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PACOM ARMY C-E INTEROPERABILITY ASSESSMENT 82 (PACIA 82) FOR: ISLAMIC REPUBLIC OF PAKISTAN (FINAL REPORT)

August 31, 1982

BDM/W-82-226-TR

Prepared for the US Army Western Command, Ft. Shafter, Hawaii
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a. Provides description of major indigenous communications systems in Pakistan.
b. Assesses interoperability of indigenous communications systems with those of the United States during the 1982-1985 and 1986-1990 time frames.
c. Recommends possible enhancements to interoperability between indigenous and US communications systems.

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FOREWORD

This report contains a compilation of the major civilian communications networks operated by the Islamic Republic of Pakistan. Unclassified information on Pakistan's military communications networks is not available for this report. The report covers both the current time period and projections for the 1986-1990 time-frame. This data is intended to enhance the US government's readiness for quick response to a request by Pakistan for communications-electronic (C-E) support in the event of national disasters and/or civilian requests for assistance. An overall assessment of the interoperability of Pakistan's communications networks with those of the United States ATACS, DCS and TRI-TAC systems is presented. Recommendations are given for overcoming identified technical deficiencies.

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CHAPTER I
NARRATIVE ASSESSMENT

A. EXECUTIVE SUMMARY

This report contains a compilation of the major indigenous civilian communications networks operating in the Islamic Republic of Pakistan and assesses the interoperability of these networks with those of the United States ATACS, DCS, and TRI-TAC systems. The data reported in this volume were acquired from a number of US Government Agencies, CONUS technical libraries, the Library of Congress, and equipment manufacturers. Sixty percent of the reference documents cited were published during 1980-1982 and the remaining forty percent during 1975-1979. No documents were used that were published prior to 1975.

One of the original goals of this effort was to assess the interoperability of the Pakistan military communications networks with the three US military systems under consideration. However, no data on Pakistan's military communications system were available for this report. This lack of data from both classified and unclassified sources prohibits any realistic interoperability assessment relating to Pakistan's military communications systems.

There are two major civilian communications networks in Pakistan which are applicable to this study -- the public communications network operated by the Telegraph and Telephone (T&T) Department, and the specialized network operated by the Pak-Arab Refinery (PARCO). The T&T network has wide coverage throughout Pakistan, while the PARCO network has limited coverage along a pipeline in the southern portion of the country. Both networks are primarily analog (FDM/FM), though T&T has implemented a small number of digital trunk facilities, and rely heavily on microwave radio as a transmission media. T&T also operates an extensive coaxial cable network.

In the current time frame (1982-1985), the analog long-haul and short-haul trunks of both the T&T and PARCO networks are interoperable with the

analog portions of the DCS. However, PARCO does not have direct access to an international gateway exchange except through the T&T network. Neither T&T nor PARCO are interoperable with ATACS. Since it is projected that during the 1986-1990 time frame, both networks will remain primarily analog and retain most of their current technical attributes, their analog long-haul and short-haul trunks will be interoperable with the analog portions of the DCS, though the DCS will become predominantly digital by 1990. TRI-TAC will not be directly interoperable with either the T&T network or the PARCO system.

B. CURRENT ASSESSMENT

1. Introduction

The Telegraph and Telephone (T&T) Department, under the Ministry of Communications, is responsible for the operation of virtually all civilian domestic and international telecommunications in Pakistan. While the T&T network satisfies most of the requirements for commercial needs, there are a number of organizations which operate their own networks to meet specialized needs. The one applicable to this study is that operated by the Pak-Arab Refinery along a pipeline in the southern portion of Pakistan. Other private networks include those operated by the Sui Gas Transmission Company (SGTC), the Water and Power Development Authority (WAPDA), the Oil and Gas Development Corporation, and Pakistan Railways. Brief descriptions of each of these appear in Chapter III. They will not be included in the interoperability assessment because of the lack of detailed data concerning their attributes. The two major indigenous networks applicable to this study will be discussed further below.

a. Telegraph and Telephone Department (T&T)

The T&T Department, under Pakistan's Ministry of Communications, is responsible for the operation of all local, long distance, and international public telecommunications services in Pakistan. T&T maintains two factories which produce telecommunications equipment--Telephone Industries of Pakistan (TIP) and Carrier Telephone Industries

(CTI). Both of these are commercial organizations in which the government is a majority shareholder.

The present T&T network has approximately 91 percent of its telephone lines operating on automatic exchanges, with the remainder on manual exchanges. There are eleven telex exchanges in the major cities of Pakistan, having a total capacity of about 3,500 lines. The telex network operates at the standard rate of 50 baud and uses the CCITT Alphabet No. 2. Telex subscribers have access to the international network through the gateway in Karachi.

Long-haul transmission in Pakistan is accomplished primarily through a microwave and cable network, most of which is a standard analog FDM/FM carrier system. The T&T microwave system consists of about 4,000 kilometers of links within both the domestic network and the regional Asian Telecommunications Network (ATN). A 960-channel coaxial cable network also interconnects Pakistan's major cities and has a number of nodes coincident with the microwave network. In rural areas and smaller towns, the primary transmission media are aerial cable and open-wire lines.

International satellite communications are provided through an earth station at Deh Mandro (20 miles outside of Karachi). The earth station operates into the INTELSAT network and has a capacity of 252 satellite circuits.

b. Pak-Arab Refinery, Ltd. (PARCO)

The present specialized telecommunications network of PARCO was engineered by Federal Electric International, a world-wide subsidiary of ITT. The backbone is a 1.5 GHz analog microwave radio system which parallels the pipeline and incorporates 17 tandem line-of-sight communications hops. The system has a 24-channel capacity, with drop and insert capability at each site. Among the services offered are provision of telephone circuits throughout the pipeline complex, teletype circuits for pipeline terminal and pumping stations, and data transmission circuits for pipeline control and supervision.

2. Interoperability Assessment

Table I-1 summarizes the predominant communications systems attributes required to assess both the current and future interoperability between Pakistan's T&T and PARCO networks and the US ATACS, DCS, and TRI-TAC systems. A bullet (o) in the table indicates the existence of a particular attribute, a number sign (#) indicates that the existence of the attribute is currently unknown, and a blank (no entry) indicates non-existence of the attribute. These attributes for the above communications systems are compared and analyzed on a one-to-one basis, with the resulting interoperability assessment shown in Table I-2. This table uses numerical indicators (0-4) to illustrate the degree to which Pakistan's communications systems are interoperable with the three US military communications systems. The number 4 means there are no or negligible technical constraints involved in the interoperability of the two systems, while an indicator of 0 means that there is not enough data available to make a valid assessment. The numbers 1, 2, and 3 respectively indicate there are major technical constraints, potentially serious constraints, and minor technical constraints involved in the interoperability of two systems.

a. The Telegraph and Telephone Department (T&T)

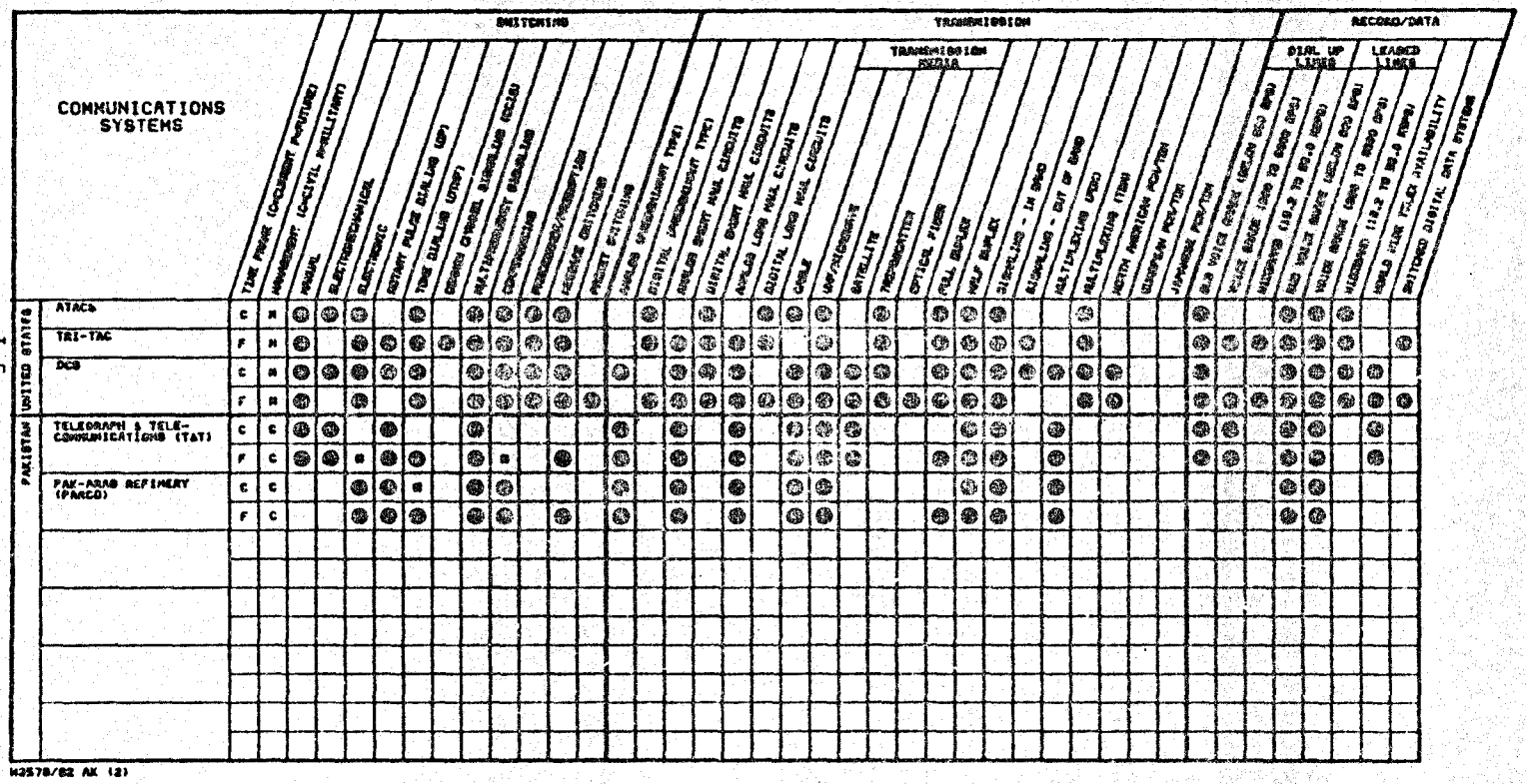
1) Telephone/Microwave Network

Table I-1 shows the key technical parameters required to assess the interoperability between the current T&T network and the current US DCS and ATACS systems. Using this table, several observations can be made about the current T&T network. First, the majority of its short-haul trunks and all of the long-haul trunks are analog FDM/FM. The T&T currently does not have any sizeable digital capability. Second, all of T&T's switches are either manual or electromechanical, using rotary pulse subscriber dialing. Third, and finally, T&T has limited data communications capability.

Based on these overall observations and available background data, the following conclusions can be drawn:

(1) The T&T short-haul and long-haul analog trunks are interoperable with the analog portions of the DCS, given that the in-band

TABLE I-1. COMMUNICATIONS SYSTEMS ATTRIBUTES, PAKISTAN



LEGEND: # = UNKNOWN

signalling methods used by each are compatible, in addition to modulation, synchronization and encoding.

(2) The T&T network is not directly interoperable with ATACS. ATACS uses a 6-bit pulse code modulation (PCM) technique with time-division multiplexing (TDM), while Pakistan's network, being primarily analog, relies on standard FDM/FM techniques. Extensive conversion equipment would be needed in order to interface the different modulation, signalling, and synchronization schemes utilized by the two systems.

The overall numerical interoperability assessment between the current T&T system and the current US DCS and ATACS systems is summarized in Table I-2.

2) Telex and Data Communications

By international convention, the transmission of telex (teleprinter) data is standardized and is therefore compatible with US equipment. Through the T&T network, Pakistan has both domestic and international telex capability, allowing its network to be easily accessed by outside nations. In the area of data communications outside of low-speed telex services, Pakistan's capabilities are limited to transmission over voice grade channels with maximum speeds up to 2400 bps, and, in some cases, 4800 bps. This situation lends itself to fast access by a variety of users and poses no interoperability problems of consequence.

3) International Gateways (Satellite)

The earth station which T&T operates into the INTELSAT network is, by design, interoperable with the US commercial network. Since the DCS is compatible with the US commercial communications network, it follows that the DCS can gain access to the T&T network through Pakistan's gateway exchange. ATACS, however, is not compatible with T&T gateways.

b. Pak-Arab Refinery (PARCO)

Table I-1 shows the key technical parameters required to assess the interoperability between the current PARCO network and the US DCS and ATACS systems. Based on this table and available background data, PARCO's analog FDM/FM short-haul and long-haul trunks are interoperable with the analog portions of the DCS (given that signalling, synchronization

TABLE I-2 INTEROPERABILITY ASSESSMENT

	COMMUNICATIONS SYSTEMS	UNITED STATES			
		CURRENT		FUTURE	
		ATACS	DCS	TRI-TAC	DCS
PAKISTAN	TELEGRAPH AND TELEPHONE (T&T) DEPARTMENT	1	3	1	2
	PAK-ARAB REFINERY, LTD. (PARCO)	1	2	1	1

LEGEND:
0 = INSUFFICIENT DATA FOR VALID ASSESSMENT
1 = MAJOR TECHNICAL CONSTRAINTS
2 = POTENTIALLY SERIOUS CONSTRAINTS (UNCERTAINTIES EXIST)
3 = MINOR TECHNICAL CONSTRAINTS
4 = NO OR NEGLIGIBLE CONSTRAINTS

and modulation are compatible) but are not interoperable with ATACS, for the same reasons as described earlier for T&T. Because of its specialized nature and limited accessibility, however, there may be potentially serious constraints in the DCS interfacing to the PARCO network. Because PARCO has no international communications capabilities, the DCS could only gain access to Pakistan's international gateways through the T&T network by way of the main PARCO exchange. This involves one more interface than would be necessary if the DCS interfaced directly to the T&T network.

Table I-2 summarizes the overall interoperability assessment for the current PARCO network.

