount importance. Software is involved in network planning, network management, network monitoring, tariff & charging, equipment functioning, circuit design, ASIC design and so on. India has a strong base in software and could develop software in a regional cooperation arrangement and could also undertake training of trainers for other developing countries.

5.3 EDUCATION & TRAINING

5.3.1 Routine Training

5.3.11 The three countries visited all had comprehensive training facilities for upgrading the skills and knowledge at various levels of their existing staff for presently used technologies. However, technologies themselves are new and advanced, training courses and facilities need to be updated. [illegible] role in providing suitable courses & facilities for such upgradation. The importance of such skills [illegible] cannot be overemphasized.

5.3.12 The expertise to be drawn upon would be in the form of short and long-term visits of experts, training of trainers, etc., printing and video taped materials, etc.

5.3.2 Fundamental Telecom Education

5.3.21 In all the countries we found most of the engineers coming into telecom had their basic technical education in general electronics. Telecom formed part of the curricula only as an adjunct. Special aspects of operation of the network such as network planning, telecom economics, software, etc. were not included in the course work, and were learned "on the job".

5.3.22 It was strongly felt that there is good scope for setting up an institution in the sub-region, which would impart to students with a basic education in electronics at the Bachelors level, suitable post-grad training in the multifarious aspects of telecom operation - technical, managerial, economics, software, etc. Mechanisms for this are suggested later in this chapter.

5.4 COMMERCIAL MATTERS

5.4.1 Collective Procurement

5.4.11 There is considerable commonality in procurement of equipments, components and technology by developing countries. If a mechanism for regional cooperation could be worked out (some suggestions are made in the next section), all the countries would make significant savings because of their combined volumes, and stronger bargaining positions. This would require considerable preliminary work including some degree of standardization, common purchasing procedures, etc. Suggestions in this regard are also made later.

5.4.2 Collective Marketing

5.4.21 Since producers of telecom equipment are largely parastatal in developing countries, marketing has been a very weak spot. An independent corporation in which different countries & companies have a financial stake could perhaps take up this enormous task. Such a corporation would be run as a commercial enterprise, selling sub-regionally and intra-regionally. Products could be from one or other country (a distant parallel can be drawn with Airbus industries) as best suits customer needs.

5.4.22 Complexities and modalities have to be dealt with before a corporation as described above can be set up. Nature of corporate entity, factory locations, prererential import tariffs, legal hurdles, etc. will have to be considered in detail before even incorporation, let alone success.

5.5 POLICIES AND INSTITUTIONS

5.5.1 General

5.5.11 The earlier Sections have identified some possible areas of regional cooperation. Such cooperation to work in practice requires the setting up of organisations and institutions. suggestions for which are given below. A summary chart is drawn up at Figure 5.3.

5.5.2 Standardisation

5.5.21 Standardisation. which will bring about a commonality of requirement. is the key factor preceding co-operation at administrative and political levels. Fortunately. the CCITT has already laid the foundation for telecom standardization internationally. It is strongly recommended that a telecom standardization & testing organisation. be set up in the Asia-Pacific region working within CCITT recommendations. but with the following additional responsibilities:

a. Draw up specifications and standards in finer detail. where CCITT specs are too general or require deviations to suit the region.

b. Through its own test house (or using existing test houses in member countries) do vendor qualification at Systems level. sub-system level as well as component level.

5.5.22 The difficulties in operating such an organisation should not be underestimated. However. in our opinion. such an organization will provide the mandatory technical base for any sort of regional cooperation. Without standardization. chances of success in regional cooperation in production and marketing will be negligible.

5.5.3 Regional Centre for Excellence

5.5.31 We have discussed in earlier sections several possible areas in the specialized field of telecom wherein the countries need to co-operate to augment their capabilities and enhance regional self reliance in this field. In the following paragraphs. we venture to broadly outline a mechanism to achieve this.

5.5.32 UNCSD may set up a Regional Centre for Excellence in Telecom. The Centre would be comprised of two major components:

i. an Advanced Telecom Training School (ATTS) to provide a wide base of training and facilitate interexchange of regional expertise.

ii. A Centre for Excellence for Development of Regional Telecom Technology (RCDATT), working to strengthen applied research & development in modern communications.

Both of these would be basically post-graduate level institutions, the suggested scope of which is outlined hereafter.

5.5.33 The ATTI will cater to the aspects of providing specialized training to a wide base of Telecom specialists in applied areas like :-

a. Special aspects of network operation
b. Production technologies including SMT/Hybrids etc.
c. VHF/UHF/Microwave equipments
d. Cellular phones/paging eqpt.
e. Test Eqpt. & Auxillary Eqpt.
f. Software development.

Besides permanent multi-national staff, the cross-flow & upgradation of technology would also be by deputation of experts from within the region. Students at the ATTI may be nominated by the various countries and will take one or more courses depending on needs.

