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# U.S. TELECOMMUNICATIONS TEAM REPORT ON NOVEMBER 1986 VISIT TO CHINA: FIRST IMPLEMENTATION PHASE OF U.S. - CHINA PROTOCOL ON COOPERATION IN THE FIELD OF TELECOMMUNICATIONS

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## PREFACE

A United States team of technical telecommunications experts, composed of Department of Commerce representatives from the National Telecommunications and Information Administration (NTIA) and private sector representatives from the telecommunications industry, visited the People's Republic of China (PRC) from November 1 to November 19, 1986. The U.S. visit, led by Alfred C. Sikes, Assistant Secretary of Commerce for Communications and Information, provided the first major international exchange of telecommunications information that has occurred following the signing of a U.S. - China Protocol on Cooperation in the Field of Telecommunications on May 16, 1986.

The report on the group's findings which follows is entitled "U.S. Telecommunications Team Report on November, 1986, Visit to China: First Implementation Phase of U.S. - China Protocol on Cooperation in the Field of Telecommunications." Containing an Executive Summary and six chapters, the report presents recommendations for the Chinese Ministry of Posts and Telecommunications (MPT) to consider in developing strategies for the implementation of a major telecommunications expansion and improvement program. In addition, the report reviews areas of possible future technical cooperation under the terms of the Protocol.

The U.S. team members are grateful for the cooperation and assistance of the MPT officials, who arranged for the series of meetings and visits that took place in Beijing, Chengdu, Shanghai, Guangzhou, and Shenzhen. Particular thanks go to Minister of Posts and Telecommunications Yang Taifang and Vice Minister Zhu Gaofeng, who officially welcomed the team and made the mission possible. The level of assistance provided to the team by the MPT officials and the provincial administrations was outstanding, and all members of the team were impressed by the warm hospitality and unflagging cooperation of the Chinese government officials with whom we worked. In addition, we extend our warm appreciation to Mr. Yun Jin and Madame Tan Xiuqing of the Department of Science and Technology, who helped make the mission a success, and to Mr. Guo Fenglin, who patiently escorted the team throughout the visit.

The team would also like to thank the personnel of the U.S. Embassy in Beijing and those who were helpful at various consulates, acknowledging in particular Mr. Ned Quistorff's enthusiastic and untiring efforts on our behalf. The fine efforts of many others with whom the team worked closely are very much appreciated. A complete list of those who assisted the U.S. team efforts is contained in Appendix B. In conclusion, Helen Shaw's excellent work in editing this report under difficult circumstances is gratefully acknowledged.

Eric M. Glasscott

# INTRODUCTION

The U.S. Telecommunications Team Report analyzes information received from firsthand observation and from discussions with representatives of the PRC's Ministry of Posts and Telecommunications (MPT) and related telecommunications organizations during the U.S. team's November, 1986, visit to China. The report reviews the data acquired during the visit, and makes recommendations in specific areas to achieve the stated PRC objectives during the seventh Five Year Plan (1986 to 1990), and for the longer term. Rather than addressing all of the activities taking place within the PRC structure, the report places emphasis on the parts of the telecommunications system which require strengthening. It is not intended to provide a comprehensive assessment of total telecommunications operations.

Following the Executive Summary in Part One, Part Two contains six chapters which focus on the U.S. team's specific findings. Chapter One delineates the MPT's organization and responsibilities, followed by a brief description of the existing telecommunications system in Chapter Two. Chapter Three addresses rates and tariffs, with Chapter Four focusing on financing. Chapter Five outlines the planning and development strategy for the seventh Five Year Plan, and Chapter Six details research and development activities.

In summary, the U.S. team found that the MPT and its related organizations are upgrading and expanding China's domestic public telecommunications network in an impressive manner, despite competition among claims for national resources. Within the PRC's modernization plans, several areas have been identified for which selective changes should prove beneficial. Part Three presents the team's observations and recommendations for institutional and operational improvements and future areas of technical cooperation under the terms of the U.S. - China Protocol on Cooperation in the Field of Telecommunications. Appendices follow the report in Part Four.

# PART ONE

## EXECUTIVE SUMMARY

# PART ONE

## EXECUTIVE SUMMARY

### I. Background

The changing political and economic environment in the People's Republic of China (PRC) places increasing demands on the existing telecommunications infrastructure, and the Chinese government recognizes that expansion and improvement of all telecommunications services are essential for the development of a strong national economy. Telecommunications sector improvement has, therefore, become an important national goal, which is directed toward the provision of modern, reliable services to support both government and commercial interests.

As part of the effort to assist in this expansion, the Ministry of Posts and Telecommunications (MPT) entered into a mutual cooperation agreement in telecommunications sciences with the National Telecommunications and Information Administration of the United States Department of Commerce on May 16, 1986. The first major activity following the signing of the U.S. - China Protocol on Cooperation in the Field of Telecommunications was a joint U.S. Government/industry mission to the People's Republic of China in November, 1986, to assess and analyze the existing telecommunications system and services. The mission consisted of a multi-disciplinary field team of U.S. Government and private sector representatives from the telecommunications industry, whose task was to provide expertise in the management of all activities involved in the operation of urban and rural telecommunications administrations.

#### U.S. Team Members

The team was led by Alfred Sikes, Assistant Secretary of Commerce for Communications and Information. Other U.S. Government team members were Richard Parlow, Associate Administrator for Spectrum Management, National Telecommunications and Information Administration (NTIA); Harold Kimball, Chief Scientist, NTIA; Charles Hutchison, Program Manager, NTIA; and Eric Glasscott, Senior Technical Advisor, NTIA, who functioned as the industry team leader.

The U.S. industry participants were senior engineers and managers from U.S. telecommunications companies. They were Gerald Breed, Bell South International; Robert Chen, AT& T; Daniel DiFonzo, Comsat Corporation; Bernard Hill, Hawaiian Telephone Co./GTE; Michael Kennedy, Motorola, Inc.; Walter Kirk, Pacific Telesis International; Norman Lerner, Transcomm

Inc.; and Robert Ryan, United Technologies/Essex. The areas of expertise represented included planning; switching and data networks; transmission and outside plant networks; rates, tariffs, and revenue requirements; land mobile radio systems; and satellite communications.

Itinerary and Agenda

The team spent almost three weeks in China, and visited Beijing, Chengdu, Shanghai, Guanzhou, and Shenzhen. Numerous discussions were held on the status and development of telecommunications. The team visited several switching centers, a cable factory, a crossbar switching factory, and Jiaotong University. Although the time was insufficient for an in-depth study of all aspects of the system, an excellent understanding of the network and its operation was obtained from the open discussions and cooperative role of the host administrations in the cities visited.

The paper which follows is entitled "U.S Telecommunications Team Report on November, 1986, Visit to China: First Implementation Phase of U.S. - China Protocol on Cooperation in the Field of Telecommunications," and presents the team's findings. In addition, the report offers recommendations for strengthening the telecommunications system, and provides suggestions for future areas of technical cooperation under the Protocol.

## II. Summary of Findings

### Overview

In China at the end of 1985, approximately 6.2 million telephones were in service, connected primarily to electro-mechanical switching systems of varying types and ages, some of which are over fifty years old. Although the telecommunications network is well maintained, it is twenty to thirty years behind current technology, seriously overloaded, and unable to meet the demands placed upon it by both the public and private sectors of the economy.

Serious congestion exists in both the local and toll service; in some cities the local call completion rates are less than forty percent of the calls placed, and delays occur in more than twenty-five percent of toll calls. Telephones average six telephones per thousand people ( 0.6 telephones per 100 people) of the population, and in the major cities of Beijing and Shanghai the averages are 7.2 and 4.4 telephones per one hundred people. Rural areas have either antiquated telephone service or no public telecommunications.

The absence of significant capital expenditures and development programs in the past has created shortages of facilities of all types throughout the network, predictably producing high calling rates, low completion rates and congestion. To modernize the network will require the concerted effort of the central government, the MPT, and the entire telecommunication sector. In order to meet the stated objective of attaining parity with the developed world in technology and quality of service within the next fifty years, allocation of finances for communications must be given priority, and direction and dedication must be maintained.