C. FUTURE ASSESSMENT

1. Introduction

The following subsections highlight planned communications upgrades in Pakistan which will have an impact upon US interoperability in the 1986-1990 time frame.

a. The Telegraph and Telephone Department (T&T)

During the 1986-1990 time frame, T&T plans to upgrade and expand the domestic long distance routes to cope with the predicted annual growth in traffic. Expansion of the network will involve connecting locations in the Northwest Frontier and the Baluchistan through additional microwave links. Telex facilities will also be expanded for some 3,200 additional subscribers. Improvements in the network will include the replacement of 9,000 telephone lines and the installation of another 300 exchanges in rural and urban areas. The predominant short-haul and long-haul media will remain analog (FDM/FM). A small number of digital short-haul trunks have been introduced into the T&T system; no significant change in the area of digital technology is expected in the future.

In the area of international and satellite communications, T&T has plans to upgrade or implement microwave or cable links to the neighboring countries of Iran, India, and Afghanistan. The existing earth station at Deh Mandro will be upgraded from 252 channels to 384 channels.

Increased capacity for the international gateway exchange in Karachi has also been planned. In addition, a second satellite earth station and gateway exchange will be installed in Islamabad to handle the projected growth in overseas traffic during the 1986-1990 time period. Furthermore, Pakistan has taken the first steps toward the launching of a domestic telecommunications satellite which would provide telephone and television services. This satellite has been tentatively scheduled for launch in 1986 or 1987 with the cooperation of either the US National Aeronautics and Space Administration (NASA) or the European Space Agency (ESA).

b. Pak-Arab Refinery (PARCO)

PARCO is expected to add some additional circuits to its telecommunications network along the pipeline; however, this is not expected to affect or significantly change its overall technical characteristics. The network will remain completely analog (FDM/FM). Modernization of the T&T network will, in the long run, provide better quality leased circuits to this and other specialized networks.

2. Interoperability Assessment

Referring back to Tables I-1 and I-2 presented in section B, it is apparent that the technical characteristics of both the T&T and PARCO networks will remain largely unchanged in the 1985-1990 time frame. Both systems will remain almost completely analog, with only a small percentage of digital trunks implemented in the T&T network. Because both systems will remain analog while DCS becomes predominantly digital, additional problems may be encountered in their interoperability than presently exist. The analog long-haul and short-haul trunks of both T&T and PARCO will remain interoperable with the analog portions of the DCS, subject to the same constraints mentioned previously. However, there will be the added constraint that a much smaller proportion of the DCS facilities will be analog. Additionally, neither the T&T network nor the PARCO network will be directly interoperable with TRI-TAC. Major technical constraints will be encountered in the conversion of single-bit delta modulated TRI-TAC signals to analog channels or groups.

International gateways will continue to be interoperable with the DCS, though not with TRI-TAC. In the area of telex and data communications, the current interoperability situation is likely to remain unchanged in the 1986-1990 time frame.

D. CONCLUSIONS AND RECOMMENDATIONS

The following tentative conclusions can be stated from the analysis of Pakistan's communications networks regarding interoperability with the US military communications systems:

(1) The present DCS and T&T networks are interoperable at the gateway exchange in Karachi; the DCS, however, is not directly interoperable with the PARCO network at this exchange,

(2) ATACS is currently not interoperable with the DCS, T&T, or PARCO networks,

(3) The analog short-haul and long-haul trunks of both T&T and PARCO are currently interoperable with the analog portions of the DCS, and will continue to be so in the future provided that signalling methods are compatible, and

(4) TRI-TAC will not be directly interoperable with either the T&T or PARCO networks.

It is recommended that the US Army continue its development of electronic interfaces that will allow TRI-TAC equipment to interface to existing DCS facilities. This, in turn, may allow Pakistan's networks to become interoperable with TRI-TAC (at least through analog DCS facilities). As recommended in the January 1980 USACC White Paper on "Communications Interoperability and Network Evaluation," the proposed TRI-TAC interface should:

(1) interface DCS and TRI-TAC at the digital channel and group rates,

(2) interface DCS (and TRI-TAC) to both North American and European PCM,

(3) convert TRI-TAC framing and signalling from its overhead channel techniques to the DCS in-band technique, and

(4) convert the TRI-TAC delta modulation format to 8-bit PCM.

Standard interface equipment is available for the transmission of digital PCM signals over cable as a transmission medium. However, in order for the digitial portions of the DCS to interoperate with the analog T&T, FDM/FM microwave radio network, it is recommended that the US Army consider the use of commercially available electronic equipment (e.g., GTE Lenkurt) for transmission of PCM signals over microwave radio. This type of equipment is capable of transmitting 96 PCM channels (unlike the conventional 960 or more analog channels) over most frequency modulated (FM) microwave radios, and could provide the interoperabilty required by the DCS, at least on a short term basis.

As both TRI-TAC and DCS become more technologically advanced through eventual implementation of all-digital networks, their systems will become more and more dissimilar to Pakistan's predominantly analog systems. This will affect all aspects of interoperability from the subscriber-switch interface to the switch-switch interface. The limited accessibility and specialized nature of a network such as that operated by PARCO will need to be examined more closely in order to determine whether interoperability is not only technically feasible, but beneficial as well.

CHAPTER II
COMMUNICATIONS MANAGEMENT STRUCTURE

A. CIVILIAN COMMUNICATIONS MANAGEMENT

1. Overview

The telecommunications services in Pakistan are administered through the Ministry of Communications and its Telegraph and Telephone Department (T&T), which is responsible for the operation of all local, long distance, and international public telecommunication services. Industrial and commercial establishments in the private sector, in general, utilize the communication facilities of the Telegraph and Telephone Department (T&T) and do not maintain their own telecommunication facilities. However, some public sector corporations and a few private sector companies and corporations are now beginning to install their own telecommunication systems.

2. Domestic Telecommunications

The T&T Department provides for the following domestic services:

(1) telephone services;
(2) telex services;
(3) leased circuits;
(4) sale or rental of modems, terminals, or equipment.

Figure II-1 depicts the organization of the Ministry of Communications. The T&T Department contains the Director General and is organizationally under the Ministry of Communications.

T&T has authorized some railway and private agency offices to handle public telegrams in places where there are no T&T offices.

3. International Telecommunications

Through the Ministry of Communications and its Telegraph and Telephone Department (T&T), the following international services are provided:

(1) telephone services,

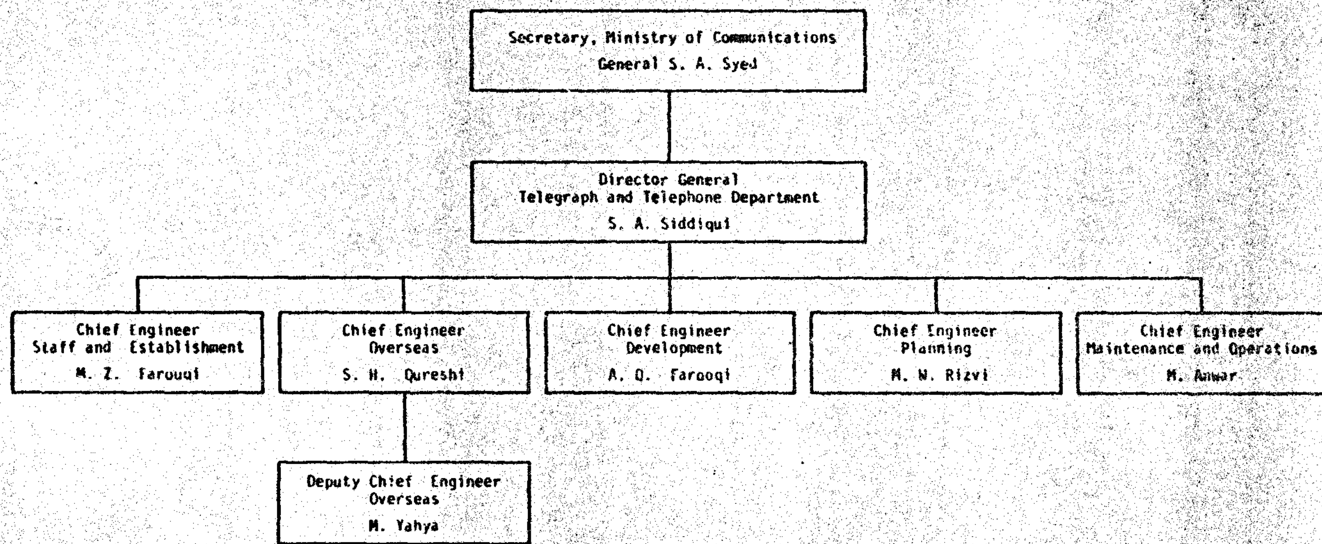


Figure II-1. Organization of the Ministry of Communications

(2) telex services, and

(3) leased circuits.

Pakistan is a member of the INTELSAT organization, signing the main agreement in 1975, the UN, and the ITU.

B. MILITARY COMMUNICATIONS MANAGEMENT

Both unclassified and classified information on military communications management in Pakistan are not available for this report.

CHAPTER III
CURRENT CAPABILITY

A. ECONOMIC AND POLITICAL OVERVIEW

1. Background Data

Agriculture is the mainstay of the Pakistan economy, employing more than half the labor force. Wheat, rice, sugar cane, and cotton are the main crops. Pakistan is a large population state with a low income, as shown in Table III-1. The GNP growth fluctuated during the 1970s and, at the time of the military coup in 1977, it was at a standstill. Industry, a declining force during the 1970s, has recently experienced an upturn. Mining is a negligible part of the GNP, but priority is being given to the exploration and development of oil reserves.

2. Geography and People

Pakistan extends from the Arabian Sea, 1,600 kilometers (1,000 miles) northward across the Thar Desert and eastern plains to the Hindu Kush and the foothills of the Himalayan mountains. It is bounded by Iran, Afghanistan, the disputed state of Jammu and Kashmir, and India. Pakistan is drained by the Indus River and its tributaries, which form the fertile and intensely cultivated Indus Valley. Generally, Pakistan's climate is dry and hot near the coast, but cool in the northeastern uplands. Annual rainfall averages less than 25.5 centimeters (10 inches) and temperatures range from below freezing to 49 degrees centigrade (120 degrees Fahrenheit). Pakistan has four provinces: Punjab, Sind, Northwest Frontier, and Baluchistan, plus several centrally-administered tribal areas located in the Northwest Frontier Province. The majority of people live in Karachi, in the Indus Valley, and along an arc formed by Lahore, Rawalpindi, and Peshawar. Punjabis make up the majority, with minorities of other Indo-Aryan peoples. The official language is Urdu, spoken as a first language by only 9 percent of Pakistanis. English is an associate language and is widely spoken.

TABLE III-1. BACKGROUND DATA, PAKISTAN

ECONOMIC DATA		
AREA IN SQUARE KILOMETERS	803,000	
POPULATION	87,720,000	(1981)
POPULATION, AVERAGE ANNUAL GROWTH RATE	2.8%	(1981)
GNP, IN MILLIONS	$23,000	(1980)
GNP, ANNUAL GROWTH RATE	6.4%	(1978-1980)
GNP PER CAPITA	$282	(1979/1980)
GNP PER CAPITA GROWTH RATE	4.0%	
MILITARY DATA		
DEFENSE EXPENDITURES, IN MILLIONS	$1,420	(1980/1981)
TOTAL ARMED FORCES	430,000	
• ARMY	400,000	
• NAVY	13,000	
• AIR FORCE	17,000	
TOTAL RESERVES	500,000	
TELECOMMUNICATIONS DATA		
TOTAL TELEPHONE LINES	281,900	(1981)
TELEPHONE EXCHANGES	784	(1981)
SATELLITE EARTH STATIONS	1	(1982)
TELEX EXCHANGES	11	(1981)
TELEX EXCHANGE LINES	3,530	(1981)

3. Politics and Government

The Pakistanis' constitution, which entered into force on August 14, 1973, provides a framework for civilian government. The ceremonial Chief of State (the President), elected by the Senate and National Assembly, and Head of Government (the Prime Minister), elected by the Assembly, form the major offices of the government.

The National Assembly (200 members elected by universal adult suffrage, plus 10 seats reserved for women) has a 5-year term, subject to dissolution. The Senate consists of 63 members indirectly elected for 4 years by the Provincial Assemblies and tribal councils with half the members up for reelection every 2 years. The Senate is not subject to dissolution.

In 1977, General Mohammed Zia-ul Haq suspended the constitution when he ousted Bhutto and established a martial law regime. The retention of the ban on political parties remains, as does the open-end postponement of a general election promised for 1979. Internal stability remains the major problem area.

External relations are polarized around the Afghanistan problem and its refugees. Problems of longer standing have been those with Iran, tribal friction over boundary division in Baluchistan, the Northwest Frontier with Afghanistan, and with India over Kashimir.

4. The Economy

The Pakistan economy surged forward in PFY 1979-1980 as agricultural production and industry output grew in real terms by 6 percent. Double-digit inflation marred this otherwise commendable performance; however, government measures to reduce reliance upon deficit spending and to control monetary expansion met with some success.

Nationalization of major industries began in 1972, but the Martial Law Government reversed this policy. The banking industry, some insurance companies, shipping, and public utilities remain under state control. The government has introduced a number of measures to restore levels of private sector investment.

Growth in the GNP averaged 4.2 percent annually in 1970-1977, compared with an average annual growth rate of 8.2 percent in 1977-1978 and 1978-1979. Export earnings, worker remittances, and imports rose substantially in PFY 1979-1980, and a $1 billion current account deficit was covered with a loan from the International Monetary Fund and assistance from Saudi Arabia.

During 1979, movement towards an "Islamic economy" was announced, and plans have been drawn up for abolishing interest and introducing religious taxes. An Islamic economic order would also involve the abolition of limited liability and incorporation.

5. Organization and Regulation of Telecommunications

The Telegraph and Telephone (T&T) Department is a government department under the control of the Ministry of Communications. The Department is responsible for the operation of all local, long distance, and international public telecommunication services in Pakistan. T&T licenses commercial and amateur radio transmitters, controls radio spectrum usage and operates a radio monitoring service.

The T&T Department maintains two factories which produce telecommunication equipment in collaboration with manufacturers from abroad. The Telephone Industry of Pakistan (TIP), the manufacturer of switching equipment, telephone instruments, and teleprinters, and Carrier Telephone Industries (CTI), the manufacturer of multiplex equipment, are both commercial organizations with the government as a majority shareholder. The other major shareholder is Siemens AG of West Germany. Pakistan provides the main technical effort and all financial and managerial direction.

B. CIVILIAN NETWORKS

1. Current Status of Telecommunications

a. Overview

As of June 1980, Pakistan has about 365,000 exchange line capacity, of which 91 percent is automatic electromechanical switching.