5.5.34 The CEDATT will focus around the advancement of appropriate basic technologies appropriate to the region :-

a. Technologies for critical facsimile components
b. Opto-electronic systems
c. Digital Systems (including related software)
d. Rural Telecom
e. Special components -- mainly ASICs, Opto-components.

Internationally renowned experts may be deputed to guide and lead teams from member-countries working on specific time-bound projects.

5.5.35 This institution may be jointly funded by the member countries and aided by multi-lateral organisations (UNIDO, UNDP, ADB, et al) The member countries may be made to contribute annually in proportion to their telecom budgets. In addition, each country would pay for its own scientists/engineers being trained. Technologies developed may be offered for commercial transfer regionally. Naturally, in such transfers, supporting countries must get beneficial terms. Specific country funded development programmes may also be undertaken. Having implemented many such schemes earlier, UNIDO would be well equipped to decide appropriate mechanisms.

5.5.4 **Trade Secretariat**

5.5.41 Various aspects of cooperation as mentioned above will require a permanent organization to support it. We recommend the setting up of a permanent Regional Telecom Secretariat whose role is envisaged as follows :

a. It would be permanent and headed by a Secretary General, something on the lines of other world bodies.

b. It would collect and disseminate commercial information of use to buyers and sellers of technology, products, etc.

c. It would provide physical facilities for meetings & discussions, translating facilities, forum for get-together, etc.

d. It would provide close relationship and laison with world bodies like ITU.

e. It would not take decisions on its own but would assist constituted committees, councils, panels, groups, etc. to efficiently and quickly reach decisions.

5.5.5 Telecom Funding

5.5.51 The difficulties of obtaining hard currency for development of the telecom network often pressurises several countries to go in for more expensive and perhaps less suited telecom equipment from advanced countries purely because it comes with a financial package. At the same time, larger countries in the area with a telecom production base are unable to supply to other countries because of lack of hard currency.

5.5.52 We suggest the setting up of a funding mechanism which would encourage & catalyse supplies between countries within the region :-

a. finance only telecom projects

b. finance only supplies from developing regional countries.

c. finance mainly hard currency requirements to the extent that equipment manufacturers in the region need for their inputs.

5.5.53 In view of the large sums involved, co-operation of international agencies like Asian Development Bank and World Bank would be required. Special cells in these organisations could look into co-operation proposals along with organisations like UNIDO, ITU, APT for techno-economic soundness. Objective always being to catalyse faster development of Telecom by mutual co-operation among developing countries in the region.

5.5.6 Marketing to Other Regions

5.5.61 The Regional Telecom Secretariat, as described above, would form a clearing house of information to member countries regarding worldwide requirements and availability of products and services. It is envisaged that purchases of individual network operators would be on purely commercial basis on a one-to-one transaction between buyer and seller. It would be difficult to introduce a regional organisation into such commercial transactions.

5.5.62 Marketing of telecom products to other countries may have to be looked at as a commercial enterprise. This has been described earlier.

5.6 CONCLUSIONS

5.6.01 The countries under study do not have varied geographies but also widely differing political systems, economies and their approaches. Inspite of this diversity, they share a common set of problems and objectives in the field of telecom development and are essentially all heading in the same technological direction for solutions.

5.6.02 Each country has worked towards self reliance in technology and production capacity in keeping with its policies, economic position and human resources. Resulting from this effort, there exists a base of telecom technology and equipment production amongst the three countries. Individual efforts at self-reliance, growth and modernisation continue though with varying levels of success.

5.6.03 The study reveals prima facie scope for significant co-operation by the three countries, not only between themselves, but also with other countries in the region. Some of the mechanisms required to foster such co-operation with the assistance of UNIDO have been suggested in the foregoing sections. However, considering the many technological, political & economic issues involved in any such co-operation, careful consideration and detailed analysis is necessary to arrive at an acceptable and workable approach. Suitable programs will have to be designed to give effect to those recommendations found acceptable.

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ANNEXURE : B MAJOR MANUFACTURERS OF TELECOM EQUIPMENTS

INDIA

1. **Advanced Communication Devices**
   7-11, Hasmigude Cross Rd
   Hyderabad 500 007.
   Tel : 851111
   Tlx :
   Fax :
   Product : VHF-UHF Duplex Filters
   VHF-UHF/MF HF Antenna
   Contact : V Venkata Rao, Chm,Exec.

2. **Applied Electronics Ltd**
   Adler House,
   A-5 Wagle Ind. Estate
   Tel : 581861 581863
   Fax : 91-22 5673[illegible]
   Tlx : 011-71979 AE
   Product : Telecommunication eqpt.
   Contact : K.B. Wagle Exec.