An ambitious expansion program is underway, which is intended to relieve the overloaded condition of the network by rapidly increasing the number of telephones in service to 12.5 million by 1990, and to 33.6 million in the year 2000. This rate of growth will increase the telephone distribution from 0.6 to 2.8 per one hundred people.

Development Program in the PRC

According to the PRC's objectives in the seventh Five Year Plan for 1986 to 1990, expansion will follow the economic growth patterns of various geographic areas, and will result in the implementation of multi-level technologies. Priority will be given to the eastern coastal areas, which will receive SPC digital technology and optical fiber systems. In addition to analog and digital microwave relay systems, the central region is slated to receive a mixture of SPC and crossbar switching systems, whereas the western and rural areas will be serviced with older technologies, including manual switching. Thus, the scheduled improvements to the year 2000 call for two-thirds of the growth to be in the East, with only ten percent in the western region.

- Switching Equipment: Switching needs will be met by importing SPC digital technology, purchasing manufacturing technology and production lines, and designing digital SPC switches within China. Progress has already been made in digital switch design, and a 2,000 line unit underwent trials in October, 1986. The PRC does not intend to continue to purchase all its telecommunications equipment from foreign suppliers, and will try to establish independence in research and development projects (R & D) in order to maintain its own advanced technology.

- Long Distance Service: For long distance services, emphasis is being placed on implementing R & D in digital microwave technology, fiber optics transmission, and domestic satellites. A third order type of multiplex equipment has been installed on a

Guanzhou optical fiber link, and work is in progress on a fourth order multiplexer in the Wuhan Research Institute.

- Cable Systems: Cable feeder and distribution systems in the local networks primarily consist of lead-sheathed paper-insulated cables. New construction will use both filled and air-cored plastic cables of modern design supplied by both local sources and foreign suppliers.

- Telex Service: Telex service has continued to grow at about thirty to fifty percent annually since 1980. Approximately five million messages were carried in 1985. Facsimile service is available in most provincial capital cities, and is primarily used for newspaper transmission.

- Data Service: Limited data service is available on leased lines as well as via the public switched network, with data transfer speeds of 9.6 Kb/s using X.25 protocols for local access, and X.75 for inter-network transfer. The quantity of data traffic to the U.S.is calculated to be third in volume after the traffic to Japan and Hong Kong. There is considerable interest in expanding data services, and a small experimental packet switch is planned for introduction in Beijing in 1987.

- Cellular Radio: Cellular radio systems have been introduced in China, and will form an important part of the MPT's expansion plans, using both NMT 450 and TACS technology. Because of its greater capacity, TACS technology will be predominately used in large urban areas.

- Satellite Communications: Satellite communications are provided from Standard A earth stations in the Beijing and Shanghai areas, and operate to the INTELSAT Pacific and Indian Ocean satellites. Although domestic satellite service is currently used for television transmissions via leased INTELSAT transponders, China plans to launch its own domestic satellite in 1988. Approximately two hundred receive-only earth stations (TVRO's) are in place for television reception, and this service will be expanded with the installation of an additional 1,000 receivers with antennas built in China. Satellite systems currently use C-band technology, but research institutes are experimenting with KU-band applications for future use.

- Research and Development: Research in telecommunications is carried out by the Science and Technology Department of the MPT. The studies and research underway cover a wide range of subjects, including telecommunications economics, network design, electromagnetic propagation, various types of equipment systems, and individual components.

- Planning: Systematic analysis and planning must take place to ensure the most efficient use of all available resources. It will be necessary to identify and establish priorities in addressing the problems and requirements of the telecommunications sector, both by determining goals and objectives and by making plans to accomplish projects within the limits of these resources.

  It is important that planning be carried out in a fully integrated manner rather than piecemeal. A national network design within which development can take place must be established to avoid future problems and expensive system rearrangements. The opportunity exists for the creation of a network which will preclude the need for interim systems and obsolete technology that have slowed modernization in many countries.[1/]

- Standardization: Standardization of equipment will avoid the proliferation of apparatus, reduce training requirements and interface problems, and keep inventories to a minimum. Standards must also be established for the quality of service provided to subscribers. Practical goals need to be set for provision and repair of service, quality of transmission, speed of connection, and the handling of billing and commercial inquiries.

  As the overall telecommunications network is designed, and standards are developed for signaling, transmission, and data protocols within the network hierarchy, standards must also be established for local networks and for types of equipment and technology. The local network is an important part of the system, for although it does not produce the return on investment of long distance service, the national

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1/ The MPT referred to the concept of sidestepping interim systems and attaining a fully integrated communications system as the possibility of "leap-frogging."

network cannot exist without it. Local loop transmission design, therefore, must be uniformly applied and given the same priority as overall network design.

- o Computerized Support Systems: While undertaking the expansion and improvement of the telecommunications system, it will be increasingly important to modernize and mechanize many support functions.[2/] The telecommunications support systems which must be implemented include message data recording and customer billing, centralized maintenance centers, computer-assisted network management, systematic demand surveys and forecasts, line and cable pair assignment, and a wide range of management information systems, all of which are considered extremely important administrative tools. Many of these programs can use a common data base and it is important to use computer systems that are compatible.[3/]

- o System Engineering Needs: MPT officials are concerned about having the expertise in system engineering and operations research to be able to establish and maintain a modern communications system. In addition, officials are aware that experience is needed to make scientific decisions on operational and economic matters, as well as to determine the practical application in technical R & D areas.[4/]

Development Financing

A complete review of revenue requirements to meet the PRC's operating costs and to support development should be considered. Funding for expansion programs comes from several sources, which

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[2/] MPT officials understand the need for computerized systems as an essential part of a modern telecommunications administration, and recognize the implications of automation on workforce staffing levels.

[3/] Based on their previous experience in the use of automated systems in the United States for management, engineering, and operations, the U.S. team considers the PRC's modernization of support functions to be an important area for future scientific cooperation with the U.S.

[4/] U.S. experience in system engineering and technical R & D can help resolve some of these concerns and reduce the time taken for practical applications.

include the central government, local governments, subscribers, and foreign participation. The U.S. team learned nothing about the actual mechanism for the allocation of funds and the distribution of foreign exchange earnings from international service.

Although a large percentage of development costs will have to be met by the central government initially, as the system improves and new services are introduced, rates can be adjusted to transfer some of the central government's support to the operating administrations. Revenues generated by telephone operations should be used, at least in part, to support future capital expenditure programs.

Innovative methods of development funding, such as countertrade, are not widely used, but joint ventures in manufacturing and technology transfer are common. Long term, low interest loans with foreign government support are used to procure switching and other types of equipment.

Review of the Manufacturing Sector

MPT officials expressed determination for the PRC to be independent in manufacturing modern telecommunications equipment by expeditiously acquiring the necessary technological expertise. Independence in manufacturing telecommunications equipment and implementation of the development program both require dedication to attainment of manufacturing efficiency and attention to arrangements for technology transfer.

In addition, close coordination will be necessary among the marketing, service, and engineering departments of the operating administrations and the factories that will supply them. It is possible that substitution of a smaller number of high output facilities for the existing factories manufacturing older types of switching equipment and cable could result in beneficial economies of scale.

An extensive review of the current manufacturing sector should be made in order to meet the needs of expansion, and to help finance development by selling part of the equipment produced at competitive prices outside of China. This manufacturing review should include an analysis of the future use of locally manufactured crossbar equipment. Consideration should be given to a planned reduction in crossbar production and a corresponding increase in digital switch installations. Continued installation of crossbar equipment will create future problems in the efficient use of the network and new technologies and in meeting the large space requirements of these machines.

Procurement

Equipment purchases should generally be based on technical suitability and network compatibility rather than on availability of soft loans. Soft financing packages are usually tied to a particular vendor, who may not provide the necessary level of technical documentation and support. Attractive financing packages often result in introducing a mixture of equipment into the network, which can proliferate into a network comprised of an increasing variety of equipment types. When it is necessary to utilize the same type of equipment from many manufacturers, consideration should be given to segregating each type into geographic areas in order to minimize maintenance and interface problems.

Rates and Tariffs

Rates and tariffs are uniform throughout the PRC, and appear in various forms of flat and measured rate service. Although rates are fixed and have not been changed since 1958, administrations have some freedom to apply "local adjustments" to enable some recovery of plant investments.