There are about 357,962 telephones for a population of about 84 million, which gives an average telephone density of .5 telephones per 100 population. By world standards, this is very low and far too low to meet the information flow needs of Pakistan's economy.

There is also a serious imbalance of telecommunications development between urban and rural areas. Out of the 357,962 telephone subscribers, about 54 percent are concentrated in the major cities of Karachi, Lahore, Islamabad, and Rawalpindi. A further 24 percent of the telephones are located in the remaining larger towns, with only 22 percent of the telephones located in the thousands of other small towns and villages.

Long distance circuits are being provided through high-capacity coaxial cable and microwave links. The cable and microwave links operate the length and breadth of the country. Telex service is available in 11 cities. Pakistan maintains connections to other countries via an earth station located 20 miles northwest of Karachi (Deh Mandro). The satellite, microwave, and cable networks have Karachi as an international and domestic gateway.

b. Public Telephone System

1) Switching

The switching system in Pakistan is a combination of step-by-step and semiautomatic exchanges; however, new automatic exchanges are being installed and are increasing the telephone switching capability. Local and long distance telephone service in Pakistan is provided to over 300,000 subscribers through a network of 784 exchanges, as of June 1981. Telephone service for main population centers is provided through automatic exchanges. Manual exchanges are installed in smaller towns and rural areas, and are being replaced by small automatic exchanges. The majority of the switching equipment is supplied by Siemens-TIP.

Switching procurement requirements from 1981-1985 are based around smaller switching systems. The estimated switching system requirements are 175 switching facilities with up to 500 lines, 191 switching facilities with 1,000 to 3,000 lines, and 10 switching facilities

with 3,000 to 10,000 lines. The location of the automatic telephone exchanges is shown in Figure III-1.

Overseas traffic is being controlled and operated through the International Gateway Exchange at Karachi which began operation in July 1980. This exchange presently has the capacity to handle 300 international telephone circuits and can be expanded up to 900 circuits.

2) Microwave Transmission

The Pakistan microwave network consists of about 4,000 kilometers of microwave line-of-sight links which are within the domestic and Asian Telephone Network (ATN). Pakistan is presently tied in with the Central Treaty Organization's (CENTO) microwave system. The CENTO microwave route which passes through Baluchistan to Iran and Turkey was installed during the early 1960s. The system has been upgraded to accommodate 960 voice channels and one TV channel. Other microwave systems are utilized in Pakistan. Figure III-2 shows the geographical network layout for the T&T microwave system.

3) Cable Transmission

In Pakistan, a 960-channel coaxial cable links Karachi with major cities in the north. Locally, underground cable is used in major cities with aerial cable and open-wire lines used in the smaller towns and outlying rural areas. The coaxial cable system has a nubmer of nodes coincident with the microwave network. Recently, an underground coaxial cable system was installed between Karachi and Peshawar by Siemens. The existing coaxial cable network is shown in Figure III-3. Future use of cable will be utilized to connect microwave systems to many outlying rural areas.

c. Telegraph, Telex, and Data Communications

The T&T Department in Pakistan operates more than 800 public telegraph offices, point-to-point. T&T has authorized railway and private agency offices to handle public telegraphs in places where there are no T&T offices.

As of June 1981, there are 11 telex exchanges in the major cities of Pakistan having a total capacity of about 3,500 lines and 2,439

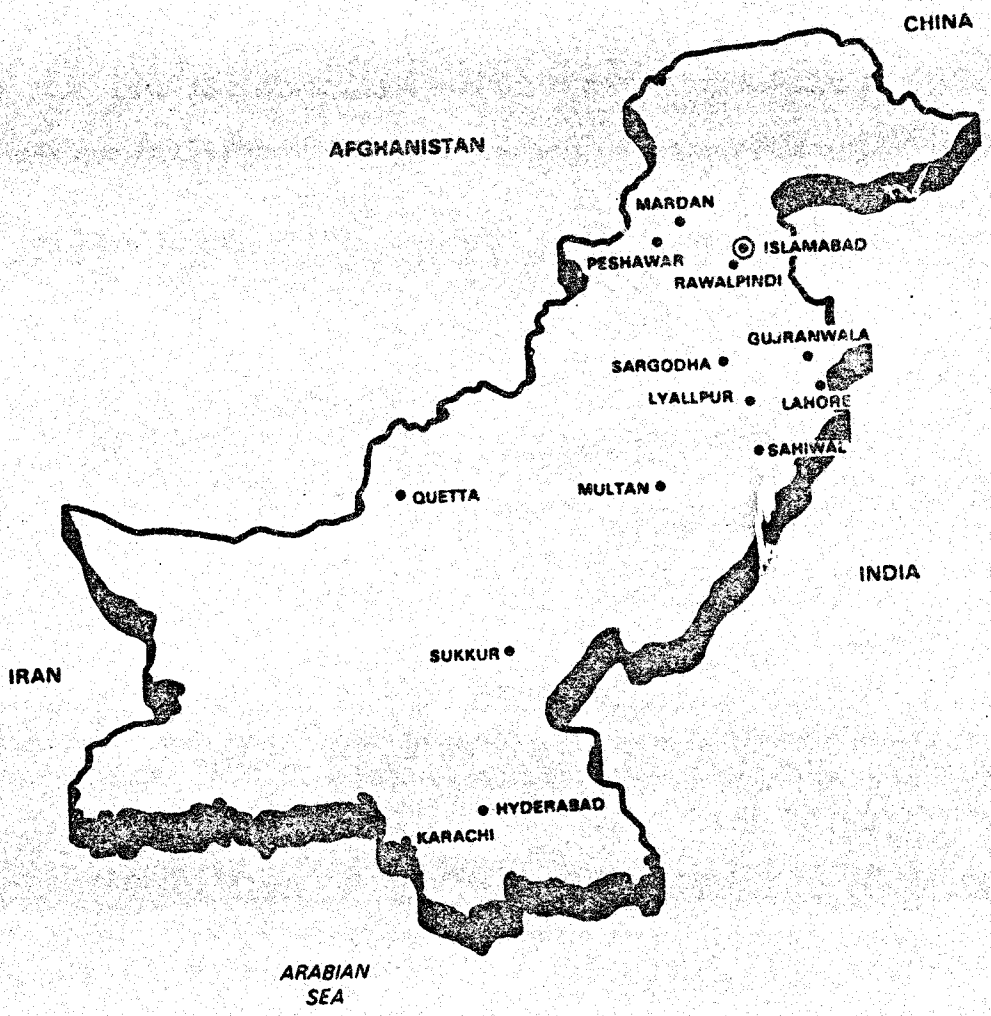


Figure III-1. Automatic Telephone Exchanges in Pakistan

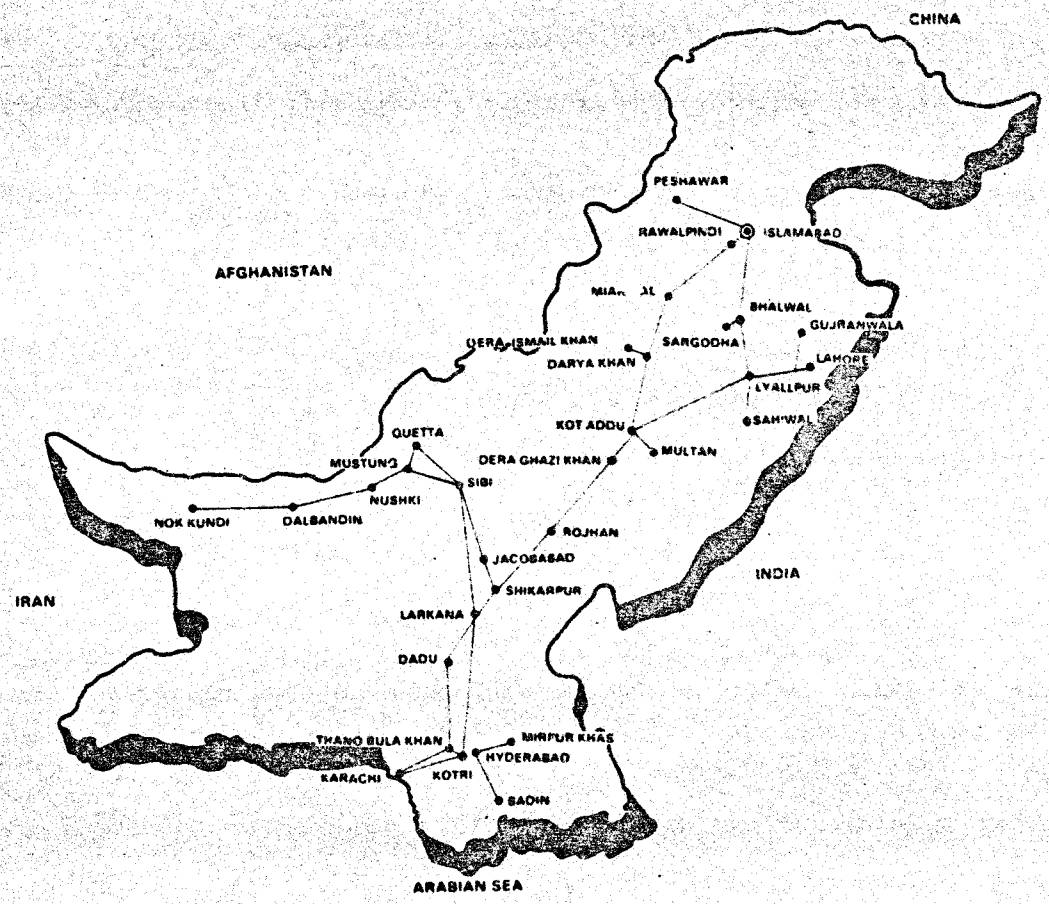


Figure III-2. T&T Microwave Network

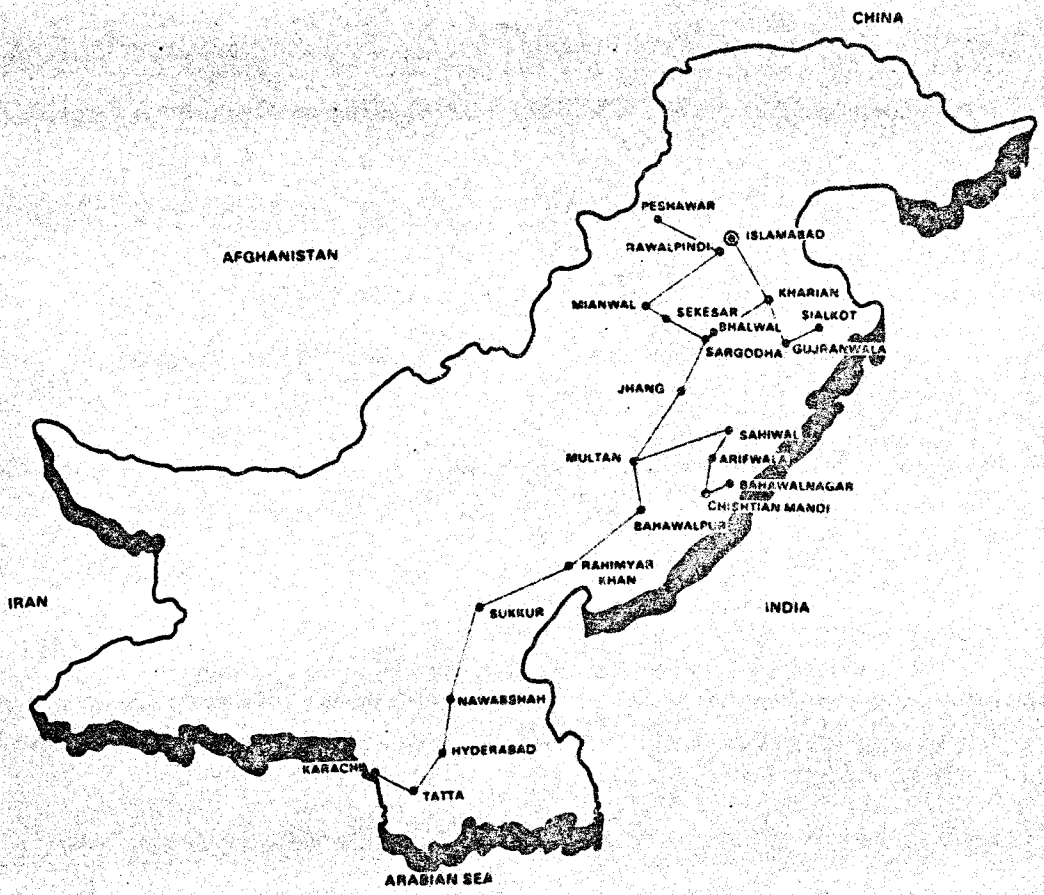


Figure III-3. T&T Cable Network

operational subscribers. There is a pending demand of about 2,500 connections. The telex demand has been growing at a rate of 36 percent per annum over the past 5 years.

d. Satellite Communications and International Gateways

Satellite communications in Pakistan provide overseas telephone, telegraph, and telex services. An earth station at Deh Mandro and the international switching and gateway centers in Karachi provide international services. The earth station which operates with the INTELSAT communications satellite in the Indian Ocean Region has at present the capacity for 252 satellite circuits of which 244 are operational. Overseas TV programs can be received and transmitted through this earth station facility. Out of the 244 circuits, 17 circuits are dedicated for telegraph and telex working directly with 16 countries (more countries are available on transit). The remaining 227 circuits provide automatic, semiautomatic, and manual telephone circuits directly to 24 countries and over 156 countries on a transit basis.