3. **Advanced Wavetronics & Systems**
   A-9, Electronics Complex,
   Kushaiguda,
   Hyderabad 500 762
   Tel. : 852855
   Tlx. :
   Fax :
   Product: Telecom. Antennas
   Contact: P Rama Rao Exec

4. **Arlem Electronics**
   Showgule House
   Mormugao Harbour
   Goa 403 803.
   Tel : 2481, 2261
   Tlx : 0191-208
   Gr. : ARLEM
   Product: EPABX
   Contact: R B Bilgunde

5. **Arvind Mills Ltd**
   Electronics Div., 16-B/1,
   Baroda Apartments , Dr. A Road
   Pune 411 001.
   Tel. : 21061 26707
   Tlx : 0145539
   Gr. : PYRAMID
   Product: EPABX Systems

6. **Asea Brown Boveri Ltd**
   22-A, Shah Ind.Estate
   Off.Veera Desai Rd,
   Andheri (W) Bombay 400 058
   Tel : 6269125 6269148
   Tlx : 011-78422
   Gr. : HINDBROWN
   Product:Telemetering Eqpt.
   Contact: K.N.Shenoy,M.D

7. **Bharat Electronics Ltd**
   Trade Centre
   116/1, Race Course Road
   Bangalore 560 001.
   Tel : 27311 27121
   Tlx : 0845-471 HOBL
   Fax : 812-226410
   Product: Telecommunication Eqpt
   Mass Communication Eqpt
   Contact: Cap S Prabha (Retd.)
   Chairman M.D

8. **Bharati Telecom Ltd**
   15th Floor, Devika Tower
   6, Nehru Place
   New Delhi 110 019
   Tel : 6415769, 6443571
   Tlx : 031-62043
   Fax : 011-6462016
   Product : Push Button Telephone
   Contact : Anoop Bhan Genl.Mgr.

9. **BPL Systems & Projects Ltd**
   Systems House,
   Palghat 678 007,Kerala
   Tel : 24968, 24969
   Tlx : 0852213
   Product: FLCC & Other telephone instruments.
   Contact: K. Chennlappan (Genl.Mgr.)

10. **Crompton Greaves Ltd**
    Telecommunication Divn.
    27, Rani Jhansi Rd,
    New Delhi 110055
    Tel : 737671,514910
    Tlx : 031-63330
    Fax : 011-514055
    Product: EPABX
    Contact: K.K.Moharia,M.D

Contd ...

12. **Delta Hamlin Ltd**
C-120, Narayana Industrial Area
Phase I
New Delhi 110 028
Tel : 6536150
Tlx : 031-66570 CDIL
Product: EPABX
Contact: Gurpreet Singh, Chairman

13. **Electronics Corporation Of India Ltd**
Industrial Dev. Area
Cherlapalli
Hyderabad 500 762
Tel : 852231, 851319
Tlx : 0155-6254 ECIL IN
Product: Telex Exchange Equipment, Fax
Contact: B S Prabhakar Chairman, M.D

14. **Electronics Corpn. of Tamilnadu Ltd**
L L A Building, 4th Floor,
735, Anna Salai,
Madras 600 002.
Tel : 867654/865942
Tlx : 041-6113 LCOT
Products: Wireless eqpt.
Contact : S Arvind, Chairman, M.D

15. **Epsilon Electronics Eqpts**
B-2, Electronic Complex,
Kushaiguda,
Hyderabad 500 762
Tel : 851091/850436
Tlx : 0425-6333 P
Product: Signal, Telecommunication Eqpt
Contact: R V S Mony, M.D

16. **Ericsson India Ltd**
15, Community Centre,
East of Kailash,
New Delhi 110 065
Tel : 6431113/6431114
Tlx : 031-62129
Product : Portable Telephone Exchanges, Special Purpose Telephones
Contact : R P Khaitan, Dir.

17. **Escorts Ltd**
Telecommunication Divn
15/7 Mathura Road,
Ballabgarh 121 004
Tel : [illegible]
Tlx : [illegible] ESTL
Product: EPABX
Contact: R.P. Lewalraman, Asst. Vice Presi.

18. **Essen Telecommunications Pvt. Ltd**
B-[illegible], GIDC Estate,
Gandhinagar 382 025
Tel : 274122 274119
Tlx : 1203126 ESSEN
Product : 64 Port EPABX 128 Port EPABX
Contact : Sameer Parekh

19. **Goa Telecommunications & Systems Ltd**
Plot No. 46 to 50,
Mapusa Indl. Estate,
Mapusa 403 [illegible]
Tel : [illegible]
Tlx : 0194 [illegible] GTEL IN
Product: Open wire commn. Equipments
Contact: Y G P Palkar, M.D

20. **Goa Telematics Ltd,**
214-A, Kundaim Indl.Estate
Kundaim, Ponda
Goa 403 [illegible]
Tel :
Tlx :
Product: Data Communication Terminals

21. **Gujarat Communication & Electronics Ltd**
Gujarat Commercial Centre
Race Course Road
Vadodara [illegible]
Tel : [illegible]
Tlx : [illegible]
Product : [illegible]
Contact : [illegible]

Contd ...