Rates are comparatively low, for example 18 Yuan ($4.85) is charged per month for a business flat rate line. The monthly charge is generally determined by the number of subscribers within the flat rate calling area. This type of charging is based on "value of service" pricing concepts rather than cost of service.

## III. U.S. TEAM'S RECOMMENDATIONS

Based on the U.S. team's observations in China and discussions after the visit, a number of steps are considered necessary for successful implementation of the telecommunications development program. The recommendations are described in detail in Part Three of the report. A brief summary follows:

1. Develop a standard, uniform, national planning process for use by national and regional authorities to ensure orderly telecommunications development in an economic manner.

2. Develop systematic procedures for setting attainable goals for improving and expanding the telecommunications system. Include requirements for financial, material, and human resources.

3. Design and implement national numbering, switching, and transmission plans as quickly as possible.

4. Establish standards for construction, maintenance, and service of local and toll networks, and carry out training programs to enable employees to reach the levels established by the standards.

5. Develop a national table of frequency allocations for radio spectrum use, and plan for the future growth of radio services, including land mobile services.

6. Adopt the cellular technology system called Total Access Coverage System (TACS) as the national standard for all public mobile telephone networks, and evaluate the cost effectiveness of serving fixed subscribers with TACS technology.

7. Establish standard cable specifications for selection of materials for local network distribution, and ensure optimum technical and economic provisioning of local line plant.

8. Establish fundamental plans for replacement of equipment in outside plant facilities in each province, and extend planning periods beyond five years. Take steps to avoid early cable replacements, and accelerate the introduction of plastic-insulated and sheathed cables.

9. Consolidate manufacturing operations to avoid inefficiencies created by duplicated facilities. Review costing and marketing concepts for all manufacturing operations.

10. Design an economically sound framework for international, toll, and local rates.

11. Consider expansion of public telephone service centers for local and toll calling.

12. Review all procurement procedures, including methods of evaluating system and equipment purchases from foreign suppliers.

13. Consider the availability of foreign financial support through expanded use of multinational bank financing, countertrade, and creative joint ventures to increase foreign exchange revenues.

14. Develop a long term plan which considers the use of satellites and terrestrial facilities as an integrated system, taking into account the ability of satellite systems to provide service at early dates to rural communities. Develop plans for the provision of data services via satellite. Ensure that standards for these services are established with terrestrial compatibility and long term development goals in mind. Take strong proactive positions with the Ministry of Astronautics to influence their decisions on future satellite parameters and capacity.

## IV. Future Technical Cooperation

Article II , Section II, paragraph 4 of the U.S. - China Protocol on Cooperation in the Field of Telecommunications specifies that there should be exploration of bilateral cooperation in telecommunications technology and in the application of communication systems to both civil and commercial needs. The budget constraints of both the U.S. and PRC telecommunications Administrations, however, may provide practical limits on the extent to which the objectives contained in the Protocol may be pursued.

Priorities in the objectives will undoubtedly have to be established. Weighing the budgetary constraints with the possibility of U.S. private sector participation may provide some opportunity for pursuing desirable objectives. Areas which could be considered for future technical cooperation are listed below:

### 1. Development Planning

- Transition from Analog to Digital Systems
- National and International Data Transmission
- Project Control and Coordination
- Forecasting Techniques
- Use of Cellular Radio Technology for Multiple Applications
- Communication Satellite Planning

### 2. Computer Based Support Systems

- Network Management
- Spectrum Management
- Automated Directory Assistance
- Systems Engineering and Operations Research
- Customer and Plant Assignment Records
- Management Information System
- Automated Traffic Usage Reporting

3. International Services

- o Measurement of Service Quality
- o Multiple-hop Control
- o Use of Echo Suppressors and Cancelers
- o Integration of Terrestrial and Satellite Services

4. Service Standards

- o Switching Maintenance
- o Transmission Maintenance
- o Outside Plant Maintenance
- o Technical Specifications
- o Technical Standards
- o Quality of Service Standards

5. Commercial Operation

- o Rate and Tariff Development
- o Revenue Requirements
- o Business Planning
- o Financial Methodology Studies
- o Division of Revenues for National and International Services

At the end of the visit to China, the U.S. team and MPT officials concluded that holding regular bilateral meetings to discuss telecommunications trade opportunities would be of mutual benefit. In addition, the U.S. team felt that there would be additional benefits from an annual exchange of basic statistical information on the telecommunications and electronic industries.

# PART TWO

## CHAPTERS ONE TO SIX

# PART TWO

## CHAPTER ONE

## MPT ORGANIZATION AND RESPONSIBILITIES

### Centralized and Decentralized Structure

The PRC's telecommunications industry emphasizes a centralized organizational structure and management control, while simultaneously allowing decentralized system management and operations. The Ministry of Posts and Telecommunications (MPT) in Beijing is responsible for postal and telecommunications affairs, and is the focus of all planning and operational initiatives. However, elements of the planning and operational activities are delegated throughout the jurisdictional hierarchy for action at provincial levels, requiring various degrees of approval for implementation by the MPT.

The lines of authority extend from the MPT through the provincial-city-town-village and rural geographic structure, providing the framework for most of the telecommunications related activities in China.5/ The MPT alone has overall responsibility for all public areas of telecommunications operations in China -- local, long distance (toll), and international. The MPT emphasis, however, is in the public switched long distance (intercity, interprovincial), and international services. Local (city, provincial) telephone authorities have planning, operational, and acquisition responsibilities within the MPT hierarchy of approvals.

### Divided Telecommunications Management Responsibilities

During the technical review meetings, MPT officials discussed activities related to (1) system and service development, (2) facilities planning, (3) facilities acquisition and financing, (4) development of rates, tariffs, and revenue requirements, (5) manufacturing, and (6) research and development (R & D). However, the MPT shares responsibility for several of the planning and operational areas with other organizations. Telecommunications activities with shared management include

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5/ See Figure One in Appendix E.

research and development, and equipment manufacturing related to telecommunications.[6/]

Many central office crossbar switch manufacturing operations come under the direct supervision and control of the MPT, regardless of geographic location. Several similar manufacturing facilities, however, are directly controlled as subsidiary operations of city, provincial telephone, or separate university authorities within the MPT hierarchy, and are only indirectly controlled by the MPT. The Shanghai Crossbar and Lead Cable Factory and Jiaotong University's involvement in the manufacturing of microprocessors are examples of city and university control of telecommunications activities. Such divided management can produce extensive inefficiencies, such as small output from multiple facilities priced equally regardless of the manufacturing facility. With a more centralized management structure, more efficient resource allocation would be possible.

A similar duplication of services can occur in R & D activities, which are controlled by the same divided organizational structure.[7/] Since there are no production quotas, sales or revenues objectives, or commonality of "product lines" for comparative evaluation, problems resulting from divided management are difficult to identify and correct. R & D budgets with ambiguous program descriptions provide the only management information available, which is of limited use since industries frequently provide "non budget" support for various projects.

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6/ Figure One does not represent the telecommunications planning and operational areas jointly managed by MPT and other organizat

7/ The MPT alone has thirty-five academies and research institutes, with a staff of 30,000 employees.

# CHAPTER TWO

# THE EXISTING TELECOMMUNICATIONS NETWORK

## Inadequacies of the Infrastructure

Although telecommunications services are considered by the PRC to be an extremely important part of the infrastructure, in its present condition, the infrastructure itself is totally inadequate to meet the service demands placed upon it. The causes for the inadequacy of the infrastructure can be explained by the following facts:

- o expansion programs were not implemented over the past several years;
- o the long distance network remains undertrunked and overloaded; and
- o both long distance circuits and switching capacity are in short supply.

The network is primarily an analog voice network, which uses magneto, common battery, step-by-step, rotary, and crossbar switching systems to connect subscriber lines. Rural services are provided by manual technology that is forty to fifty years old. Some digital Stored Program Control (SPC) systems are in service. Installation of one million SPC lines is scheduled during the seventh Five Year Plan (1986 to 1990). Although locally manufactured crossbar equipment continues to be installed, step-by-step switching installations have been discontinued.[8/]

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8/ In the telephone exchanges the U.S. team visited, maintenance of switching equipment was carried out by trained staff, and most exchanges were staffed twenty-four hours per day. Dust covers protect equipment, and equipment rooms were generally clean and orderly. The staff responded to alarms immediately, and performed corrective maintenance as needed. Scheduled preventive maintenance is carried out on critical equipment on a monthly basis. Service observations permit evaluation of the level of service provided.