As of December 1981, Pakistan has a total of two routes from the United States. All of these routes are combined cable and satellite facilities with a total of 16 circuits from the US Mainland as shown in Figure III-4. Figure III-5 shows that all the circuits use Green Hill, Rhode Island, as a terminal point in the United States. These circuits are than transited to the Pleumeur Bodou earth station in France and the Indian Ocean Region (I.O.R.) primary satellite. The other three channels leave Green Hill, Rhode Island, on the TAT-5 cable into San Fernando, Spain. These circuits are then transited to the Buitrado earth station in Spain and also use the Indian Ocean Region primary satellite. The combined 16 channels are directed by the Deh Mandro earth station to Karachi for network distribution.

e. Specialized Networks

Apart from the telecommunications network operated by the T&T to meet the requirements of commercial and other public needs, there are other organizations which have specialized needs and operate a

Figure III-4. United States - Pakistan Satellite Circuits

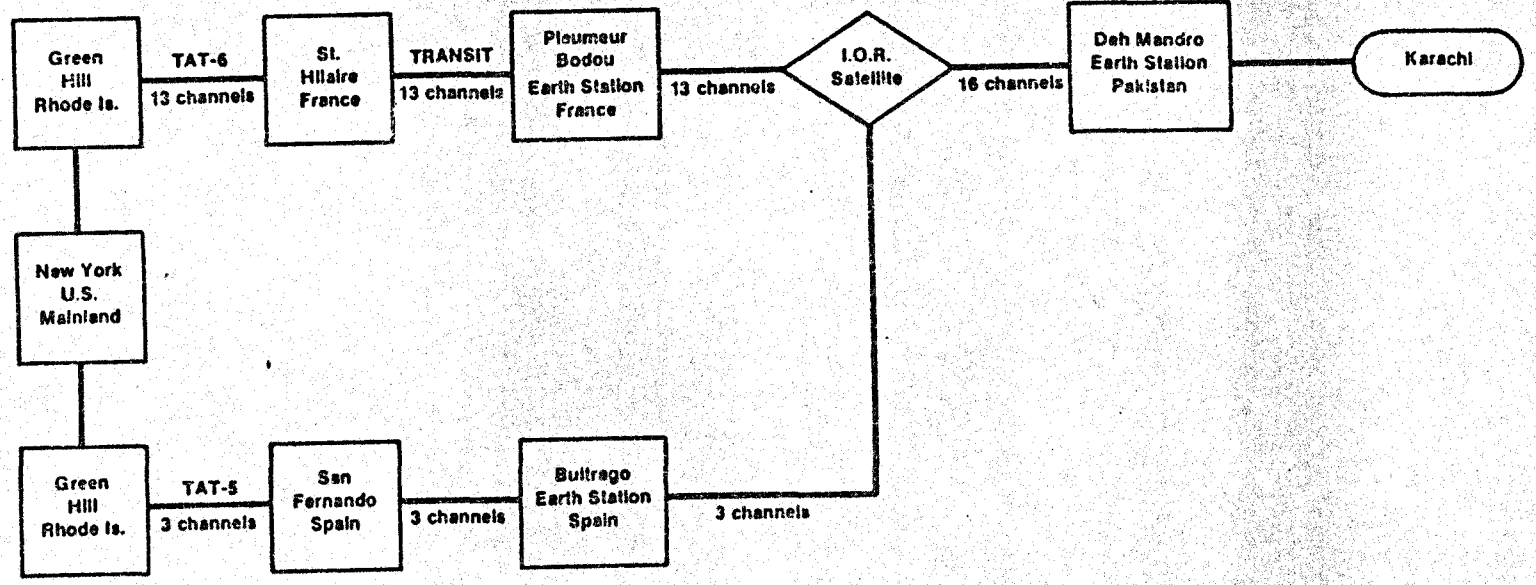


Figure III-5. United States Mainland - Pakistan Satelite Circuits

telecommunications network of their own. One of the most important of the specialized networks is that operated by the Pak-Arab Refinery (PARCO).

1) Pak-Arab Refinery, Ltd. (PARCO)

In the mid-seventies, the Government of Pakistan decided to undertake the design and installation of a pipeline capable of carrying sufficient products north to meet current and future demands. Pak-Arab Refinery, Ltd. (PARCO) was given this challenge.

The telecommunications system engineered by Federal Electric International, a world-wide service subsidiary of International Telephone and Telegraph, provides the pipeline with the following services:

(1) Telephone circuits throughout the pipeline complex end-to-end,
(2) Teletype circuits for the pipeline terminal an pumping stations,
(3) VHF mobile radio coverage of the entire pipeline,
(4) Data transmission circuits for pipeline supervisory control,
(5) Monitor and control system for the pipeline block valves,
(6) Voice paging system at all pipeline facilities, and
(7) Alarm system.

The hub or the pipeline operation and the terminus of the telecommunications system is the Master Control Center (MCC) located at Korangi. From this MCC, the telecommunications backbone parallels the pipeline and provides transmission for all communication and control services.

The backbone is a 1.5 gigahertz (GHz) analog microwave radio network that incorporates 17 tandem line-of-sight communications hops utilizing 18 sites. The average hop length is 45 kilometers with the longest hop being 60 kilometers. The backbone system has a 24-voice channel capacity with drop and insert capability at each site. Figure III-6 shows the PARCO microwave network.

2) Other Specialized Networks

Other services in Pakistan op rate either through leased circuits or their own specialized networks. Some of the other specialized netwo ks are discussed below.

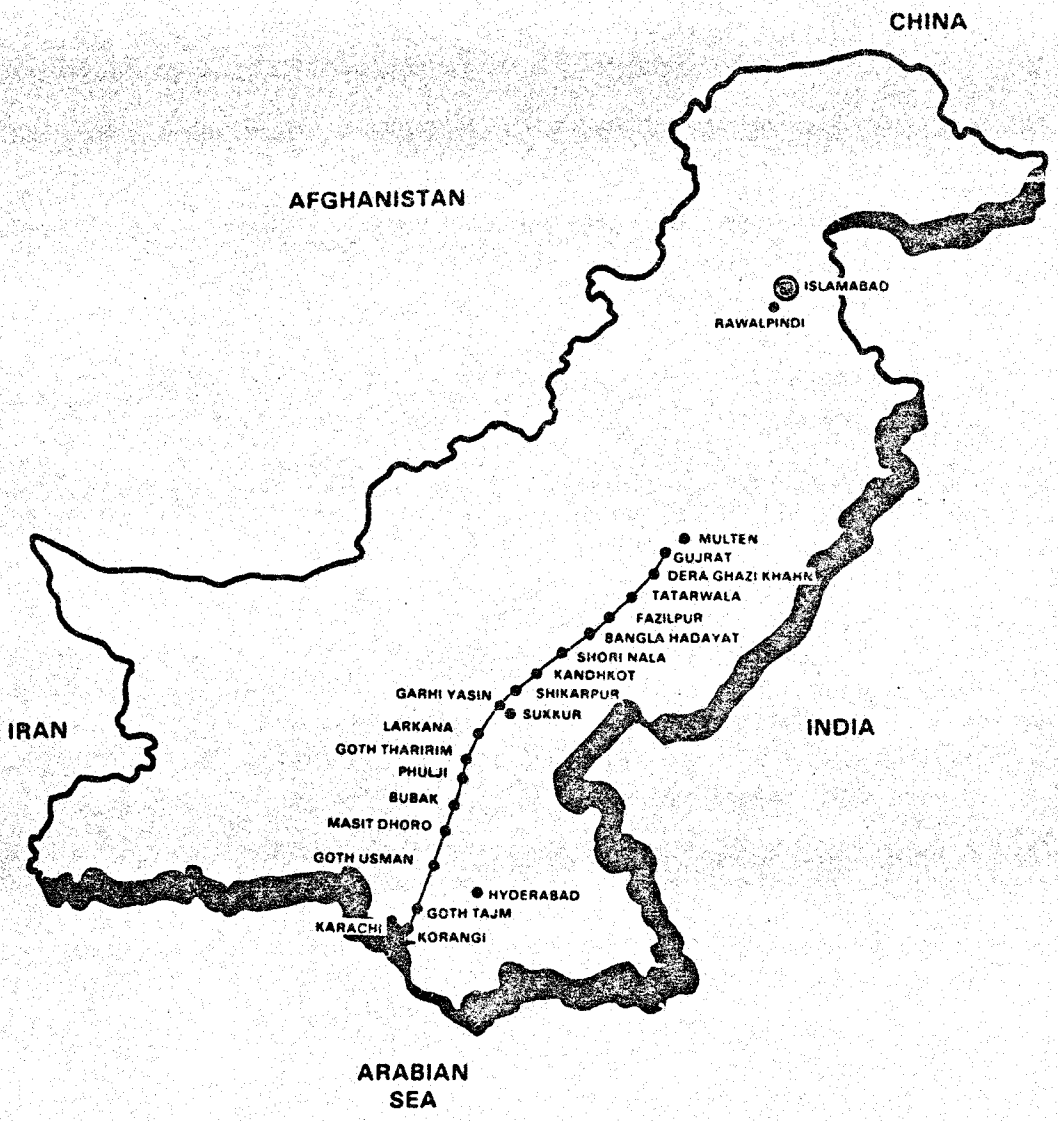


Figure III-6. PARCO Microwave Network

The Water and Power Development Authority (WAPDA), a government-owned corporation, maintains its own telecommunication directorate using the power carrier system for its power distribution network. It uses HF, VHF, and overhead carrier telecommunications systems. For HF and VHF, WAPDA's needs are relatively low, but its demand for carrier power communications is relatively large.

The Oil and Gas Development Corporation operates a comprehensive VHF multichannel telecommunications system for telephones, teleprinters, and operational telemetry, which follows closely the pipeline from the fields at Sui to Multan, via a monitoring station at Faisalabad (Lyallpur) to Lahore and Rawalpindi.

The Pakistan Railways has contracted Kentron International for a $50 million microwave system. The 4,500-mile system involving 325 communication sites will have duplex HF/VHF, block signalling, multiplex voice, and data transmission. The system is being installed along the railroad tracks between Karachi and Peshawar.

Sui Gas Transmission Company, Limited (SGTC), operates a 1.7 to 1.8 gigahertz (GHz) ultra-high frequency (UHF) backbone system along the right bank of the Indus River from Karachi to Dadu and Shikapur. The 11-station microwave system supplied by the Canadian Marconi Company stretches 480 kilometers. The digital microwave system uses pulse code modulation for voice and data multiplexing.

2. Detailed Listings

a. Remarks

In this section, detailed listings are provided which describe the current civilian communications capabilities discussed in the preceding sections. The Glossary in Chapter V describes all abbreviations used. The numbered data sources are listed in the Bibliography of Chapter V.

b. Telephone Switches

The telephone switches of Pakistan are mainly step-by-step electromechanical. The switching equipment is largely supplied by Siemens. Telephone switches in Pakistan are listed in Table III-2.

TABLE III-2

CIRCUIT SWITCH CAPABILITY

X CIVIL
___ MILITARY

___ X CURRENT
___ FUTURE

SWITCH	TYPE	MANUFACTURER	YEAR INSTALLED	CAPACITY	FILL	NETWORK FUNCTION	SIGNALLING	LOCATION	OPERATED BY	DATA SOURCE
KARACHI	SPC	NEC	78	880TR	.75	MSC	CCITT	KARACHI	T&T	1,16
SUKKUR	EM	SIEMENS	77	200TR	.60	TOLL	DP	SUKKUR	T&T	1,16
MULTAN	EM	SIEMENS	77	250TR	.60	TOLL	DP	MULTAN	T&T	1,16
RAWALPINDI	EM	SIEMENS	77	670TR	.70	TOLL	DP	RAWALPINDI	T&T	1,16
QUETTA	EM	SIEMENS	77	830TR	.70	TOLL	DP	QUETTA	T&T	1,16
FAISALABAD (LYALLPUR)	EM	SIEMENS	77	580TR	.60	TOLL	DP	FAISALABAD	T&T	1,16

TABLE III-2 (CONTINUED)

CIRCUIT SWITCH CAPABILITY

X CIVIL
___ MILITARY

X CURRENT
___ FUTURE

SWITCH	TYPE	MANUFACTURER	YEAR INSTALLED	CAPACITY	FILL	NETWORK FUNCTION	SIGNALLING	LOCATION	OPERATED BY	DATA SOURCE
HYDERABAD	EM	SIEMENS	77	200TR	.60	TOLL	DP	HYDERABAD	T&T	1,16
SAHIWAL	EM	SIEMENS	77	85TR	.60	TOLL	DP	SAHIWAL	T&T	1,16
LAHORE	EM	SIEMENS	77	560TR	.70	TOLL	DP	LAHORE	T&T	1,16
GUJRANWALA	EM	SIEMENS	77	190TR	.60	TOLL	DP	GUJRANWALA	T&T	1,16
MARDAN	EM	SIEMENS	77	55TR	.60	TOLL	DP	MARDAN	T&T	1,16
PESHAWAR	EM	SIEMENS	77	180TR	.60	TOLL	DP	PESHAWAR	T&T	1,16

TABLE III-2 (CONTINUED)
CIRCUIT SWITCH CAPABILITY

NATION: PAKISTAN
X CIVIL
___ MILITARY

X ___ CURRENT
___ FUTURE

SWITCH	TYPE	MANUFACTURER	YEAR INSTALLED	CAPACITY	FILL	NETWORK FUNCTION	SIGNALLING	LOCATION	OPERATED BY	DATA SOURCE
SARGODHA	EM	SIEMENS	77	90TR	.60	TOLL	DP	SARGODHA	T&T	1,16

c. Transmission Capability

Long haul transmission is through a microwave and cable network. These networks are a part of the CENTO and domestic ATN. The transmission capability of Pakistan is listed in Table III-3.

d. Record/Data Equipment

Some of the major cities of Pakistan have telex service. The demand for telex service is growing. Record and data equipment in Pakistan are listed in Table III-4.

e. International Gateways

The international gateways of Pakistan provide telephone, telegraphy and telex services. The international gateways of Pakistan are listed in Table III-5.