22. **Haryana State Electronics Dev Corpn. Ltd**
SCO 111-113, Sector 17-B
Chandigarh 160 017
Tel : 43922 43933
Tlx : 0395-319 HSD
Product : Telecommunication Equipment
Contact :Dr.K.S. Baisin M.D.

23. **Heltos Antennas & Electronics**
234, Avvai Shanmugam Road,
Gopalapuram,
Madras 600 086.
Tel : 471680
Tlx : 041-23128
Product : Antennaes.
Contact : T. Krishnan
Managing Partner

24. **Hindustan Teleprinters**
G.S.T. Road,
Guindy,Madras 600 032
Tel : 432771
Tlx : 041-477
Product : Teleprinters
Contact : Smt. Laxmi G. Menon
Chairman, M.D

25. **Indchem Electronics Ltd,**
124 A Lattiee Bridge Rd
Adyar ,
Madras - 600020
Tel : 418978,418387
Tlx : 041-21029
Fax : 91-44-413071
Product: EPABX,LAN cards
Contact: R Ramachandran
President

26. **Karnataka Telecom Ltd**
UNI Building
Thimmaiah Road, Miller Tank
Bangalore 560 052
Tel : 267026
Tlx : 0845-2136 KTL IN
Product : EPABX
Contact : S Narayana Shetty

27. **Keonics Video Ltd**
30, Race Course Road,
Emlyn Haven,
Bangalore 560 001
Tel : 27201/28919
Tlx : 0845-313
Product: Two-way Communication eqpt
Contact: S.Srikantan M.D.

28. **Kerala State Electronics Dev. Corpn. Ltd**
Keltron House,
Vellayambalam
Trivandrum 695 033.
Tel : 60621
Tlx : 0884-272 KEDC IN
Product : EPABX,PCM MUX Radio Networks Terminals.
Contact : M R Sitharaman, M.D

30. **L'Avenir Telecom Ltd,**
26, 1st Floor,
Nagarjuna Hills
Panjagutta,
Hyderabad 500 482
Tel : 226506/226507
Tlx :
Product: EPBTs

Contact:

31. **Larsen & Toubro Ltd,**
KIADB Indl Area
Hebbal, Hootagalli,
Mysore 571 186
Tel : 42561/42467
Tlx : 0846-281/318
Fax : 0821-42468
Product: EPABX
Contact: N M Desai, President

32. **Marine & Communication Electronics (I) Ltd**
APIE, Autonagar,
Vishakapatnam 530 012.
Tel : 91(891)57170/33
Tlx : 0495-417
Fax :
Product : Communication Equipment
Contact : U V Warlu
Chairman

Contd ...

33. **Meltron Radio Communication Division**
Plot No. 21a, Backbay
Reclamation,
Raheja Centre, Nariman Point,
Bombay 400 021.
Tel : 210538/2873812
Tlx : 011-86817
Fax : 022-2871549
Product : Transmitting Eqpts.
Contact : Dr. R.K. Bhargawa, M.D

34. **Meltron Telematics Divn. PLot No. 1,B/1**
1, Chikalthana Indl.Area
Jalana Road,
Aurangabad: 431 210.
Tel : 82611/82117
Tlx : 0745-231 METD IN
Fax : 02443-82118
Product : EPABX.RAX
Contact : R.K. Bhargawa M.D

35. **Northern Digital Exchanges Ltd**
SCO 54-56,Sector 17-A,
Chandigarh- 160 017.
Tel : 87655/87225
Tlx : 0395-344
Product : EPABX,EPAX,& Allied Equipments
Contact : H Luthra,Director

36. **P & T Telecom Factory.**
Telecom Commission
TF(P) Section, Sanchar
Bhavan, 20 Ashoka Rd.
New Delhi 110 001.
Tel : 3032399
Tlx :
Product : Telecom Eqpt
Contact : R K Sinha

37. **Punjab Communication Ltd**
C-135,Indl.Area Phase VIII,
Elton Estate
SAS Nagar,
Mona,i 160 059
Tel : 8-7516
Tlx : 0395-366 PCL
Fax : 17243633
Product: EPABX,MUX,PCM Eqpt.
Contact: Lt Col.Inderjit Singh MD

38. **Punjab Wireless System Ltd**
53, Phase VI, SAS Nagar,
(Mona,i)
Chandigarh 160 055.
Tel : 87652 87692
Tlx : 0395-319 PWS
Product: Telephone Instruments
Contact: Gokhul Patnaik Chairman

39. **Rajasthan Communications Ltd**
3 Kanakpura Indl. Area
Kanakpura, Jaipur 302 012
Tel : 78712 74273
Tlx : 365-2148
Product: RAX,EPABX,
Transreceivers.
Data Modems
Contact: B S Solanki,Director