During the sixth Five Year Plan (1981 to 1985), 1.36 million telephones were added, and additional long distance circuits were placed in service, equalling the entire growth achieved in the previous twenty years. As of the end of 1985, approximately 6.2 million telephones were installed, with three million in major urban areas. During the year, 400 million long distance calls were completed on 40,000 long distance circuits.

Nonetheless, additions to the local and long distance networks have not been able to meet increasing demands on the system, and congestion in the network and demand for new service have continued. For example, in 1985, telex traffic increased seventy percent above the previous year's traffic; long distance message traffic increased twenty-one percent; and international traffic, including that to Hong Kong and Macao, increased sixty-eight percent.

Difficulties in Supplying Services Demands

In general, in all of the cities the U.S. team visited, the existing networks are overloaded, and the demand for telecommunications service far exceeds the available service.[9/] In the major cities the waiting list for local service probably exceeds 700,000 subscribers. Difficulty in constructing new outside plant facilities in the urban areas, failure of foreign equipment manufacturers to deliver serviceable equipment on time, and lack of coordination with other public utilities have created problems in delivering adequate service.

Replacement of Switching Equipment

Much of the existing telephone switching equipment used currently in China has exceeded its economic life and needs replacing. For example, in Shanghai some ITT rotary switching equipment has been in service about fifty-five years. Maintenance of this equipment must be costly and replacement parts difficult to obtain. Other more modern equipment is limited in capacity and capability, and needs to be replaced in the urban areas to provide up-to-date services. Recognizing the obsolescence factor, the MPT has started to introduce digital switching to orient the network toward modern technology and services. In the rural areas, however, both antiquated equipment and the absence of

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9/ Usage is estimated at 0.2 erlangs per line in the cities. The completion rate for incoming calls is as low as twenty percent in some areas, and most city exchanges operate at only eighty percent of installed lines because of heavy usage. Direct Distance Dialing (DDD) and International Direct Distance Dialing (IDDD) services are available to only a small percentage of subscribers.

telephone service are impeding economic and cultural development.

An analysis of the plans for exchange switching equipment reveals a basic conflict between the MPT's desires to install modern exchanges in major cities, and the factories' production of crossbar equipment in record quantities. The conflict must be addressed quickly by the MPT to prevent installation of crossbar equipment in large cities and high growth areas. This type of equipment is undesirable for the large cities, not only because of its limited capacity, but because it requires more than twice the amount of building space and significantly more electrical power.

Crossbar equipment is equally undesirable in high growth areas, because its service life will be short. In addition, with use of such equipment, a proliferation of small exchanges may result, creating inefficient trunking networks and an inefficient use of telephone exchange numbers. To prevent the installation of crossbar equipment in urban areas, the MPT should consider installing SPC exchanges with a minimum capacity of 50,000 lines in such areas, confining the use of crossbar equipment to areas where limited growth is expected to occur.

Need for Computerized Support Operations

Although the seventh Five Year Plan emphasizes expansion of telephone services, very little emphasis has been placed on the use of computer systems to support operations. As the network is in transition from a small analog telephone network to a rapidly expanding digital network, it will be extremely important to use the most modern planning tools and computer systems available.10/

In the U.S. team's discussions with both MPT and provincial leaders, there were indications of interest in the use of computers to support maintenance, billing, traffic data collection, and network planning. Additional planning is needed to ensure that the correct type of computer system is deployed to deal with critical areas, such as processing of customer requests for new service, customer reported problems, billing details, and engineering data. However, despite the fact that there was no indication that management support and information systems were actually under consideration, there is current evidence of some computer-aided activity. In Beijing, a Wang system assists with billing long distance calls, and in Guangzhou, an IBM Personal Computer inventories exchange equipment, such as telephone numbers, line equipment, and customer trouble reports.

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10/ One of the MPT managers referred to the need for modern planning tools and computer systems as a need for additional emphasis in the area of "soft science."

## The Long Distance Network

Most long distance telephone calls made in China require the assistance of an operator, although some automatic and semi-automatic operation is in place. More than 14,000 manual operator switchboards are in use, 3,000 magneto type and 11,400 common battery. Only a small number of automatic switchboards use Stored Program Control (SPC) systems.

In China a sizeable work force provides operator services. The Beijing long distance center has over eight hundred telephone operators, who have access to direct dialing trunks to most Chinese cities, and complete approximately 53,000 calls daily. During the transition from manual to automatic exchanges, the number of operators providing long distance service will diminish.[11/]

Direct long distance and international dialing are services that need to be expanded as soon as possible. Direct distance dialing is normally faster, the caller has complete control over the timing, and there is no language problem in dealing with a foreign operator. Introduced in the PRC in July, 1986, international direct distance dialing to thirteen countries is possible at present. Satellite earth stations are located in Beijing and Shanghai, and operate to the Indian Ocean and Pacific Ocean INTELSAT satellites. International gateway exchanges are located in Beijing and Shanghai, and have direct access to fifty-seven and twenty-nine countries respectively.

## The Local Network

The average cable route length from a central office in urban areas is 3.5 kilometers, and most cables are underground from the main distribution frame to cross-connect cabinets, with a maximum allowable route resistance of 2000 Ohms. Cables are mainly lead-sheathed paper-insulated copper, but new construction utilizes plastic-insulated copper supplied by local and foreign manufacturers. For new exchange systems, outside plant plans are based on thirty percent occupancy in local distribution networks and sixty percent occupancy for trunk cables during the first year of service. Cable relief is based on having eighty-five percent working pairs in the existing plant.

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11/ Transmission facilities use analog technology over a variety of facilities, including paired cable, four and eight tube coaxial cable, with 1,800 and 4,380 channel capacity, and both 4 GHz and 6 GHz microwave systems of 960 and 1800 channel capacity. Open wire carrier systems are used extensively, and will continue to be used, especially in rural areas.

In Shanghai, conversion to plastic-sheathed, filled cables began in 1986. The U.S. team saw a typical example of the outside plant network, where ninety percent of the cables are placed. In the suburban network, aerial lead-sheathed air-cored cables are in place, but in the future air-cored plastic cables in hangers will be used and will be pressurized out to the cable terminal.

The Data Network

Planning and development for data communications have begun in the research area, in which scholars are linking the Chinese written language and binary languages. In the equipment area, the approach the PRC appears to be taking in developing the data network follows the traditional model of progression from telegraph, telex, facsimile, shared use of the switched network, and the eventual introduction of local area networks, ISDN and/or packet switching networks.12/ Since the traditional, incremental approach to development of a data network is both time-consuming and expensive, it may be possible for the PRC to decide to bypass and avoid some of the problems other countries have experienced through the following activities:

a. Understanding the important linkages between networking of computers, interworking of computer networks, data communications network, and ultimately, integrated telecommunications networks.

b. Adopting a national standard in computer communications protocols that is compatible with the evolving CCITT data communications protocols.

c. Working with international standard setting bodies in order to:

   - o Become familiar with the philosophical, technological, and procedural matters in setting international standards; and
   - o Acquaint the international body with the unique needs of the Chinese language and/or other national characteristics.

d. Taking advantage of the emerging ISDN architecture in the planning process to preclude the possible need of

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12/ In the PRC's consideration of equipment for developing a data network, it is important to recognize that a good data communications network demands a good office automation system to solve the end-to-end service problem.

having an overlaid data network in addition to the telephone network.

Current Data Services Provided

Current PRC data communications consist of computer-to-computer information services, telegraph, telex, and facsimile, which are described below.

- Telegraph Service: The total telegraph traffic in 1985 approximated 220,000,000 messages. Most of these messages were switched by automatic exchanges located in seventeen provincial capitals. Automatic character translation has been implemented for the transmission of telegraph traffic. Beijing has the largest automatic telegraph message switching center in the network, with 352 trunks to eighteen cities, handling 120,000 messages daily.