TABLE III-3

TRANSMISSION CAPABILITY

X CIVIL
____ MILITARY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
KARACHI TO TATTA	CABLE	FDM/FM	960CH	SIEMENS	TR	TATTA	T&T	KARACHI	1,8, 16
TATTA TO HYDERABAD	CABLE	FDM/FM	960CH	SIEMENS	TR	HYDERABAD	T&T	TATTA	1,8, 16
HYDERABAD TO NAWABSHAH	CABLE	FDM/FM	960CH	SIEMENS	TR	NAWABSHAH	T&T	HYDERABAD	1,8, 16
NAWABSHAH TO SUKKUR	CABLE	FDM/FM	960CH	SIEMENS	TR	SUKKUR	T&T	NAWABSHAH	1,8, 16
SUKKUR TO RAHIMYAR KHAN	CABLE	FDM/FM	960CH	SIEMENS	TR	RAHIMYAR KHAN	T&T	SUKKUR	1,8, 16
RAHIMYAR KHAN TO BAHAWALPUR	CABLE	FDM/FM	960CH	SIEMENS	TR	BAHAWALPUR	T&T	RAHIMYAR KHAN	1,8, 16

NATION: PAKISTAN

TABLE III-3 (CONTINUED)

X CIVIL

____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT

____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
BAHAWALPUR TO MULTAN	CABLE	FDM/FM	960CH	SIEMENS	TR	MULTAN	T&T	BAHAWALPUR	1,8, 16
MULTAN TO JHANG	CABLE	FDM/FM	960CH	SIEMENS	TR	JHANG	T&T	MULTAN	1,8, 16
JHANG TO SARGODHA	CABLE	FDM/FM	960CH	SIEMENS	TR	SARGODHA	T&T	JHANG	1,8, 16
SARGODHA TO SEKESAR	CABLE	FDM/FM	960CH	SIEMENS	TR	SEKESAR	T&T	SARGODHA	1,8, 16
SEKESAR TO MIANWAL	CABLE	FDM/FM	960CH	SIEMENS	TR	MIANWAL	T&T	SEKESAR	1,8, 16
MIANWAL TO RAWALPINDI	CABLE	FDM/FM	960CH	SIEMENS	TR	RAWALPINDI	T&T	MIANWAL	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
RAWALPINDI TO PESHAWAR	CABLE	FDM/FM	960CH	SIEMENS	TR	PESHAWAR	T&T	RAWALPINDI	1,8, 16
MULTAN TO SAHIWAL	CABLE	FDM/FM	960CH	SIEMENS	TR	SAHIWAL	T&T	MULTAN	1,8, 16
SAHIWAL TO ARIFWALA	CABLE	FDM/FM	960CH	SIEMENS	TR	ARIFWALA	T&T	SAHIWAL	1,8, 16
ARIFWALA TO CHISHTIAN MANDI	CABLE	FDM/FM	960CH	SIEMENS	TR	CHISHTIAN	T&T	ARIFWALA	1,8, 16
CHISHTIAN MANDI TO BAHAWALNAGER	CABLE	FDM/FM	960CH	SIEMENS	TR	BAHAWALNAGER	T&T	CHISTIAN MANDI	1,8, 16
SARGODHA TO BHALWAL	CABLE	FDM/FM	960CH	SIEMENS	TR	BHALWAL	T&T	SARGODHA	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
___ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
___ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
BHALWAL TO KHARIAN	CABLE	FDM/FM	960CH	SIEMENS	TR	KHARIAN	T&T	BHALWAL	1,8, 16
KHARIAN TO ISLAMABAD	CABLE	FDM/FM	960CH	SIEMENS	TR	ISLAMABAD	T&T	KHARIAN	1,8, 16
KHARIAN TO GUJRANWALA	CABLE	FDM/FM	960CH	SIEMENS	TR	GUJRANWALA	T&T	KHARIAN	1,8, 16
GUJRANWALA TO SIALKOT	CABLE	FDM/FM	960CH	SIEMENS	TR	SIALKOT	T&T	GUJRANWALA	1,8, 16
QUETTA TO MUSTUNG	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	MUSTUNG	T&T	QUETTA	1,8, 16
MUSTUNG TO NUSHKI	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	NUSHKI	T&T	MUSTUNG	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
NUSHKI TO DALBANDIN	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	DALBANDIN	T&T	NUSHKI	1,8, 16
DALBANDIN TO NOK KUNDI	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	NOK KUNDI	T&T	DALBANDIN	1,8, 16
KARACHI TO THANO BULA KHAN	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	THANO BULA KHAN	T&T	KARACHI	1,8, 16
THANO BULA KHAN TO DADU	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	DADU	T&T	THANO BULA KHAN	1,8, 16
DADU TO SHIKARPUR	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	SHIKARPUR	T&T	DADU	1,8, 16
SHIKARPUR TO ROJHAN	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	ROJHAN	T&T	SHIKARPUR	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
ROJHAN TO DERA GHAZI KHAN	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	DERA GHAZI KHAN	T&T	ROJHAN	1,8, 16
DERA GHAZI KHAN TO KOT ADDU	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	KOT ADDU	T&T	DERA GHAZI KHAN	1,8, 16
KOT ADDU TO LYALLPUR	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	LYALLPUR	T&T	KOT ADDU	1,8, 16
LYALLPUR TO LAHORE	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	LAHORE	T&T	LYALLPUR	1,8, 16
KOT ADDU TO DARYA KHAN	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	DARYA KHAN	T&T	KOT ADDU	1,8, 16
DARYA KHAN TO MIANWAL	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	MIANWAL	T&T	DARYA KHAN	1,8, 16

TABLE III-3 (CONTINUED)

TRANSMISSION CAPABILITY

X CIVIL
___ MILITARY

X CURRENT
___ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
MIANWAL TO RAWALPINDI	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	RAWALPINDI	T&T	MIANWAL	1,8, 16
LYALLPUR TO BHALWAL	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	BHALWAL	T&T	LYALLPUR	1,8, 16
BHALWAL TO ISLAMABAD	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	ISLAMABAD	T&T	BHALWAL	1,8, 16
KARACHI TO KOTRI	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	KOTRI	T&T	KARACHI	1,8, 16
KOTRI TO LARKANA	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	LARKANA	T&T	KOTRI	1,8, 16
LARKANA TO SIBI	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	SIBI	T&T	LARKANA	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
SIBI TO QUETTA	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	QUETTA	T&T	SIBI	1,8, 16
MUSTUNG TO SIBI	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	SIBI	T&T	MUSTUNG	1,8, 16
SIBI TO JACOBABAD	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	JACOBABAD	T&T	SIBI	1,8, 16
JACOBABAD TO SHIKARPUR	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	SHIKARPUR	T&T	JACOBABAD	1,8, 16
KOTRI TO THANO BULA KHAN	MW	FDM/FM	600CH & 1 TV CH	RCA	PTP	THANO BULA KHAN	T&T	KOTRI	1,8, 16
BADIN TO HYDERABAD	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	HYDERABAD	T&T	BADIN	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
HYDERABAD TO MIRPUR KHAS	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	MIRPUR KHAS	T&T	HYDERABAD	1,8, 16
KOT ADDU TO MULTAN	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	MULTAN	T&T	KOT ADDU	1,8, 16
PESHAWAR TO ISLAMABAD	MW	FDM/FM	960CH & 1 TV CH	SIEMENS	PTP	ISLAMABAD	T&T	PESHAWAR	1,8, 16
DARYA KHAN TO DERA ISMAIL KHAN	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	DERA ISMAIL KHAN	T&T	DARYA KHAN	1,8, 16
BHALWAL TO SARGODHA	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	SARGODHA	T&T	BHALWAL	1,8, 16
LAHORE TO GUJRANWALA	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	GUJRANWALA	T&T	LAHORE	1,8, 16

TABLE III-3 (CONTINUED)

X CIVIL
___ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
___ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
LYALLPUR TO SAHIWAL	MW	FDM/FM	960CH & 1 TV CH	NEC/ TOSHIBA	PTP	SAHIWAL	T&T	LYALLPUR	1,8, 16
KORANGI TO GOTH TAJM	MW	FDM/FM	24CH	ITT	PTP	GOTH TAJM	PARCO	KORANGI	7
GOTH TAJM TO GOTH USMAN	MW	FDM/FM	24CH	ITT	PTP	GOTH USMAN	PARCO	GOTH TAJM	7
GOTH USMAN TO MASIT DHORO	MW	FDM/FM	24CH	ITT	PTP	MASIT DHORO	PARCO	GOTH USMAN	7
MASIT DHORO TO BUBAK	MW	FDM/FM	24CH	ITT	PTP	BUBAK	PARCO	MASIT DHORO	7
BUBAK TO PHULJI	MW	FDM/FM	24CH	ITT	PTP	PHULJI	PARCO	BUBAK	7

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
PHULJI TO GOTH THARIRIM	MW	FDM/FM	24CH	ITT	PTP	GOTH THARIRIM	PARCO	PHULJI	7
GOTH THARIRIM TO LARKANA	MW	FDM/FM	24CH	ITT	PTP	LARKANA	PARCO	GOTH THARIRIM	7
LARKANA TO GARHI YASIN	MW	FDM/FM	24CH	ITT	PTP	GARHI YASIN	PARCO	LARKANA	7
GARHI YASIN TO SHIKARPUR	MW	FDM/FM	24CH	ITT	PTP	SHIKARPUR	PARCO	GARHI YASIN	7
SHIKARPUR TO KANDHKOT	MW	FDM/FM	24CH	ITT	PTP	KANDHKOT	PARCO	SHIKARPUR	7
KANDHKOT TO SHORI NALA	MW	FDM/FM	24CH	ITT	PTP	SHORI NALA	PARCO	KANDHKOT	7

TABLE III-3 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

X CURRENT
____ FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
SHORI NALA TO BANGLA HADAYAT	MW	FDM/FM	24CH	ITT	PTP	BANGLA HADYAT	PARCO	SHORI NALA	7
BANGLA HADAYAT TO FAZILPUR	MW	FDM/FM	24CH	ITT	PTP	FAZILPUR	PARCO	BANGLA HADAYAT	7
FAZILPUR TO TATARWALA	MW	FDM/FM	24CH	ITT	PTP	TATARWALA	PARCO	FAZILPUR	7
TATARWALA TO DERA GHAZI KHAN	MW	FDM/FM	MW	ITT	PTP	DERA GHAZI KHAN	PARCO	TATARWALA	7
DERA GHAZI KHAN TO GUJRAT	MW	FDM/FM	24CH	ITT	PTP	GUJRAT	PARCO	DERA GHAZI KHAN	7

TABLE III-4

RECORD/DATA EQUIPMENT CAPABILITY

X CIVIL
___ MILITARY

X CURRENT
___ FUTURE

SWITCH NODES	TECHNICAL TYPE	MANUFACTURER	YEAR INSTALLED	CAPACITY	LOCATION	OPERATED BY	STANDARD PROTOCOLS	DATA SOURCE
ISLAMABAD/ RAWALPINDI	TLX	SIEMENS-TIP	77	300LN	ISLAMABAD/ RAWALPINDI	T&T	CCITT ALPHABET #2 50 BAUD	4
LAHORE	TLX	SIEMENS-TIP	77	350LN	LAHORE	T&T	CCITT ALPHABET #2 50 BAUD	4
KARACHI	TLX	NEC NEDIX-510A	78	2,640LN	KARACHI	T&T	CCITT ALPHABET #2 50 BAUD	15
HYDERABAD	TLX	SIEMENS-TIP	77	50LN	HYDERABAD	T&T	CCITT ALPHABET #2 50 BAUD	4
QUETTA	TLX	SIEMENS-TIP	77	50LN	QUETTA	T&T	CCITT ALPHABET #2 50 BAUD	4
SUKKUR	TLX	SIEMENS TIP	77	50LN	SUKKUR	T&T	CCITT ALPHABET #2 50 BAUD	4

TABLE III-4 (CONTINUED)

X CIVIL
____ MILITARY

RECORD/DATA EQUIPMENT CAPABILITY

X CURRENT
____ FUTURE

SWITCH NODES	TECHNICAL TYPE	MANUFACTURER	YEAR INSTALLED	CAPACITY	LOCATION	OPERATED BY	STANDARD PROTOCOLS	DATA SOURCE
PESHAWAR	TLX	SIEMENS-TIP	77	50LN	PESHAWAR	T&T	CCITT ALPHABET #2 50 BAUD	4
MULTAN	TLX	SIEMENS-TIP	77	50LN	MULTAN	T&T	CCITT ALPHABET #2 50 BAUD	4
FAISALABAD (LYALLAPUR)	TLX	SIEMENS-TIP	77	50LN	FAISALABAD	T&T	CCITT ALPHABET #2 50 BAUD	4
GUJRANWALA	TLX	SIEMENS-TIP	79	50LN	GUJRANWALA	T&T	CCITT ALPHABET #2 50 BAUD	4
SIALKOT	TLX	SIEMENS-TIP	79	50LN	SIALKOT	T&T	CCITT ALPHABET #2 50 BAUD	4

TABLE III-5

GATEWAYS TO FOREIGN NETWORKS

X CIVIL
___ MILITARY

X CURRENT
___ FUTURE

GATEWAY	TYPE	CAPACITY	TRANSMISSION	OPERATED BY	LOCATION	CONNECTS TO	DATA SOURCE
GREEN HILL, RHODE ISLAND TO ST. HILLIARE, FRANCE	TRANSMISSION	13CH	CABLE	AT&T	GREEN HILL, RHODE ISLAND	ST. HILLIARE, FRANCE	8
GREEN HILL, RHODE ISLAND TO SAN FERNANDO, SPAIN	TRANSMISSION	3CH	CABLE	AT&T	GREEN HILL, RHODE ISLAND	SAN FERNANDO, SPAIN	8
ST. HILLIARE, FRANCE TO PLEUMEUR BODOU, FRANCE	TRANSMISSION	13 CH	CABLE	MOPT	ST. HILLIARE, FRANCE	PLEUMEUR BODOU, FRANCE	8
SAN FERNANDO, SPAIN TO BUITRAGO, SPAIN	TRANSMISSION	3CH	CABLE	CTNE	SAN FERNANDO, SPAIN	BUITRAGO, SPAIN	8
KARACHI TO DEH MANDRO	TRANSMISSION	16CH	CABLE	MOPT	KARACHI	DEH MANDRO	8
KARACHI TO BAHRAIN	TRANSMISSION	2CH	SATELLITE	MOC	KARACHI	BAHRAIN	8

TABLE III-5 (CONTINUED)

GATEWAYS TO FOREIGN NETWORKS

X CIVIL
___ MILITARY

X CURRENT
___ FUTURE

GATEWAY	TYPE	CAPACITY	TRANSMISSION	OPERATED BY	LOCATION	CONNECTS TO	DATA SOURCE
KARACHI TO LONDON	TRANSMISSION	4CH	SATELLITE	T&T	KARACHI	LONDON	8
KARACHI TO ROME	TRANSMISSION	1CH	SATELLITE	T&T	KARACHI	ROME	8
KARACHI TO KUWAIT	TRANSMISSION	1CH	SATELLITE	T&T	KARACHI	KUWAIT	8
KARACHI TO HONG KONG	TRANSMISSION	1CH	SATELLITE	T&T	KARACHI	HONG KONG	8
BUITRAGO, SPAIN TO INDIAN OCEAN REGION	TRANSMISSION	3CH	SATELLITE	CTNE	BUITRAGO, SPAIN	INDIAN OCEAN REGION	8
DEH MANDRO, PAKISTAN TO INDIAN OCEAN REGION	TRANSMISSION	16CH	SATELLITE	T&T	DEH MANDRO, PAKISTAN	INDIAN OCEAN REGION	8

TABLE III-5 (CONTINUED)

GATEWAYS TO FOREIGN NETWORKS

X CIVIL
___ MILITARY

X CURRENT
___ FUTURE

GATEWAY	TYPE	CAPACITY	TRANSMISSION	OPERATED BY	LOCATION	CONNECTS TO	DATA SOURCE
PLEUMEUR BODOU, FRANCE TO PACIFIC OCEAN REGION	TRANSMISSION	13CH	SATELLITE	T&T	PLEUMEUR BODOU, FRANCE	INDIAN OCEAN REGION	8
DALBANDIN, PAKISTAN TO ZAHEDAN, IRAN	TRANSMISSION	600CH	MW	T&T	DALBANDIN, PAKISTAN	ZAHEDAN, IRAN	1

CHAPTER IV
PLANNED IMPROVEMENTS

A. PROJECTED GROWTH

1. Economy

The Five-Year Plan (1978-1983) lays emphasis upon greater production of basic food stuffs. Included in the plan are improvements in the rural infrastructure, improved manpower to enable Pakistanis to work abroad, and a larger role in industry for the private sector.