40. **Rajasthan Telematics Pvt. Ltd**
278, Shopping Centres,
Kota
Tel : 25363
Tlx : [illegible]
Product: EPABX,HMC & Relay Testers
Contact: Sudhir Kumar Director

41. **Rajasthan Telephone Industries Ltd**
[illegible] Community Centre
[illegible] Bhawan,
New [illegible]
Tel : [illegible]
Tlx : [illegible]
Product: [illegible]
[illegible]
Contact: [illegible]
[illegible]

42. **Set Telecommunication Pvt. Ltd**
[illegible] Vasant Rd
Bombay 400 0[illegible].
Tel : [illegible]
Tlx : [illegible]
Product: Push Button Telephones
Contact: [illegible]
President

Contd ...

43. **Swede (India) Teletronics Ltd**
[illegible]
[illegible] Road
Bangalore 560 0[illegible]
Tel : [illegible]
Tlx : 0845-8278 SIT
Product: Electronic Push Button Telephones
Contact: K C Rajaram, M.D

[illegible] **Tata Keltron Ltd**
Kanjikode,
Palghat 678 621.
Tel : [illegible]
Tlx : [illegible]
Fax : [illegible]
Product: Push Button Telephones
Contact: Vijay Rawat President

45. **Tata Telecom Ltd**
Devika Tower, 2nd Floor
6 Nehru Place
New Delhi 110 019.
Tel : 6434067
Tlx : 031-71407
Product: EPABX
Contact: K Balasubramanian M.D

46. **TVS Electronics Ltd.**
Jayalakshmi Estate, No.8
Haddows Rd Madras 600006
Tel : 0816491/0816493
Tlx : 08404-206 TVSE IN
Product: Modems/LAN Cards/ Graphic Cards
Contact: V A Raghu, Presi.

47. **Unitel Communication Ltd**
8, Community Centre, Saket,
New Delhi 110 017
Tel : 657410/665015
Tlx : 031-62886 UTCL IN
Product: EPABX, Push Button Telephones
Contact: [illegible], M.D

48. **Uptron India Ltd**
10, Ashok Marg,
Post Box 313,
Lucknow 226 001.
Tel : 31371/48131
Tlx : 0535-320
Product: Radio and Telecommunication Eqpt
Contact: C P Joshi, M.D

49. **Webel Communication Industries Ltd.**
9/1, R N Mukherjee Road,
Calcutta 700 001.
Tel : 20-5712
Tlx : 021-2415
Fax : 033-289110
Product: Electronic Push Button Telephones
Contact: S P Chatterji

50. **Webel Telecommunication Industries Ltd**
4 & 5 Canal West Road
Calcutta 700 015
Tel : 248491/248492
Tlx : 021-7657
Fax :
Product: Walkie-Talkie Sets (Hand Held) Walkie-Talkie Sets (Mobile ph.)
Contact: D Bhattacharyya

51. **Webel Telematik Ltd**
AG Towers, 2nd Floor,
125/1 Park Street,
Calcutta 700 017
Tel : 299405, 299438
Tlx : 021-4760/021-4818
Product: Electronic Teleprinter
Contact: S Srinivasan

Contd ...

INDONESIA

1. **Pt. INTI**
Jl. Moh. Toha 77
Bangung 40253
Tel : (022) 471532, 5701783
Tlx : 28241 INTI IA
Fax : (022) 472444
Contact : Setyanto P.Santosa
Director
Product: Switching equipment
Transmission Eqpt.
Small Earth Station
Radio Communication
Eqpt.Telephones

2. **Pt.Radio Frequency Communication**
Jl. Ir. Juanda 474
Bandung 40135
Tel : (022)81235,
81876,83135
Tlx : 28236 RFCBD IA
Fax : (022) 87724
Contact: Drs.Dicky Turner
Director
Product: VHF-UHF Eqpt.
Radio Communication Eqpt.
Telephones.Transmission eqpt.

3. **Pt. Elecktrindo Nusantara**
Jl. Yos sudarso 58. Sunter
Jakarta - Utara
Tel : 492567, 49141
Tlx : 640699 Eltara
Fax : 491726
Contact : IR K.E Pribadi
Director QA
Product : Switching Eqpt
Transmission eqpt
Small Earth station

4. **Pt. Global Communication**
Jt. Melayu Besar 1B
Jakarta
Tel : 8291441
Contact: A Sugiarto
Product: Radio communication eqpt.
VHF-UHF Eqpt.

5. **Pt. Compact Microwave Indonesia**
Jl. Naripan No. 34.
Bandung
Tel : (022) 434495, 436793
Fax : (022) 430401,431583
Contact : Ir. Renario Prathama
Product : Switching Equipment.
Transmission Eqpt.
Microwave Radio
Broadcast & Sma..
Earth station.