- Telex Service: Telex service was first provided in 1950 with use of a manual switchboard, which has since been replaced by SPC machines developed in 1979. Today SPC machines are being used in thirty-nine cities. Since 1980, telex traffic growth has been at a rate of thirty to fifty percent per year; and in 1985, the telex traffic was about 4.8 million messages with a total of 4,500 subscribers. In Beijing telex service is provided through a 7,000 line exchange, which currently has 1,600 working subscribers, and is estimated to grow at a rate of four hundred new subscribers annually.

- Facsimile Service: Facsimile service (FAX) was first started in 1956, with subscriber service, which is available in Beijing, Shanghai, and twenty provincial capitals, introduced in 1981. Currently, facsimile service is used primarily for the transmission of newspapers. At present, twelve important newspapers use this service; total traffic is 270 pages per day.

- Computer-to-Computer Service: Limited data services are provided through leased lines and the public switched network. Data bases in the United States and Europe are accessed via leased circuits. Traffic to the U.S. is handled by ITT, AT&T, RCA, and WUI. The greatest number of data messages are to Japan, Hong Kong, and the U.S. A small, experimental packet switch is planned for introduction in Beijing in 1987, which will be connected to Shanghai, Guangzhou, and other cities.

## Land Mobile Communications

Land mobile radio systems in the PRC are currently used in both public and private telecommunications networks. Mobile telephone, two-way dispatch, one-way paging and high frequency fixed communications systems are employed to varying degrees in the most heavily populated provinces. Land mobile communications are still at an early stage of development, however, and there is considerable room for expansion.

### Uses of Public and Private Systems

Private land mobile systems are used mainly by the public safety, industrial, and land transportation ministries. They are allocated frequency bands at 150 MHz, 400 MHz and 800 MHz for both two-way communications and one-way paging. Although the MPT allocates spectrum usage and determines system standards for private mobile networks, these networks are controlled by the users.

Public radio systems are assigned frequencies at both 450 MHz and 800 MHz to facilitate the use of two different cellular technologies: Nordic Mobile Telephone 450 (NMT-450) and Total Access Coverage System (TACS). Of these two, the NMT-450 technology is a lower capacity system and is being considered for use in small cities and some private networks. The MPT has decided that all major cities, however, will use TACS technology because of its greater subscriber capacity. The frequency bands 879-899 MHz paired with 924-944 MHz have been allocated for TACS systems nationwide.

### Cellular Radio Networks

Cellular radio networks are already under development in two of China's major cities, Beijing and Shanghai. The Beijing Telecommunications Administration (BTA) is currently installing a TACS system. It is expected to be fully operational by the summer of 1987, with service available to the public in the fall of that year.[13/] The Shanghai Long Distance Telecommunications Office will also install a TACS system, and expansion plans are already being considered.[14/]

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13/ The initial system will comprise six cells and a digital switch with 960 ports that can be expanded to 1,920 ports, with the capacity to serve up to 20,000 cellular subscribers.

14/ In the initial stage, the system will have one cell and the same switching capacity as Beijing.

China's citizens will benefit with the development of compatible public mobile systems in Beijing and Shanghai. Now may be the time, however, for the MPT to review its decision to allow smaller cities to use NMT-450 systems. As a result of its dual cellular standard, the MPT must reserve two major spectrum allocations for public mobile systems, resulting in an inefficient allocation program. As the land mobile services expand in China, the MPT will have to respond to more pressure for radio spectrum, and efficient spectrum use will become increasingly important.

o Arguments in Favor of TACS Systems

It is interesting to note that the administrations of most other countries are moving towards 800 to 900 MHz systems to accommodate demand for cellular communications. The United Kingdom, Ireland, and India have all chosen TACS as their national system. The United States, Canada, and approximately twelve other countries have chosen AMPS, a system that is similar to TACS and operates in the 800 to 900 MHz band, as a national standard.[15/]

As a result of the worldwide preference for TACS and AMPS systems, between eighty to ninety percent of the world market will be served by 800 to 900 MHz systems. At present, infrastructure costs of TACS and NMT-450 systems are comparable, but TACS subscriber equipment is already thirty to fifty percent less than NMT-450 equipment.

Moreover, the large market for 800 to 900 MHz systems will allow the cost of TACS technology to drop even more. Subscriber products are projected to fall an additional thirty to fifty percent during the next five years, and infrastructure expenses should decrease during the same time frame, making the TACS infrastructure significantly lower in price than NMT-450 equipment.[16/] Thus, the total cost of a TACS system, which includes both the costs of infrastructure and subscriber equipment, is already lower than the cost of an NMT-450 system, and the differential will continue to widen.

Aside from the cost issue, the performance of both cellular systems needs to be considered. Although NMT-450 systems can exhibit somewhat greater range than their 800 to

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15/ Table One shows some basic parameters of the AMPS and TACS systems, in addition to the NMT-450 MHz system.

16/ The calculation concerning the thirty to fifty percent drop in the cost of subscriber products during the next five years was made in terms of the value of the dollar in 1986.

900 MHz counterparts, the expected range of 450 MHz systems is only slightly greater than 800 to 900 MHz systems for either mobile or fixed subscribers.[17/] This slight increase in coverage is simply not enough to offset the advantages of increased capacity and lower cost of TACS technology.

The cellular radio systems currently being implemented will predominately serve mobile and portable subscribers. The system under construction is Beijing is expected to serve an equal number of mobile and portable telephones. As other major cities construct TACS systems, portable telephones will comprise an even greater percentage of total subscriber equipment, both because of their convenience and the relatively low density of moving vehicles. In terms of portable telephones, TACS technology also has an advantage over NMT-450, because the higher frequency of TACS systems allows the manufacture of smaller and lighter portable telephones. In fact, there are no 450 MHz portable telephones on the market today.

In light of the factors in favor of developing a single cellular standard, the MPT should review its policy of allowing two incompatible cellular systems to develop side-by-side. Because of the cost trends of both infrastructure and subscriber equipment, similarity of TACS and NMT-450's radio coverage, and the availability of portable telephones, TACS is the superior system for both large and small cities. Moreover, the MPT can save valuable radio spectrum by selecting TACS as a nationwide standard for all public mobile systems in China.

o Use of TACS Technology for Fixed Subscriber Service

Since TACS is rapidly becoming a cost effective alternative to wireline networks in rural applications, the MPT and its provincial P & T offices may be interested in providing fixed subscriber service with TACS technology in the future. At the same time that the cost per subscriber for rural wireline plant is steadily increasing, the large and growing cellular market is stimulating product innovation and cost reduction.

Fixed radio service can be provided today at an equipment cost of $2,000 to $4,000 per subscriber for user populations of 500 or more subscribers. The exact point in time at which cellular loops become less expensive than copper loops depends on a number of factors, including traffic statistics. It is inevitable, however, that the cost of cellular loops will fall below the cost of wireline loops

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17/ See the data presented in Figures Two and Three.

in the future.[18] Thus, as China expands its telecommunications networks, the MPT and the provincial administrations should continue to compare the cost of serving fixed subscribers with wireline or cellular radio systems.

## Satellite Communications

International communications via satellite are rapidly developing in China, but technology and equipment provisioning are still below the level that satisfies the needs of the various users. The steps that the PRC has taken to be self reliant in satellite communications are, nevertheless, impressive. The Chinese apparently have clearly resolved the C-band versus Ku-band debate in favor of C-band, and the Ministry of Astronautics is responsible for developing and launching its own satellites. The Ku-band will be studied and researched, but evidently will not figure in plans until the 1990's.[19]

## MPT'S Lack of Control over Satellite Developments

The driving force behind the development of commercial satellite facilities is not the MPT, but the Ministry of Broadcasting and Television, which will consume about sixty-five to seventy percent of the available domestic capacity over the long run. As customers of the Ministry of Astronautics, the MPT and the Ministry of Broadcasting and Television influence the satellite design parameters.

Although the MPT determines total system capacity for communications purposes, and appears to want all users to route communications through its public network, it evidently cannot fulfill the demand by all users. Yet, the MPT's plans for introducing satellite facilities for communications purposes do not appear to utilize the entire potential of this medium. Satellites offer a unique opportunity to accelerate the penetration of communications into remote and rural areas, where considerable time and expense are associated with the introduction of terrestrial facilities.