2. Telecommunications

The T&T Department is faced with the challenges of rapidly growing demand, clearing of the backlog, and the rapid changes in technology development besides maintaining and operating the existing facilities efficiently. The T&T Department has been aware of these factors and has been planning, both in the short- and long-terms, various schemes to improve the situation.

Due to the limited availability of foreign exchange funds, financial constraints, and priorities imposed by the government, the T&T Department has curtailed the size of its development schemes. Planning for telecommunications is contained within the national Five-Year Plan (1978-1983). The Five-Year Plan has allocated the majority of funds to local telephones and the long-distance networks.

B. CIVILIAN NETWORKS

1. Telecommunications Development Plans

a. Public Telephone System

The estimated growth rate in demand of telephone service will average about 8 percent for the 1986-1990 time period. T&T plans to augment the long distance and subsidiary trunk routes capacity to cope with a 14 percent annual growth in traffic and to connect new places and remote areas in the Northwest Frontier and the Baluchistan, including the Mekran

Coast, through new microwave links. The planned microwave links are shown in Figure IV-1. This would increase the existing long distance channel capacity from 7,000 to over 12,000 channels. T&T will replace 9,000 telephone lines of old F-1 exchanges. The T&T has also expressed interest in setting up a third telecommunications equipment manufacturing plant.

Switching procurement requirements from 1986-1990 will be based around smaller switching systems. It is estimated that 180 switching facilities with up to 500 lines, 254 switching facilities with 1,000 to 3,000 lines, and 15 switching facilities with 3,000 to 10,000 lines will be needed.

By FY 1983, T&T envisages increasing the telephone connections up to 492,000. For this purpose, it would extend its exchange network and install another 300 exchanges making a total of 1,050 exchanges in the rural and urban areas. Moreover, T&T plans to ex and its Nation-Wide Dialing (NWD) system from its present coverage of 50 cities to 61 cities by FY 1983. The trunk traffic would, therefore, grow and is expected to be nearly 145 million calls in FY 1983. Extrapolations of statistical information indicate a doubling of the telephone density leading to 1 million telephones in use by 1990.

b. Telegraph, Telex, and Data Communications

Telex, at an early stage of development, shares the Gentex automatic exchanges together with a number of manual exchanges. T&T plans expansion of the telex facilities for some 3,200 additional subscribers and extension of telex and telegraph networks accordingly.

c. Satellite Communications and International Gateways

During the remaining period of the Fifth Plan (termed the midterm plan, 1981-1983), T&T is envisaging an increase in overseas communications through expansion of the existing satellite earth station (at Deh Mandro) channel capacity from 252 channels to 384 channels. The expansion of the international gateway exchange capacity is also planned accordingly. A second satellite earth station and a gateway exchange at Islamabad are planned to cater to future overseas traffic.

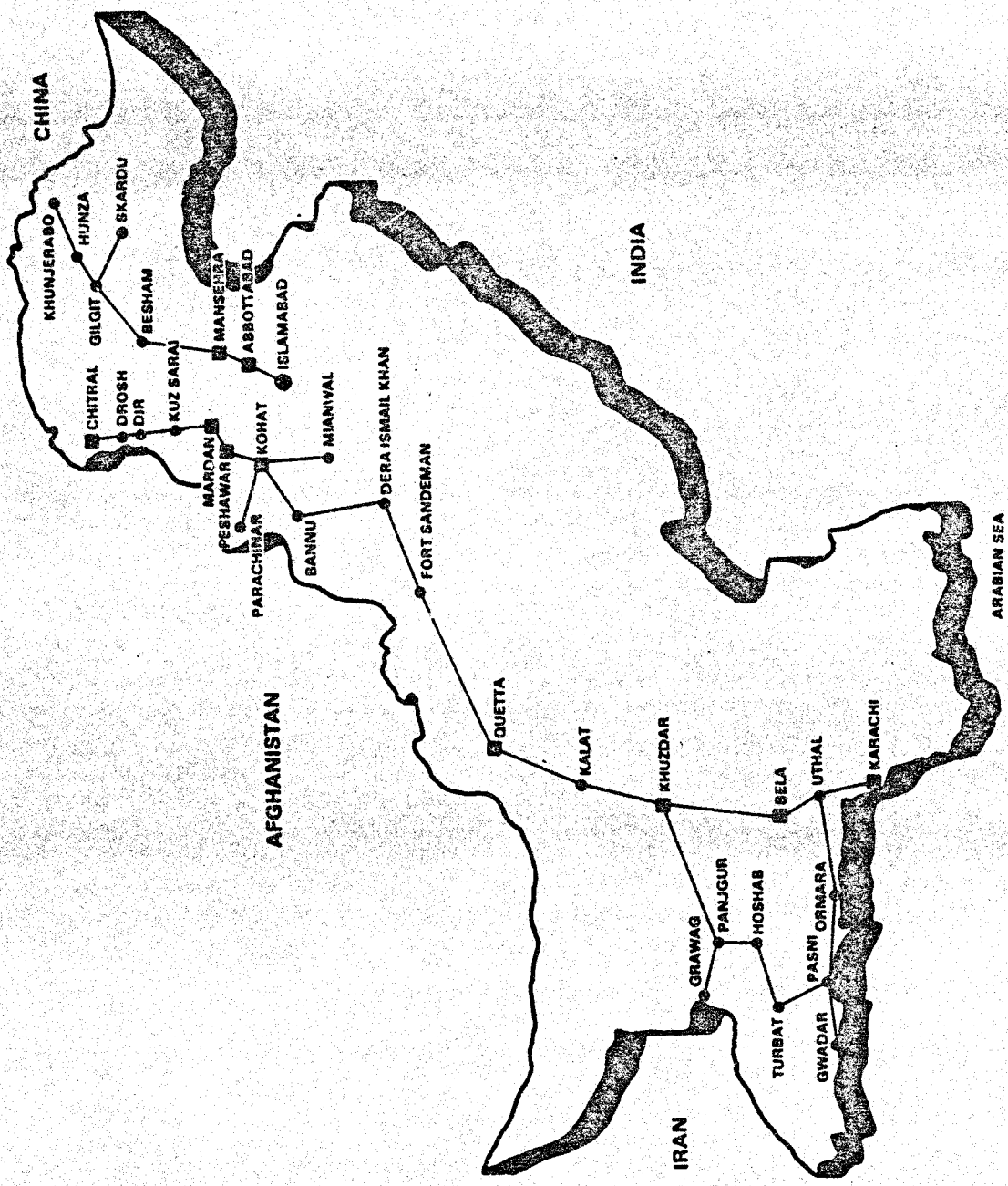


Figure IV-1. T&T Microwave Network (Planned Links)

Programs for telecommunications with nearby countries is forecasted. Pakistan will upgrade the microwave link between Pakistan and Iran. Another program is the transborder linkage on coaxial cable between Lahore and Amritsar for India-Pakistan telecommunications traffic as a part of the Asian Telecommunication Network. Figure IV-2 shows these future gateways.

Pakistan has taken the first steps towards eventual launching of a telecommunications satellite. The Pakistan Space and Upper Atmosphere Research Commission proposes the launching of a multipurpose national satellite at an altitude of 35,800 kilometers above the equator. According to the tentative schedule, the telecommunications satellite is to be launched in about 5 or 6 years, with the cooperation of either the US National Aeronautics and Space Administration (NASA) or the European Space Agency (ESA).

2. Datailed Listings

a. Remarks

In this section, detailed listings are provided which describe the future planned civilian communications assets discussed in the preceding sections. The abbreviations may be interpreted as previously defined in Chapter III.

b. Telephone Switches

There were no detailed data available on switches to be installed in Pakistan in the future time frame.

c. Transmission Capability

The future planned long haul trunks will be located in the Northwest Frontier and the Baluchistan. Table IV-1 lists the future planned transmission capability.

d. Record/Data Equipment Capability

Detailed future plans for the installation of additional record/data equipment were not available for this report.

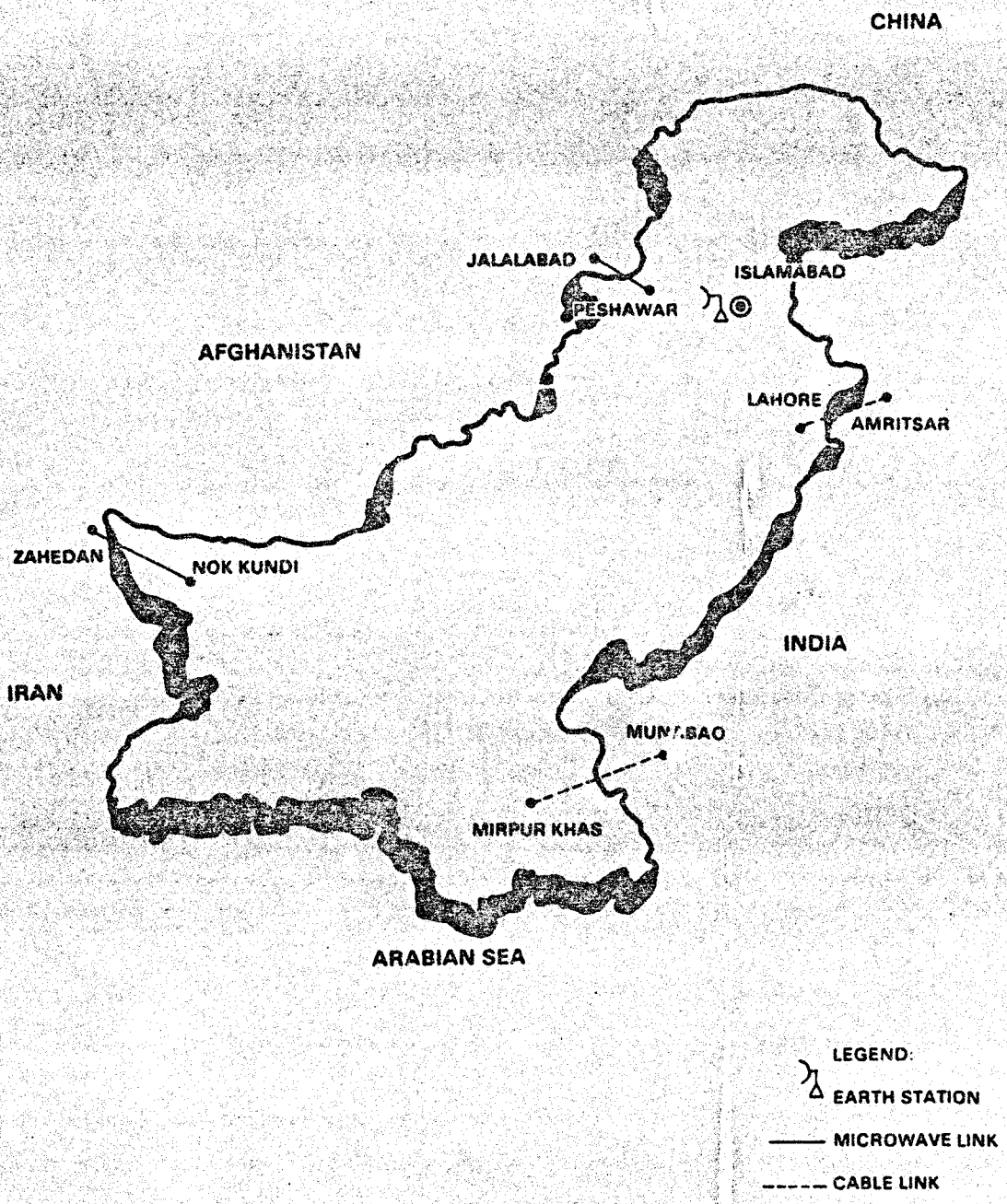


Figure IV-2. International Gateways to Pakistan (Future)

TABLE IV-1

TRANSMISSION CAPABILITY

X CIVIL
____ MILITARY

____ CURRENT
X FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
KARACHI TO UTHAL	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	UTHAL	T&T	KARACHI	1,8, 16
UTHAL TO BELA	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	BELA	T&T	UTHAL	1,8, 16
BELA TO KHUZDAR	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	KHUZDAR	T&T	BELA	1,8, 16
KHUZDAR TO KALAT	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	KALAT	T&T	KHUZDAR	1,8, 16
KALAT TO QUETTA	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	QUETTA	T&T	KALAT	1,8, 16
QUETTA TO FORT SANDEMAN	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	FORT SANDEMAN	T&T	QUETTA	1,8, 16

TABLE IV-1 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

____ CURRENT
X FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
FORT SANDEMAN TO DERA ISMAIL KHAN	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	DERA ISMAIL KHAN	T&T	FORT SANDEMAN	1,8, 16
DERA ISMAIL KHAN TO BANNU	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	BANNU	T&T	DERA ISMAIL	1,8, 16
BANNU TO KOHAT	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	KOHAT	T&T	BANNU	1,8, 16
KOHAT TO PESHAWAR	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	PESHAWAR	T&T	KOHAT	1,8, 16
PESHAWAR TO MARDAN	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	MARDAN	T&T	PESHAWAR	1,8, 16
MARDAN TO KUZ SARAI	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	KUZ SARAI	T&T	MARDAN	1,8, 16

TABLE IV-1 (CONTINUED)