6. **Pt. Angkawidjaya Bina Putra**
Harmoni Plaza Blok
B 23-24
Jl. Suryopranoto 2
Jakarta
Te. : 3803649
Fax : 3841344
Contact: -
Product: Radio Microwave
Link. Walkie
Talkie

7. **Pt. Centronix**
Jl. Matraman Raja 36
Jakarta
Te. : 859137,859718
Fax : [illegible]
Contact : Joan Santosa
Product : Radio Microwave Link
Small Earth Station
Radio Paging Eq
Power Supply

8. **Pt. Electronika Nusantara**
Jl. Setyen 3 german 105
Jakarta Utara
Tel : 690411,690541
Fax : 6903871
Contact: Ir.Santi Tamar
Product: Small Earth
Station

Contd ...

9. **Unit Produksi Len-Bpis**
Jl.Sukarno Hatta 470-485A
Bandung
Tel : (022)472661,472696
Fax : (022)472695
Contact : E Februanus
Product : Small Earth Station

10. **Pt.Altron Niagatamanusa**
Jl.Raya Bogor km 36
Cimanggis, Bogor
Tel : (99) 82376
Fax : (99) 82376
Contact: M.Choirul S
Product: TVRO

11. **Pt. Dinatermisat**
Jl. Pluit Raja No. 127
Jakarta
Tel : 6680168,6680169,
6693771
Fax : 6680170
Contact : Gatot Setiono
Product : TVRO

12. **Pt. Dianamika Semesta**
Jl. Penjernihan II/36C
Jakarta 10210
Tel : 584674,582276
Contact: Budi Sutantyo
Product: TVRO

13. **Pt. Hartono Istana Electronics**
Jl. Arpha K.3 Tubon II/6,
Jakarta
Tel : 5480808,5485944
Fax : 5485141
Contact : Purjono
Product : TVRO

14. **Pt. Inter Bisindo Sistima**
Jl. Tirtayasa Raya 34,
Jakarta
Tel : 347360,362955
6499760
Fax : 6593695
Contact: Ir. Airlangga

15. **Pt. Kwintercom**
Jl, Gunung Sahari 96
Jakarta
Tel : 3805560,3805567
Fax : 345168
Contact: Iwan Herman D
Product: TVRO

16. **CV Chatulistiwa**
Jl. Jatibaru Raya
No. 56 A, Jakarta
Tel : 373490,368252
Fax : 588113
Contact: Bastiansyah
Product: TVRO,Radio
Communication
Eqpt.VHF-UHF
Eqpt.Walkie
Talkie,Coin
Box Telephone

17. **Pt. Dian Wahana**
Jl. Batuceper No.7A
Jakarta
Tel : (021)3841451,3801999
Fax : (021) 352633
Contact: Darwin Hasan
Product: Radio Communication
Eqpt.

18. **Pt.Dharma Dwitunggal**
Utama
Prisma Kedova Plaza
Block A17-18,Jakarta
Tel : (021)3841451,
3801999
Fax : (021)352633
Contact: F. Natnan
Product: Radio Communi-
cation eqpt,
VHF-UHF Eqpt,
Telephone Insts

Contd ...

19. **Pt. Firmansyah & Sons**
Jl. Musi S Bk LT.3
Jakarta
Tel : 370843.371432
Contact: Bombam Sanyoto
Product: Radio Communication Eqpt.VHF-UHF Eqpt. Walkie Talkie & Modems

20. **Pt. Indisi**
Jl. Gatot Subroto 105
Bandung
Tel : (022)411216, 58665
Fax : (022) 57096
Contact: Ir.Kun Garjito
Product: VHF-UHF Eqpt & Coin Box telephone

21. **Pt.Mirusa Graha**
Jl. Gunter 32-34
Jakarta
Tel : 8292737,8293988
Fax : 8291769
Contact: Julius Usman
Product: Radio Communication eqpt.VHF-UHF Eqpt.

22. **Pt. Natela Corporation**
Pusat Perkantoran
Pulomas
Block I/8. Jl.Perintis
Kemerde-kaan. Jakarta
Tel : 4890211,4894490
Fax : 4891274
Contact: -
Product: Radio Communication Eqpt. VHF-UHF Eqpt.

23. **Pt.Bumi Nusantara Srimaya**
Jl. Biak Ujung No.32
Jakarta
Tel : (021)347540
Contact: Elvas Jurnara
Product: Radio Communication Eqpt.,VHF-UHF Eqpt. Walkie-Talkie. UPS Power supply.

24. **Pt. Citra Kirana**
Komplek Pertrokoan
Pulomas Blok
IV/12. Jl.Perintis Kemer-dekaan. Jakarta
Tel. : 4893021,4893387
Contact: Herman Susilo
Product: Radio Communication Eqpt. VHF-UHF Eqpt.