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[18] For example, if one assumes that fifty percent of the subscribers place a call during the busiest hours, and that the average conversation length is five minutes, the crossover point at which the cost of cellular loops will fall below the cost of wireline loops will occur sometime during 1987 for the average subscriber.

[19] Although the East China Sea Cable connects Shanghai and Japan, no plans exist for additional submarine cables, because international traffic of all types will primarily be carried by satellite systems.

The MPT seems to have an opportunity to play a more significant role regarding satellites. Continued planning to use FDM/FM instead of moving quickly to digital modulation and TDMA apparently stems from the MPT's desire for the technical infrastructure to evolve gradually within the country. Yet, by delaying introduction of efficient modern technologies and needlessly building up an investment of outmoded technology, such a slow technological transition could be detrimental. The MPT's planning process should fully integrate satellites into the system, rather than adopting a piecemeal approach. Integral planning should be hierarchical, working from both the top and the bottom of the communications infrastructure.

China's Use of the INTELSAT System

China is a member of INTELSAT and uses the INTELSAT system for international traffic, with Beijing and Shanghai as the two international gateways. The main domestic use of satellites is for television distribution, which is administered by the Ministry of Broadcasting and Television. In addition, the MPT uses the INTELSAT system for telephone communications to remote rural communities.[20]

At the Sha He earth station outside Beijing there are two antennas. One is a thirty-meter Standard A station for international traffic via the Indian ocean INTELSAT satellite, and the other an eighteen-meter antenna for domestic television and telephony using leased INTELSAT transponders. The domestic station was built in 1973 following President Nixon's visit to China, and was modified in 1982 for dual polarization to facilitate operation with Intelsat V satellites. Having begun preliminary operation in 1985, the domestic satellite station now handles television and two-way voice traffic with some low speed data.[21]

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[20] Analog and digital microwave terrestrial links operating at 2 GHz, 8 GHz, and 11 GHz currently link the gateways and earth stations. Fiber optic links are planned for introduction in the future. The microwave links are 960 channel analog, and the digital terrestrial links are 70 Mbit/s and 140 Mbit/s (from GTE Milan). International traffic is primarily to Japan, Hong Kong, the U.S., and Western Europe, with approximately twenty-five percent of the traffic directed to each.

[21] The domestic earth station at Sha He is eighteen meters in diameter, has three kw transmitters, 83 dBW maximum e.i.r.p. and 77 dBW actual e.i.r.p. Each 72 MHz transponder has one 25 MHz television channel in order to maximize available e.i.r.p.

An additional earth station site, two miles south of Beijing contains another Indian Ocean Standard A station, which with a Pacific Ocean Standard A, provides the Beijing area with one Pacific and two Indian Ocean stations. These stations were built by China in joint ventures with RCA and NEC. Dual polarization retrofits were carried out in 1982 and 1983 by NEC and SPAR of Canada.

As of the end of 1986, international direct dialing became possible from Beijing to sixteen countries. 22/ Most international traffic requires the use of operators, but a new interface under development will allow international direct dialing to the U.S., Japan, and Hong Kong. There are ten circuit groups for direct international connections, including the U.S., Japan, Singapore, West Germany, Italy, France, and Australia.

Shanghai has a thirty-meter SPAR Standard A earth station connected to the Pacific INTELSAT, carrying 220 voice channels and thirteen telegraph channels.23/ For any new stations, Shanghai usually proposes a plan based on traffic, and the decision is made by the MPT in Beijing, which provides most of the funds. Shanghai keeps a percentage of the revenues, which depends on its contribution to the cost of the facilities. The view in Shanghai regarding domestic capacity is to follow the MPT's planning from Beijing.

Satellite Capacity for Domestic Use

The INTELSAT satellite capacity leased for domestic use consists of two 72 MHz transponders, one 36 MHz transponder and one-half of a 36 MHz transponder (18 MHz). Three transponders are used for television, and the half transponder is used for telecommunications traffic, which currently consists of 100 voice channels. The system design was created by the Academy of Sciences, and the station design resulted from efforts with foreign companies in a joint venture.

The MPT now has a total of five earth stations, and plans to add ten more over the next five years, primarily in the six to ten meter category. The Ministry of Petroleum has plans for fifteen earth stations, and the Ministry for Coal plans an

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22/ By June, 1987, the number of international telephone trunks will be 600, with 1,200 trunks expected by 1988. International traffic includes 5,000 daily cables, sixty percent originating from Beijing.

23/ There is a ten kilometer line-of-sight microwave link between the Shanghai gateway and the earth station, using analog FDM, 960 channels capacity. Locally made terminal equipment uses CCITT No. 5 interface.

additional five. More than two hundred receive-only television stations (TVRO's) are in place, and contracts have been signed to construct an additional 1,000 four to five-meter antennas, which will be built locally. Television signals received from the satellite are rebroadcast on UHF.

Use of Satellites for Rural Communications

The use of satellites for rural voice communications is under review. The provinces will follow the MPT lead from Beijing in terms of selecting the appropriate technology. Although they currently have Scientific Atlanta SPC equipment, officials correctly think a single-channel earth station is expensive.

In Sichuan Province the team observed that there are one hundred TVRO stations, with more than 1,000 planned by 1990. Sichuan will set up one eleven-meter earth station by 1987 to connect Chengdu to Beijing and internationally. The earth station voice traffic is sixty channels for 1987, increasing to 972 channels by 1990.

# CHAPTER THREE

# RATES AND TARIFFS

## Objectives for PRC's Telecommunications Rates

The PRC's stated objectives for telephone and telecommunications rate design are: (1) to promote economic development, (2) to increase subscriber usage, and (3) to generate revenue for new construction. Unfortunately, these objectives -- low rates to promote usage versus high rates to generate revenue -- are inherently contradictory. In addition, maintaining low rates tends to increase the demand for services beyond the level which can now be served.

In a strictly regulated economy, which manages prices in general, and monopoly industrial organizations in particular, prices are generally designed to achieve specific objectives. The price may be set to achieve objectives similar to those in an unregulated or competitive market, such as economic efficiency, or the price may be designed to accomplish specific socio-economic goals, such as universal telephone service. Sometimes prices can be set to achieve a compromise among various objectives, which can result in canceling out achieving objectives altogether.

## Pricing Reflects Inherent Contradictions in Goals

The pricing of telecommunications facilities and services in the PRC reflects the contradictions resulting from attempting to achieve such compromises in objectives. Complicating factors include:

- undersupplied facilities for local, toll and international services;
- shortages of foreign exchange for acquisition of foreign equipment and technology;
- lack of a domestic advanced technology manufacturing base for needed telecommunications equipment; and
- lack of domestic operating revenues necessary for network expansion.

The stated overall goal for PRC telecommunications is that growth in the telecommunications sector should be greater than the growth required for the country's "national recovery," in order to compensate for the current inadequate telecommunications

facilities and services base. This goal is economically sound, based on the fact that the PRC's overall economic growth cannot be sustained without the infrastructure base (including telecommunications) progressing at a greater rate than the economic growth of the country as a whole.

The overall goal of growth in the PRC's infrastructure has been broken down into specific goals for public telecommunications growth, increasing from 6.2 million telephones in 1986 to about 33.6 million telephones by the year 2000. The MPT's general objective in this sector is for China to attain parity in telephone penetration with the developed countries within fifty years. Such growth would create a national average telephone density of three percent by the year 2000, with larger metropolitan areas averaging a density of twenty-five to thirty percent. The current national average telephone density is 0.6 percent.

The U.S. technical review conducted during the visit to China does not provide sufficient information for the U.S. team to evaluate these goals or objectives. However, sufficient data is available to comment upon certain areas in which prudent modifications can promote greater movement toward these goals. An area which will benefit from modification is the development of rates and tariffs for existing and new services.[24/]

Rates and Variations for Basic Services

The MPT sets all rates and tariffs, including local, long distance toll, and international, and these rates apply throughout the PRC.[25/] Although rates and variations for basic services are generally consistent in all local areas, it is clear that rates increase in relation to the size of the central office switch to which the subscriber is connected; in other words, higher rates are charged for accessibility to a greater number of subscribers. This rate method indicates that a value of service concept is being used for pricing rather than cost of service.