TRANSMISSION CAPABILITY

X CIVIL
____ MILITARY

____ CURRENT
X FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
KUZ SARAI TO DIR	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	DIR	T&T	KUZ SARAI	1,8, 16
DIR TO DROSH	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	DROSH	T&T	DIR	1,8, 16
DROSH TO CHITRAL	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	CHITRAL	T&T	DROSH	1,8, 16
ISLAMABAD TO ABBOTTABAD	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	ABBOTTABAD	T&T	ISLAMABAD	1,8, 16
ABBOTTABAD TO MANSEHRA	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	MANSEHRA	T&T	ABBOTTABAD	1,8, 16
MANSEHRA TO BESHAM	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	BESHAM	T&T	MANSEHRA	1,8, 16

TABLE IV-1 (CONTINUED)

X CIVIL
____ MILITARY

TRANSMISSION CAPABILITY

____ CURRENT
X FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
BESHAM TO GILGIT	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	GILGIT	T&T	BESHAM	1,8, 16
GILGIT TO HUNZA	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	HUNZA	T&T	GILGIT	1,8, 16
HUNZA TO KHUNJERABO	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	KHUNJERABO	T&T	HUNZA	1,8, 16
UTHAL TO ORMARA	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	ORMARA	T&T	UTHAL	1,8, 16
ORMARA TO PASNI	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	PASNI	T&T	ORMARA	1,8, 16
PASNI TO GWADAR	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	GWADAR	T&T	PASNI	1,8, 16

TABLE IV-1 (CONTINUED)

X CIVIL
___ MILITARY

TRANSMISSION CAPABILITY

___ CURRENT
X FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
KHUZDAR TO PANJGUR	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	PANJGUR	T&T	KHUZDAR	1,8, 16
PANJGUR TO HOSHAB	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	HOSHAB	T&T	PANJGUR	1,8, 16
HOSHAB TO TURBAT	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	TURBAT	T&T	HOSHAB	1,8, 16
TURBAT TO PASNI	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	PASNI	T&T	TURBAT	1,8, 16
PANJGUR TO GRAWAG	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	GRAWAG	T&T	PANJGUR	1,8, 16
KOHAT TO PARACHINAR	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	PARACHINAR	T&T	KOHAT	1,8, 16

TABLE IV-1 (CONTINUED)

TRANSMISSION CAPABILITY

X CIVIL
___ MILITARY

___ CURRENT
X FUTURE

LINK	MODE	TECHNOLOGY	CAPACITY	MANUFACTURER	NETWORK FUNCTION	ROUTING	OPERATED BY	LOCATION	DATA SOURCE
KOHAT TO MIANWAL	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	MIANWAL	T&T	KOHAT	1,8, 16
GILGIT TO SKARDU	MW	FDM/FM	960CH & 1 TV CH	NEC	PTP	SKARDU	T&T	GILGIT	1,8, 16

e. International Gateways

International telecommunications of Pakistan are planned for expansion to nearby countries. Table IV-2 lists the future planned international gateways.

TABLE IV-2

GATEWAYS TO FOREIGN NETWORKS

____ CIVIL
____ MILITARY

_ _ _ CURRENT
_X_ FUTURE

GATEWAY	TYPE	CAPACITY	TRANSMISSION	OPERATED BY	LOCATION	CONNECTS TO	DATA SOURCE
MIRPUR KHAS TO MUNABAO, INDIA	TRANSMISSION	960CH	CABLE	T&T	MIRPUP KHAS	MUNABAO, INDIA	1,8, 16
LAHORE TO AMRITSAR, INDIA	TRANSMISSION	960CH	CABLE	T&T	LAHORE	AMRITSAR, INDIA	1,8, 16
PESHAWAR TO JALALABAD, AFGHANISTAN	TRANSMISSION	960CH	MW	T&T	PESHAWAR	JALALABAD, AFGHANISTAN	1,8, 16
NOK KUNDI TO ZAHEDAN, IRAN	TRANSMISSION	960CH	MW	T&T	NOK KUNDI	ZAHEDAN, IRAN	1,8, 16
ISLAMABAD TO INDIAN OCEAN REGION	TRANSMISSION		SATELLITE	T&T	ISLAMABAD	INDIAN OCEAN REGION	1,8, 16

CHAPTER V
NOTES AND REFERENCES

A. EQUIPMENT SUPPLIERS

1. Overview

The key to determining the impact upon interoperability of the Pakistan telecommunications development plans is to understand the history and trends of the major Pakistan equipment suppliers, both foreign and domestic. This information provides the technical and political insight required to formulate the interoperability assessment and recommendations.

Prior to 1965, most of the Pakistan telecommunications equipment used in the public sector was supplied by USA or UK companies. From then into the 1970s, the situation changed to one where companies from Europe, Japan, Canada, and the USSR gradually penetrated the market. Local industry is still comparatively young and a majority of telecommunications and broadcasting equipment requirements are imported each year. Most local industry uses imported components and parts in the assembly and manufacture of telephones, telex machines, exchanges, radio, and television products.

2. Domestic Suppliers

Telephones Industries of Pakistan (TIP) is a commercial company in which the government has a shareholding agreement with Siemens of West Germany, the other shareholder. TIP provides the main technical effort, finance, and management, with Siemens providing technical assistance when required and components not available to TIP. TIP manufactures and assembles electromechanical switching equipment for extensions to existing exchanges, new local exchanges, and for automatic transit switching centers. It also makes telephone sets and teleprinters.

Carrier Telephone Industries (CTI) is jointly owned by the government and Siemens, who provide technical assistance when required. Carrier Telephone Industries manufactures multiplex equipment and similar transmission equipment.

The equipment from the two factories is standardized and its import from other sources is prohibited.

3. Foreign Suppliers and Major Contracts

Table V-1 identifies some of Pakistan's major foreign suppliers of telecommunications equipment and the principal ranges of products supplied. Specific contracts associated with these suppliers are presented in Table V-2.

4. Summary

Internal stability has been precarious since independence in 1947, with no firmly defined sociopolitical patterns emerging and the situation has not really changed since the political volte-face of the 1977 military coup. Development planning has, however, recognized that efficient telecommunication and broadcasting services and systems are an essential part of a strong infrastructure. This approach has continued and is incorporated in the latest Development Plan for 1978-1983, which proposes further expansion and extension in all telecommunications and broadcasting areas. Of note is the firm intent to provide a domestic telecommunications manufacturing capability evident in the fact that nearly 90 percent of radio and television requirements are being met from locally produced equipment, often assembled from 50 percent locally manufactured components. Active involvement within the Asian Telecommunications Network has also positively encouraged expansion.

While the import of components produced locally is prohibited, the bulk of equipment has to be procured externally. Shortages of foreign exchange have long been a major limiting factor when acquiring such equipment. Tied bilateral trade and loan agreements have often been necessary and, as such, have predetermined supplier source. Today, the market, once dominated by US and U.K. companies, is spread across a wide spectrum which includes firms of the following countries which, in order of dominance, are West Germany, Japan, the United States, Canada, and the United Kingdom, with growing penetration from other companies in the Netherlands, France, Italy, and recently the U.S.S.R. The market for telecommunications imports is expected to grow while the pattern of suppliers is unlikely to change substantially in the medium term.

TABLE V-1. IDENTIFIED EQUIPMENT SUPPLIERS

COUNTRY & COMPANY	SWITCHING		TRANSMISSION			
	XCHS & NTKS	SETS & TERMS	L.O.S. & TROPO	VHF UHF HF Mobile	E/STNS & ANTEN	COAX & SUB CABLE
PAKISTAN						
CTI				X		X
NRTC			X	X		
TIP	X	X				
UNITED STATES						
FEC - ITT			X	X		
GTE INTL.			X			
MOTOROLA				X		
RCA CORP			X			
SOUTHCOM				X		
STONER				X		
CANADA						
MARCONI				X		
RCA - SPAR			X		X	
JAPAN						
NEC	X	X	X			
TOSHIBA			X			
EUROPEAN						
ELEKTRISK (LME)						
GEC - MARCONI				X		
PYE (PHILIPS)				X		
SIEMENS	X	X				X
SIT- SIEMENS			X			

TABLE V-2. MAJOR FOREIGN CONTRACTS

CONTRACTOR	EQUIPMENT SUPPLIED	CONTRACT PERIOD	CONTRACT $m
NEC (JAPAN)	• Int'l Tph. Exchange (Karachi) • Electronic Exchange (Lahore) • Local Tph. Switching Eqpt.	78-79	
NEC & TOSHIBA	• Microwave route (7 GHz, 960 CH) • Microwave route (960 CH)	70-73 73-75	1.4
SIEMENS (WEST GERMANY)	• Automatic telex switches (Karachi, Lahore, Rawalpindi) • Buried Coaxial Cable System	77-78 Mid-1970s	
GEC-MARCONI (UK)	• VHF & HF Systems	Late 1960s	
SIT-SIEMENS (ITALY)	• Microwave link (960 CH)	74-75	
FEDERAL ELECTRIC CORP (ITT) (US)	• Monitor and control network for PAK-ARAB refinery • Microwave, UHF, and mobile radio links	78-81	10.0
GTE-INTERNATIONAL	• Microwave link (narrow band)	Early 1970s	
RCA (CANADA)	• Microwave route (600 CH) • Satellite Earth Stn., 30m diam. antenna	75-76 70-74	10.0
MARCONI-CANADA LTD.	• Microwave, 2GHz PCM system along pipeline in lower Indus Valley (24-120 CH)	76-77	
RCA CORP (USA)	• CENTO Microwave route through Baluchistan (600 CH)	Mid-1960s	

B. BACKGROUND INFORMATION ON US GOVERNMENT COMMUNICATIONS SYSTEMS

1. Army Tactical Communications System (ATACS)

The Army Tactical Multichannel Communications System is an integrated system of communications equipment providing secure and non-secure high quality transmission paths, circuit and message switching, the means to terminate these circuits and paths, and the means to control the system at the nodal level.

The transmission systems for Echelons Above Corps (EAC) consist of multichannel and single channel capabilities. Both systems operate at line-of-sight (LOS), over cable, and beyond line-of-sight. Tandeming capability is provided with radio relay for LOS, and with unattended/attended repeaters for cable. ATACS uses a combination of analog and digital transmission. However, new equipment being installed is almost exclusively digital.

There are two automatic circuit switches in ATACS which are interim solutions to the more advanced TRI-TAC hardware, and these switches have replaced the older manual types (also found in ATACS). The AN/TTC-38 switch serves a large area or command node at Echelons Above Division (EAD) to include Echelons Above Corps (EAC), while the SB-3614 is a unit level switch which can be employed at any echelon.

All signalling within the AN/TTC-38 is performed using dual tone multifrequency (DTMF) tones for military locals and trunks. In addition, it also has the capability for single frequency (SF) signalling to commercial trunks. Supervisory signals are single frequency (SF) tones for off-hook and on-hook conditions to telephones operating on local battery and DC supervisory signals are used for telephones operating on common battery (using the AN/TTC-38 battery as a power source). Trunking supervision is DTMF for military switchboards and DC closure for commercial switchboards. Telephone signal converters are used to interface with the older ringdown switchboards and special trunks are available in the AN/TTC-38 to provide this capability.

Since 1980, ATACS equipment has been in the process of being modified and upgraded. In some cases this includes additional components

only, while in others it includes new assemblages. The most critical of the improved ATACS components are the multiplexer and combiners, the TD-1065, TD-1069, TD-976, and TD-992. These items will allow integration of the various TRI-TAC equipment with the ATACS family.

2. TRI-TAC Digital Telecommunications Program

In 1971, the DoD established the Joint Tactical Communication Office to design and implement a tri-service tactical communication system (TRI-TAC) of the future. The TRI-TAC system is designed to replace or make efficient use of existing ATACS analog equipment inventory, as well as to utilize the rapidly improving digital technology. The TRI-TAC Charter sets down three major objectives, as follows:

(1) To place, in a timely fashion, new tactical equipment reflecting the most effective technology in the field to support the Armed Forces in the performance of their missions;

(2) To achieve the necessary degree of interoperability among tactical communications systems and other DoD telecommunications systems (i.e., DCS); and

(3) To eliminate duplication, when feasible, in the development of military service equipment.

TRI-TAC will evolve in a step-by-step fashion from a combined analog/digital system to a completely automated digital system, with all analog equipment phased out by 1992. Its primary functions will include trunking, access control, switching, and communications security (COMSEC). Switching and system control interfaces will be provided to the current tactical Army System (ATACS), to the DCS (AUTOVON and AUTODIN), and to NATO subscribers.

The TRI-TAC transmission facilities consist of: (1) line-of-sight (LOS) multichannel radio systems, (2) digital tropospheric scatter multichannel radio systems, (3) digital group multiplexer systems, (4) demand-assigned time division multiple access (DA/TDMA) tactical satellite SHF and UHF systems, (5) mobile subscriber access (MSA) systems, and (6) communications security (COMSEC) equipment. Equipment used in the LOS

multichannel radio systems include the AN/GRC-144 radio set which operates in the 4.4 to 5 GHz and 14.4 to 15 GHz ranges, and the AN/GRC-103 radio set, which operates in the 220 to 1850 MHz range. All of the digital troposcatter radio sets will utilize time division multiplexing (TDM) with a switch-selectable channel capacity of 64, 48, 32, or 16 channels of 32 kbps each. In addition, each set will be designed to operate in the 4.4 to 5.0 GHz band.

The family of tactical circuit and message switches (AN/TCC-39 and AN/TYC-39, respectively) will provide service for analog, digital, and secure voice, data and facsimile subscribers. The hybrid AN/TTC-39 circuit switches handle analog and digital voice, as well as data communications. Signalling is common-channel, both in-band and out-of-band. For analog loops and trunks, supervisory signals include 2600 Hz single frequency (SF), DC, and controlled E&M; other signalling used includes DTMF, manual, dial pulse, and multi-frequency (MF). Features of the AN/TTC-39 include conferencing, precedence/preemption, and call intercept. The AN/TYC-39 message switch employs in-band signalling and supervision and has a store and forward capability. In addition, it has an automatic interface to AUTODIN. All versions of the circuit and message switches are modular in design and can handle a capacity from 300 to 2400 lines for the circuit switch, and 25 to 50 lines for the message switch. Switching, routing, and processing of calls and record traffic are under computer control. The hybrid circuit switch has been designed to provide for both analog and digital service during the transition to the all-digital objective system.