25. **Pt. Rajasa Hazanah Perkasa**
Jl. Pejaten Barat No.6
Jakarta
Tel. : 7992925,7990543
Fax : 790091
Contact: Hari Subagio
Product: ATLB

26. **Pt.National Global**
Jl.Raya Bogor Km 29,
Gandaria. Jakarta 13710
Tel : (021)870121
Fax : (021)870691
Contact: Ir.Hardianto
Product: Teleprinter

27. **Pt. Prima Citra Lazuwardi**
Jl. Mangga UBI Blok A.
Kav 17,Kebon
Jakarta 11710
Tel : 6194[illegible]
Fax : 6[illegible]
Contact: [illegible]
Product: UPS Power [illegible]

28. **Pt. Guna Elektro**
Jl. Hayam Wuruk 3
Jakarta 11120
Tel. : 380014
Fax : 385488
Contact: Ir.Lasmara
Product: UPS Power Supply

Contd ...

29. **Pt. Priosonic Utama Jaya**
Jl. Rampoa Raya No.11
Bintaro,Jakarta.Selatan
Tel : 7491021
Contact: Ir.Iwan Juanda
Product: UPS/Power Supply

30. **Pt. Wira Mustika Indan**
Jl. Cideng Timur No.15A.
Jakarta 10151
Tel. : 367[illegible]
Fax : 3[illegible]
Contact: Achmad Syarif
Product: UPS-Power supply

31. **Supreme Cable Mfg.Corpn.**
(Supreme)
Jl.Gajah Mada 184,
Jakarta
Tel : 610044
Product: Cable

32. **Terang Kita (Tranka)**
Jl. Gajah Mada
18 C. Jakarta
P.O. Box 2248
Jakarta
Tel : 340664
Contact: -
Product: Cable

33. **Nikkatsu Electric Works**
Jl.Cimuncang 21E,
Bandung
Tel : 74008, 78088
Product: Cable

34. **Pt. Dwi Tunggal Putra**
Jl. Embong Tanjung
No.40, Surabaya
Tel : (031)44861,
470851
Contact: Sugeng Arifin
Product: Radio commn.&
VHF-UHF eqpt.

Contd ...

CHINA

1. **China National Posts & Telecommunications**
Industry Corpn(PTIC)
28,Xin Jie Kou Wai Da
Jie Beijing, -
P.R China 1000 88
Te. : 2015364 2011144-
2157, 2137
Tlx : 22018 PTIC CN
Fax : (861)2014795
Product: Postal Communication System. Fascimile Eqpt.Telephone sets. Satellite Eqpt. Transmission Eqpt Switching Eqpt.Cables. Power supply.

2. **Shanghai Bell Telephone Eqpt. Mfg.Co.Ltd**
(SBTEMC)
25, Hetian Road
Shanghai.
China 200070
Tel : 6622000
Fax : 021-6639761
Product: Switching Systetm.PABX

3. **Shanghai International Digital**
Telephone Eqpt Co.Ltd
Shanghai Gong He Xin Rd 395.
Post code - 200072
Te. : 6652660
Tlx : 33533774 SIDTE CN
Fax : 6653774
Product : ISDX Digital Switching Products

4. **Guangzhou Telecomm.Eqpt**
Guangzhou 510630
Tel : 518888
Tlx : 44705 GPTTF CN
Fax : 511096
Contact: Mr.Chen Zhen Tian. Sr.Mgr
Product: Transmission Eqpt,Telegraph. Switching Eqpt. Optical Fibre Communication. Teleprinter. VHF-UHF Eqpt

5. **Zuhai Economic Zone Peace**
Telecommunication Industry Co
Hua Xing Bldg. Ji Da Rd. Zhuhai
Guang Dong,PR China 519000
Te. : 333191
Fax : 331409
Product : Radio Paging ,IPT PABX System

6. **Shen Zhen Peace Digital**
Telecommunications Industry Corpn.
23. Floor,Bldg. of Construction Bank Finance Centre,Shenzhen China 518015
Tel : 246109
Fax : 246119
Product:Telephone,Cable Integrated & Supervisory Control Eqpt.

7. **Shandong Cowitel Electronics Ltd**
83,Jen Hua Zhong Road,
Weihai City,Shandong Province
P.R. China 264209
Te. : 21444
Tlx : 27209 SDWH CN
Fax : 24444
Product: PBX,Intercommunication

Contd ...

9. **TCL Telecommunication Eqpt Co.Ltd**
Huizhou Guang dong
China 516 001
Tel : 260868
Fax : 20 1868
Product: Push button Telephones

10. **Wuhan Telecommunication**
Power Supply Eqpt.
Factory of MPT 1,Gutian No.2 Road,
Wuhan, China
Tel : 331757
Tlx : 40218 CPSEF CN
Fax : 027-333828
Product: Power Supply for Telecom

11. **Beijing International**
Switching System Corpn. (BISC)
14,Jiu Xian Road,
Beijing 100016 ,P.R China
Tel : 4363132
Fax : 4363123
Product: Public SPC Tel. Switching System

12. **Beijing Communication**
Equipment Factory
5, Jiang Tai Lu,Beijing, China
Tel : 171722,171031-225 383
Cable : 01681
Fax : 500 6891
Product: Microwave Commn. Eqpt.