Although the provinces and cities are free to make "local adjustments," they cannot alter the rates as published in the tables shown. Local adjustment of rates allows provincial areas to recover new investments made for basic services by applying a locally determined charge in addition to the recurring and

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24/ Tables Two to Four are translations of the local service rates, which were developed and published by the MPT in consultation with the organizations responsible for providing local services.

25/ The price for a single line telephone is approximately 50 to 90 Yuan. In November, 1986, $1.00 U.S. equaled 3.71 Yuan.

nonrecurring fixed charges shown in the Tables.[26] The locally determined charges vary among localities, and are designed to recover the local incremental investment per subscriber line. These charges may include both connection fees and initial fees for new and existing business subscribers connected to newly installed crossbar central office switches.[27]

Any formal rate changes must be approved, not only by the MPT, but by the National Price Council within the Ministry of Finance. No approval has been given by the Council for a revision of the formal published rates for telecommunications services since 1958. Consequently, there have been no formal changes to account for new facilities and improved quality of service for basic services in almost thirty years.[28]

In addition, subscribers purchase their own premises equipment, usually from an affiliate of the telephone authority, such as the Sichuan Telephone Authority.[29] The fees received from the purchase of customer premises equipment, however, do not appear to recover the monthly operating costs.[30] Depending upon the type of central office switch, there is, therefore, additional local billing on a per call basis whenever possible.

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[26] In Shanghai, for example, new and existing business subscribers connected to a newly installed crossbar central office switch are charged 2500 Yuan as an additional initial charge, plus an 80 Yuan connection fee (approximately U.S. $674 and $22, respectively).

[27] Shenzhen charges 4,000 Yuan for connection to a Stored Program Control (SPC) switch, and the Guangzhou Telephone Authority charges 3,500 to 4,000 Yuan, which is claimed to represent the installed SPC cost per line.

[28] Another example of unchanging prices is the first class letter rate of 8 Fen (U.S. 2.16 cents), which has been in effect since 1949.

[29] The PRC's telecommunications authorities do not market Private Automatic Business Exchanges (PABX`s), but provide installation and maintenance service on MPT approved equipment types. Although the Beijing Telephone Authority does not currently sell telecommunications equipment, the U.S. team was told that if the sales volume were large enough and the price economical, the Beijing Telecommunications Authority would act as a sales agent.

[30] Table Two shows that to lease a business single line on a switch with a 2,000 to 10,000 line capacity at a flat rate would be 18 Yuan (U.S. $4.85) per month on a recurring basis.

Currently in China, full multimetering service charges based on the number of calls, call duration, and distance are not possible, until Stored Program Control (SPC) switches are installed.[31] It appears that these new metered rates will also vary among jurisdictions.[32] Thus, local adjustments seem to be applicable to both nonrecurring (one time) and multimetering charges, varying by location and switch capabilities.

Charges for Toll Telephone and International Calls

Toll telephone charges are based upon call duration and distance, with thirteen basic rate differences based on zone distances.[33] Operator handled calls (manual or semiautomatic) are billed at a higher rate for a minimum three minute call, plus each additional full or fractional minute. In summary, it appears that underlying distance-sensitive transmission costs for the use of cable or microwave are reflected in the basic rates for telephone services, but these underlying costs are not charged for other similar dependent services.

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[31] With such switches, the measured local rate would take the basic form of 4 Fen (approximately U.S. one cent) for the first three minutes of use, plus an additional 4 Fen for the next forty-eight seconds, the next twenty-four seconds, and each twelve second increment thereafter. Outside of the local service area, but within the city limits, the same rate is applicable to the first three minutes, plus each additional twelve second increment.

[32] The Shenzhen Telephone Authority charges 5 Fen for an initial three minute call and additional 5 Fen for each increment in three minute units.

[33] The charges range from 5 Fen to 1.20 Yuan for a one minute direct dial (automatic) call, increasing in relation to the zoned distance. A six second pulse rate is used for billing with fractional usage billed at a full minute increment and rate.

Direct dialing of international calls is limited both by facilities available and required administrative authorizations. Although distance insensitivity is appropriate for satellite service from Beijing or Shanghai, the international direct dialing rate patterns appear to be generally inconsistent in terms of distances, countries called, and types of services.34/

Although all of the major cities have basic telephone and telegraph services, in most of these cities, supply of facilities is so limited and commercial demand so great, that basic services are not universally available.35/ Chengdu, for example, does not yet supply residential telephone service, since facilities are strained to meet commercial subscriber needs. Low per capita or per household income may also contribute to residential unavailability.

In addition, the backlog of subscriber service orders in the major cities is extremely large. These orders are for new subscribers who are waiting for installation of adequate central office switching and local distribution facilities. Both Beijing and Shanghai, for example, each have over 60,000 unfilled orders, and despite its concentrated growth, Shenzhen still has a current backlog of 8,000 unfilled orders. Even if the planned objectives are achieved by 1990, the expected growth can only reduce the backlog rather than eliminate it.

Rural Services

Rural telecommunications services are basic at best. In many locations, magneto switches are still in use. Although there are plans to provide step-by-step or crossbar central office switches and additional lines, expansion is dependent upon the provincial budgets for telecommunications rather than upon planning by the central MPT. Furthermore, projects such as replacing a metropolitan area crossbar switch with a new SPC switch and moving the crossbar switch to rural operation are rarely carried

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34/ The rates for international services, shown in Table Five, do not demonstrate any consistent distance-related rate component among countries or services. For example, telephone charges to the U.S. and Canada are 10.90 Yuan per minute and 13.60 Yuan per minute respectively, while telegram charges to the same countries are 2.20 Yuan per word and 1.90 Yuan per word, with telex charges for both at 9.20 Yuan per minute.

35/ Domestic telegraph is billed at the rate of 7 Fen per Chinese character, independent of distance. Intracity telex, when available, is 50 Fen per minute, and intercity telex is 1.00 Yuan per minute, with both rates billed independently of distance. Facsimile is also distance insensitive, charged at 8 Yuan per page for A4 format, and 12 Yuan per page for photo transmissions.

out, because both switches are needed in the metropolitan area to meet its subscriber demand.

Introduction of New Services

The provision of services, such as cellular radiotelephone, paging, facsimile, digital data, etc., vary in direct relation to the state of economic development. Many new services and improved facilities are available only in the most prosperous and largest cities and Special Economic Zones (SEZ's), for which advanced economic development is sought. Thus, cities such as Beijing, Shanghai, Guangzhou, and Shenzhen all have telex, facsimile, and data communications. Cellular radiotelephone is being introduced in Beijing and paging in Beijing, Shanghai, and Shenzhen. The cities and areas designated for concentrated economic growth, which are generally the coastal cities and Special Economic Zones, are scheduled to receive the new services listed above, plus packet switching.36/

Such designated growth in telecommunications is consistent with the PRC's general pattern of dividing the country by actual and planned economic zones, allowing as much decentralized planning, acquisition, and operation, as possible within the MPT structure. The rates for new services in these areas are developed at the local levels, require approval of the central MPT authorities (rather than the Price Council), and reflect price variation among different local telephone authorities providing similar services.

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36/ See the cities and areas designated for concentrated economic growth in Table Six.

Conclusion

The PRC asserts that telecommunications investments are recovered through the local adjustment surcharges for basic services, and that operating costs are recovered by the operating organizations, which generate a profit to be used for new construction. The MPT's claim that low operating costs generate profits suggests that actual economic costs may not be employed in the accounting process.[37/] Since investment and operating expenses do not seem to be recovered at any level of operation, the deficits which are generated can only be offset by the central government.[38/]

In summary, the U.S. team's examination of the PRC's rate structure reveals contradictory objectives in terms of maintaining low rates to promote usage while having high rates to generate revenue. A complete review of rate and tariff design should be undertaken to ensure that operating costs are fully covered and sufficient additional revenues are generated to support capital expenditure programs as much as possible.

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37/ The stated annual revenue of 500 Yuan per line, which the MPT receives from telecommunications operating costs, seems low in comparison with the current rate levels and structure.