3. Defense Communications System (DCS)

The DCS is the worldwide complex comprising all United States Government long-haul point-to-point communications facilities, associated personnel, and material within the Department of Defense (DoD). It is primarily a long-haul, general purpose system of government-owned and leased transmission media, relay stations, and switching centers. The composite DCS is a very extensive and complex system located in 70

countries throughout the world. The DCS comprises three major networks: AUTOVON, AUTOSEVOCOM, and AUTODIN.

a. Automatic Voice Network (AUTOVON)

AUTOVON, as part of the DCS, is a worldwide automatic switched voice network for the DoD and other authorized agencies. The Continental United States (CONUS), Hawaiian, and Canadian portions of the network are leased, with switches and transmission facilities provided by commercial carriers. The overseas portion of the network consists of Government-owned switching centers and transmission facilities supplemented by leased transmission facilities. Transoceanic trunks are leased between the CONUS and overseas area gateway switches. They provide the requisite connectivity for the worldwide network. In addition to providing subscribers with nonsecure voice grade switching service, AUTOVON can provide access lines and switching for the primary use of other DCS networks for restoral purposes. The combination of all AUTOVON switches and their supporting transmission facilities coupled with varied four-wire subscriber instrument configurations and Private Branch Exchange and Private Automatic Branch Exchange (PBX and PABX) services, both leased and Government-owned, and their supporting transmission facilities, is designed to provide the media with real-time voice and alternate voice and data switching service for validated subscriber requirements.

Although fully compatible, the CONUS and overseas segments of AUTOVON have slightly different operating characteristics. This is due basically to differences in equipment and routing logic. The CONUS segment of the worldwide network is leased from commercial carriers and includes that portion of the network within the 48 contiguous states plus Canada. The overseas portion, with minor exceptions, uses government-owned facilities and includes the network outside the 48 contiguous states in the European, Pacific, and Caribbean areas. Both the CONUS and overseas segments are designed to provide the same service features. The transmission media interconnecting the switching centers include transoceanic and landline cables, microwave radio, tropospheric scatter systems, and communications satellite links.

The CONUS AUTOVON comprises approximately 45 to 61 switching centers, each containing a modified CCITT Number 5 crossbar switching machine, an ESS-1 or modified Automatic Electric switch that is widely used in the telephone industry. These switching machines function like their commercial counterparts but with added features designed to meet the needs of DoD.

b. Automatic Secure Voice Communications (AUTOSEVOCOM)

AUTOSEVOCOM is a secure voice subsystem of the Defense Communications System serving approximately 1400 subscribers throughout the world. The AUTOSEVOCOM system consists of Wideband Subscriber Terminals (WBST), Narrowband Subscriber Terminals (NBST), and specialized AUTOSEVOCOM switches. WBSTs operate at 50 Kbps. Due to the high bit rate, WBSTs are grouped in close geographical proximity within communities of interest and are terminated by wideband (WB) circuits to the serving AUTOSEVOCOM switch. NBSTs provide secure voice service to isolated subscribers which cannot be economically connected to an AUTOSEVOCOM switch on a WB basis. These terminals operate at a slower bit rate (2400 or 9600 bps) and are connected to AUTOVON, or other 4-wire switches by narrowband (NB) DCS transmission facilities.

AUTOSEVOCOM switches are interconnected by AUTOVON, dedicated narrowband (NB) circuits and dedicated wideband (WB) circuits. All NBSTs and AUTOSEVOCOM switches have NB connectivity directly or indirectly to AUTOVON. Where direct access to AUTOVON is not available, connectivity is derived from other existing NB DCS transmission facilities. WBST access to the worldwide NB AUTOVON media always requires operator assistance and WB-to-NB conversion. WB-to-NB conversion is performed at the AUTOSEVOCOM switches by a Narrowband Trunking Unit which converts the 50 Kbps WBST signal to a 2400 or 9600 bps signal suitable for transmission over the NB networks. This conversion reduces the high quality speech of intra-switch WB calls to the lower quality artificial/reconstructed speech typical of lower bit rates.

Eventually, the existing AUTOSEVOCOM Network will be replaced by a more modern system. It is anticipated that the existing system will continue in operation until at least 1985.

c. Automatic Digital Network (AUTODIN)

AUTODIN is the switched data network of the Defense Communications Agency-managed Defense Communications System, providing secure worldwide communications for the DoD and other federal agencies. There are a total of 18 AUTODIN Switching Centers (ASCs) worldwide, 9 in the CONUS and 9 overseas. The 9 ASCs in the CONUS are nominally managed, on-site, by the military departments, with the ASC and certain related services leased from the domestic communications industry. Interconnecting CONUS ASC communications trunks are all leased from common carriers. The 8 overseas ASCs are managed and operated by the military departments.

The AUTODIN consists of all AUTODIN switching centers (ASC) and terminal stations connected thereto. This secure, fully automatic switching network is designed, engineered, and programmed to provide continuous operation, minimum loss of service, and no loss of traffic. AUTODIN accepts and delivers traffic in a variety of modes: teletypewriter punched cards, magnetic and paper tape, and some classes of computer-to-computer traffic. Transmission rates vary, according to subscriber needs, from 45 to 4800 baud.

C. INTERNATIONAL STANDARDIZATION

It is desirable that one communication system be able to communicate with another, and so standardization of signalling procedures is necessary. Standardization exists within countries; however, many different incompatible signalling systems exist in different countries. The Consultative Committee on International Telegraphy and Telephony (CCITT) has standardized a number of signalling systems for general use in international automatic and semi-automatic switching networks. These are designated by serial numbers 3, 4, 5, 6, and 7. For this report, systems No. 5 and 6 are of special interest. System No. 5 is the international in-band system for two-way operation. It uses two frequencies, 2400 Hz and 2600 Hz, for link-by-link supervision; and two-out-of-six frequencies (700, 900, 1100, 1300, 1500, and 1700 Hz) for addressing. System No. 6 is the international system designed for digital two-way signalling over a common channel. The digital signals may be transmitted over a quasi-analog channel at 2400 b/s or over digital channels derived from the Pulse Code Modulation (PCM) multiplexer at 4 kb/s. The North American Common Channel Interoffice Signalling (CCIS) system is similar to System No. 6. The differences noted are largely due to the fact that the System No. 6 was developed for use internationally, whereas CCIS is being implemented for domestic use in the US on toll networks.

D. PULSE CODE MODULATION (PCM)

Although PCM was conceived and patented in the 1930's, the first commercial systems were not installed until the 1960's. PCM is the representation of a speech signal, or other analog signal, by sampling at a regular rate and converting each sample to a binary number. In analog modulation (FDM/FM), the modulated parameter varies continuously and can take on any value corresponding to the range of the message. When the modulated wave is affected by noise, there is no way for the receiver to discern the exact transmitted value. The advantage of PCM is that only a few discrete values are allowed in the modulated parameter. If the separation between these values is large compared to the noise perturbations, it is a simple matter to decide at the receiver precisely which specific value was intended. Thus the effects of random noise can be virtually eliminated.

In determining interoperability, it is important to know which type of PCM is being used or considered in the foreign nation. In this study, three standards of PCM are applicable--North American, European and Japanese. Table V-3 presents the technical parameters of the three international PCM standards. Though North American and Japanese PCM are identical at the first level shown in the table (and also at the second level), their characteristics diverge at the third level and above.

TABLE V-3. INTERNATIONAL PCM STANDARDS

	NORTH AMERICAN	JAPANESE	EUROPEAN
[1st ORDER] (PCM-1)			
BIT RATE	1544 Kbps	1544 Kbps	2048 Kbps
NO. OF BITS/CH. TIME SLOT	8	8	8
NO. OF CH TIME SLOTS/FRAME	24 (1 to 24)	24 (1 to 24)	32 (0 to 31)
NO. OF BITS/FR	193	193	256
FRAME REPETITION RATE	8000	8000	8000
FRAMING	BIT-ORIENTED	BIT-ORIENTED	CHANNEL ORIENTED
CH. TIME-SLOT ASSIGNMENT	24 CH (1 to 24)	24 CH (1 to 24)	30 CH (1 to 15, 17 to 31)
SIGNALLING	CCS (4 Kbps)	CCS (4 Kbps)	SEPARATE CHANNELS (0 and 16)
CHANNEL CAPACITY	64 Kb	64 Kb	64 Kb
VOICE QUALITY	8 BITS/5 FRAMES 7 BITS/6th FR	8 BITS/5 FRAMES 7 BITS/6th FR	8 BITS/ALL FRAMES
TRANSMISSION MODE	BIPOLAR	BIPOLAR	BIPOLAR

TABLE V-3. INTERNATIONAL PCM STANDARDS (continued)

	NORTH AMERICAN	JAPANESE	EUROPEAN
[2nd ORDER] (PCM-2)	6312 Kbps (96 CH)	6312 Kbps (96 CH) - - - - - - - - ALSO 7876 Kbps (120 CH)	8448 Kbps (120 CH)
[3rd ORDER] (PCM-3)	44736 Kbps (672 CH)	32064 Kbps (480 CH)	34368 Kbps (480 CH)
[4th ORDER] (PCM-4)	274176 Kbps (4032 CH)	97728 Kbps (1440 CH)	139264 Kbps (1920 CH)
[5th ORDER] (PCM-5)		397200 Kbps (5760 CH)	

E. DEFINITION OF ATTRIBUTES

Provided below are short definitions of some of the communications systems attributes used in Table I-1. Understanding these attributes and how they were interpreted is critical in the evaluation of Table I-1 and the assessment of interoperability.

CCIS — Common Channel Interoffice Signalling is a technique by which the signalling information for a group of trunks is transmitted between switching offices over a separate voice channel using time-division methods..

DP — Dial Pulse or Pulsing is a method of transmitting a telephone address by the momentary opening and closing of a dc circuit a specified number of times, corresponding to the decimal digit which is dialed. This is usually accomplished by the manual operation of a finger wheel or phone dial.

DTMF — Dual Tone Multifrequency Signaling. A method of signalling in which a combination of two frequencies, each from a group of four, are used to transmit numerical address information. The two groups of four frequencies are 697 Hz, 770 Hz, 852 Hz, 941 Hz, and 1209 Hz, 1336 Hz, 1477 Hz, and 1633 Hz.

FDM — Frequency-Division Multiplex is a multiplex system in which the available transmission frequency range is divided into narrower bands, each used for a separate channel.

FULL DUPLEX — Refers to a communications system or equipment capable of transmission simultaneously in two directions.

HALF DUPLEX — A communications system in which information can be transmitted in either direction but only in direction at a time.

IN-BAND SIGNALLING	The transmission of signalling information via tones at some frequency or frequencies that lie within a carrier channel normally used for voice transmission.
MESSAGE SWITCHING	The technique of receiving a message, storing it until the proper outgoing line is available, and then retransmitting. No direct connection between the incoming and outgoing lines is set up.
MF SIGNALLING	Multifrequency signalling or pulsing a method of transmitting address information and other signals for controlling the telephone network. The identity of each of ten possible digits (0 to 9) plus the required supervisory functions is determined by a combination of two out of six possible frequencies.
OUT-OF-BAND SIGNALLING	A method of signalling which uses a frequency that is within the passband of the transmission facility, but outside of a carrier channal normally used for voice transmission.
PACKET SWITCHING	The transmission of data by means of addressed packets whereby a transmission channel is occupied for the duration of transmission of the packet only. The channel is then available for use by packets being transferred between different data terminal equipment. The data may be formatted into packet or divided and then formatted into a number of packets for transmission and multiplexing.
PCM	Pulse Code Modulation is the representation of an analog signal (speech) by sampling at a regular rate and converting each sample to a binary number. See Chapter V, Section D.

TDM

Time Division Multiplexing is a means of obtaining a number of channels over a single path by time-dividing the path into a number of time slots and assigning each channel its own intermittently-repeated time slot. At the receiving end, each time-separated channel is reassembled. The system is ideally suited for the transmission of digital data, and is now used for digitized speech and other signals.

F. GLOSSARY OF ACRONYMS

A

ANTEN	Antenna (e)
ATACS	Army Tactical Communications System
ATN	Asian Telecommunications Network
AUTODIN	Automatic Digital Network
AUTOSEVOCOM	Automatic Secure Voice Communications
AUTOVON	Automatic Voice Network

B

bps	Bits per second

C

CCIR	Consultative Committee on International Radio
CCIS	Common-Channel Interoffice Signalling
CCITT	Consultative Committee on International Telegraphy and Telephony
CENTO	Central Treaty Organization
CH	Channel (s)
CKTS	Circuits
CO	Central Office
COAX	Coaxial Cable
CONUS	Continental United States
CTI	Carrier Telephone Industries

D

DCS	Defense Communications System
DDD	Direct Distance Dialing
DOD	Department of Defense
DP	Dial Pulse
DTMF	Dual-Tone Multifrequency Signalling

E

E/STN	Earth Station
EM	Electromechanical (Switching)
ESA	European Space Agency
ESS	Electronic Switching System

F

FDM	Frequency Division Multiplex
FM	Frequency Modulation

G

GHz	Gigahertz
GNP	Gross National Product
GTE	General Telephone and Electronics

I

IBRD	International Bank for Reconstruction and Development
INTELSAT	International Telecommunications Satellite Consortium
IOR	Indian Ocean Region
ITT	International Telephone and Telegraph Corporation
ITU	International Telecommunications Union

K

km	Kilometer

L

LEO	Local End Office
LL	Leased Line
LNS	Lines
LOS	Line-of-Sight

M

MCC	Master Control Center
MHz	Megahertz
MOC	Ministry of Communications
MW	Microwave

N

NASA	National Aeronautics and Space Administration
NEC	Nippon Electric Company (Japan)
NTK	Network
NWD	Nation-Wide Dialing

P

PABX	Private Automatic Branch Exchange
PARCO	Pak-Arab Refinery, Ltd.
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
POR	Pacific Ocean Region
PR	Pair
PRI	Primary
PTP	Point-to-Point

R

REG	Regional

S

SAT	Satellite
SGTC	Sui Gas Transmission Company
SPC	Stored Program Control
STD	Subscriber Trunk Dialing
SUB	Submarine
SXS	Step-by-Step

T

T&T	Telegraph and Telephone Department
TDM	Time-Division Multiplex
TERM	Terminal
TIP	Telephone Industries of Pakistan
TLX	Telex
TR	Trunk
TRI-TAC	Tri-Service Tactical Communications
TROPO	Tropospheric Scatter Microwave
TTY	Teletypewriter Equipment

U

UHF	Ultra High Frequency (300 MHz to 3 GHz)
UK	United Kingdom
UN	United Nations

V

VF	Voice Frequency
VHF	Very High Frequency (30 MHz to 300 MHz)

W

WAPDA	Water and Power Development Authority
WECO	Western Electric Company

X

XBAR	Crossbar (Switching)
XCH	Exchange

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