13. **Panda Electronics Group (PEG)**
301,East Zhong Shan Rd,
Nanjing,
China 210 002.
Tel : 400855
Tlx : 34152 NRFNJ CN
Fax : (8625) 405030
Product: UPS, Transmitters, Receivers, Satellite Commn. Eqpt, Mobile TGI. system

14. **Beijing Wire Communications Plant.**
314, Jiuxianqiao Rd
Chaoyang District
Beijing - PC 100016
Tel : 4361155,4361364
Fax : 5006 621
Product: Automatic Tel.Exchanges.

15. **Jiangdu Wired Electrics**
Factory of Jiangsu
32, Sanyuen Bridge Rd
Jiangdu ,Jiangsu,
PC225 200
Tel : 552402
Product : Telephones

16. **Hubei Xiangfan Radio Technology**
Shengi Road,Outside to South Door of Xiangyang
Hubei
P.C 441 021
Tel : 8588
Tlx : 2477
Product: Mobile stn.Fixed & Repeated Stn, Transmission System

17. **China Tongguang Electronics Corpn.(CTGC)**
Tongguang Mansion
12,Nangzhanguan Nanla
Beijing PC 100026
Product: Commn. Navigation & Broadcasting system

Contd ...

18. **Fushun Radio Factory**
Yanji Rd. Xinfu. District
Fushan Province.China
Tel : 72145
Product : Radio Telephone Systems

19. **Beijing Broadcasting eqpt**
Factory
23. Huangsi Street
Xcheng District
Beijing. PC 100011
Product:Broadcasting & Television Transmitting eqpt

20. **Benxi Communication Eqpt Co.**
Zijin rd. Benxi
Liaoning Provice
China
Tel : 34969
Product: Telephone sets.Cross bar, Automatic Tel. switch system

21. **Anshan Broadcasting Eqpt**
Plant
No.159,Xingsheng Rd
Anshan,Liaoning Province
China
Tel : 43258
Product: Broadcasting & Television eqpt VHF-UHF Xmitters

22. **Liaoning No.4 Radio Factory**
615,Hongkong Street
Dandong, Liaoning Province
China
Tel : 52421
Product: Wireless Telephone sets

23. **Changde Telecommunication**
Eqpt
Factory
No.2, The East People Rd
Changde. Hunan Provice
China 415000
Tel : 22995
Product: Crossbar Telephone Exchanges Digital programme control Exchanges

24. **Tianjin Electronic Wire & Cable Corpn.**
No.62,Jingjin Highway
Hebei District
Tianjin 300 231
Tel : 262307
Contact: [illegible]
Product: RF & Optical Cables

25. **Suman Group Ltd**
46,Baishiqiao Rd
Beijing P.C 100081
Tel : 8317511
Fax : 8315320
Product: Satellite Comn. Eqpt.

END-USERS OF TELECOM EQUIPMENT

INDIA

1. **Ministry of Communications**
   Department of Telecommunications
   Sanchar Bhavan
   20, Ashok Road
   New Delhi - 110 001
   Tel : 388698
   Telex : 3161741

2. **Videsh Sanchar Nigam Ltd**
   Videsh Sanchar Bhavan
   M.G. Road, Fort
   Bombay - 400 001
   Tel : 277175
   Telex : 81(11)2429
   Fax : 91(22)2046976

3. **Mahanager Telephone Nigam Ltd**
   Telephone Bhavan
   2nd Floor, Colaba
   Bombay - 400 005

4. **Mahanagar Telephone Nigam Ltd**
   Jeevan Bharati Tower
   1124, Connaught Place
   New Delhi - 110 001
   Tel : 350012
   Contact : M.P.Shukla,MD
   P.S.Narula,GM (Tech)

INDONESIA

1. **Pt. Telekomunikasi Indonesia**
   Kantor Pusat
   Jl. Jend. Gatot Subroto 52
   Jakarta - 12190
   Tel : 203321
   Telex : 60751
   FAX : 5203322
   Contact : Mr.Murvono
   Deputy Director for
   Services

2. **Perusahaan Umum Telekommunikasi**
   (PERUMTEL)
   Jl. Cisanggarung No.2
   Bandung - 40113
   Telex : 28227 DIRKUG
   FAX : 440-042

CHINA

1. **National Posts & Telecommunications**
   28, Xin Wai Street
   Beijing - 100 088
   China
   Tel : 2025634
   Telex : 22019 PTIC IN
   FAX : 2014795
   Contact : Mr. Zhang Ji, MD