38/ The U.S. team learned that there is no recovery of research and development costs related to telecommunications at the local level. Thus, any contributions to R & D at the universities will lead to additional deficits at the provincial level. Similarly, since the MPT is designed as a not-for-profit operation, if revenues for R & D are not generated through toll or international rate designs, such support can only be provided by deficits recovered from the central government.

# CHAPTER FOUR

# FINANCING

The PRC's short term development objectives are currently based upon three policies, which include: (1) purchasing foreign SPC switches, (2) importing foreign technology, and (3) developing R & D for domestic manufacturing. These policies, which were devised to satisfy high demand, should be reflected in the seventh Five Year Plan (1986 to 1990). The PRC recognizes that investment in all forms is the key to attaining its objectives.[39/]

## Sources of Funds to Meet PRC Objectives

The primary sources of funds to meet these objectives will come from the central government, local governments, revenues from provincial PTT administrations, capital contributions from subscribers for specific construction projects, and foreign participation. The central government contributes undetermined amounts to development through outright grants and loans. It is probable that the government supplements investment and operating deficiencies for R & D, network expansion, and similar programs. Government funds are also probably used for specific objectives associated with major metropolitan areas, Special Economic Zones, and other designated high growth areas.

In addition, the MPT central authority provides as much budgetary support as possible for other areas and projects through the division of revenue process. In this procedure, the long distance toll revenue and international operating revenues are divided among the MPT and various provincial and local operating authorities. As part of this process, provincial and local telephone authorities also pay the MPT a proportion of the local and intra-provincial toll revenue generated. The MPT reallocates these revenues back to selected operating authorities at its discretion.

The largest proportion of funds attained through the

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39/ Chengdu plans to spend about 10 billion Yuan (U.S. $2.7 billion) for investment and 100 million Yuan (U.S. $27 million) for imports during the seventh Five Year Plan (1986 to 1990). There are similar budget objectives for the other major coastal cities and Special Economic Zones. In addition, during the same time frame, the Shenda Telephone Company (a joint venture with Cable and Wireless) (C&W) is planning a 250 million Yuan five year budget, with 150 million Yuan (U.S. $40.4 million) for local construction, and 120 million Yuan (U.S. $32.3 million) for imports. Any additional investment from C&W will increase the Shenda Telephone Company's five-year budget.

division of revenue process is probably from toll service (interprovincial facilities), the major area of MPT responsibility. However, the U.S. team was unable to ascertain whether the MPT receives revenues which exceed the "costs" of all operations and can be used to recover investment.40/

The local governments in the provinces, Special Economic Zones, and major cities have the capacity to generate and expend funds, both in local currency and foreign exchange revenues, which support investment, new construction, and operations. Local participation in the financing of the PRC's telecommunication infrastructure is included in the centralized budget planning process and revenue allocation process at the MPT.41/

In addition, subscribers provide a major contribution toward funding investment and operations from the special surcharges imposed when seeking new or expanded services. Additional revenues are generated from subscribers' purchases of customer premises equipment, such as local switching equipment (PABX) and telephone sets.42/

Foreign Assistance in Financing Operations

Foreign participation in telecommunications operations is both direct and indirect. Direct foreign participation occurs through government-to-government loans, usually designated for specific development projects with preferential terms and rates. It does not appear that multinational loans or agencies, such as those provided by the World Bank and InterAsian Bank, are utilized in the telecommunications sector.

Indirect foreign assistance or participation is provided through "package" arrangements between the purchasing authority, such as the local telephone authority, and the foreign equipment

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40/ The U.S. team does not know whether the foreign exchange funds generated by international services offered by the MPT are allocated to selected operating authorities at the MPT's discretion in a manner similar to the allocation of the local and intra-provincial toll revenues.

41/ About twenty percent of operating revenues at the Shenda Telephone Company is in foreign exchange funds. The Shanghai government generates foreign exchange revenues from both telephone and non-telecommunications activities. In addition, the city of Chengdu received 30,000 Yuan from the Sichuan provincial government in 1985.

42/ Subscribers do not participate in any co-financing arrangements or in any equity roles.

supplier, which frequently provides support through preferential arrangements with its own government. For example, a foreign equipment supplier may provide a "soft" loan to finance the purchase of its equipment by reducing or eliminating interest for a specified time period, or extending the payment period.

In addition, a foreign equipment supplier may provide extensive training, peripheral equipment, or other assets as part of its "package." In many instances, preferential terms are supported financially by the foreign government. Such packages produce a reduction of the price of the equipment when compared to similar offers from competing vendors.[43/]

Although in the short term, indirect foreign assistance or participation may seem advantageous to the PRC, which may be inclined to minimize spending its foreign exchange revenues, it is important to realize that such foreign assistance may necessitate maintenance training and equipment interface costs in the longer term. Expenditures will increase as successive investment decisions are made without considering the need for equipment and system standardization. Thus, the goal of saving foreign exchange revenues is clearly a short term position, which does not seem to have been evaluated in terms of the longer range costs or benefits.

## Consideration of Other Financing Arrangements

MPT officials expressed interest in a wide spectrum of creative financing arrangements, such as those associated with countertrade, joint ventures, and technology transfer.[44/] At present, countertrade, which occurs in many developing countries and supports investment expansion without direct foreign exchange purchases, does not appear to be used extensively in the telecommunications sector.

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43/ In Guangzhou, for example, soft loan financing through NEC will be used to acquire 40,000 lines of SPC switching equipment. Similar soft loans from Canada, France, the United Kingdom, and Sweden have been utilized.

44/ An example of such "creative" financing occurred recently in Guangzhou, where a West German manufacturer sold television broadcast equipment worth $40 million U.S. Instead of cash or notes, the manufacturer received an agreement allowing resale privileges of broadcast advertising time for forty-five minutes daily. The foreign advertisers will be billed for the air time in their respective currencies or dollars in order for the PRC to acquire the necessary foreign exchange revenues.

# CHAPTER FIVE

# EXPANSION PLANS

Basic guidelines were established in 1986 at the fourth Plenary Session of the People's Congress, which required telecommunications expansion programs to be given very high priority in the current Five Year Plan (1986 to 1990). In carrying out the necessary development, MPT officials stated that the government intends to be as self-reliant as possible, while cooperating with foreign companies in technical assistance and technology transfer. In addition the government intends to strengthen internal R & D capability and to introduce advanced technology with foreign assistance.

During the seventh Five Year Plan, imported technology will include fiber optic equipment, SPC switching, PCM terminal equipment, and manufacturing technology. However, purchases from other countries will be reduced as the PRC develops its own internal manufacturing capability. Locally manufactured switching systems are expected to meet at least two-thirds of the PRC's telecommunications requirements internally by 1990.

## Short Term Goals

General goals and objectives have been established for the improvement and expansion of telecommunications services. The most important of these are as follows:

1. By the end of year 2000, increase the number of telephones in service by eight times the number in service in 1980. Over a twenty-year period the goal is to reach a total of 33.6 million telephones, with an average density of 2.8 percent. A longer range objective is to attain parity with the U.S. and the rest of the developed world in telephone penetration within fifty years.

2. By the end of the seventh Five Year Plan in 1990, double the number of telephone sets which were installed in 1985, to bring the total to 12.4 million. Two and a half to three million lines will have to be added to the 3.36 million in service at end of 1985, so that by 1990 the total should be in excess of 6.0 million.

    - At least one million digital SPC lines will need to be installed for additional switching capacity. Digital switch installations will be placed in Beijing, Tianjin, Shanghai, Guanghzou, and in the coastal cities.

- Current policy is to give priority to expansion in the following three categories, but these could be revised as a result of changing economic or social conditions:

  a) The eastern area covering eleven economically developed provinces will receive two-thirds of development expenditures.

  b) The relatively thinly populated western area of nine underdeveloped provinces will receive ten percent of the total development.

  c) The remaining ten provinces in medium stages of development will receive twenty percent.

- Switching installations and other technologies must match the needs of the individual development areas in order to maximize the benefits to be derived from the provision of new services. In general, major cities and Special Economic Zones will be provided with digital stored program control (SPC) exchanges and transmission systems, medium-sized cities with crossbar exchanges, and rural areas will retain manual exchanges.

3. Mechanize all long distance circuits except in some remote areas, and add 60,000 new trunks lines. Enhance existing analog microwave systems, and introduce digital microwave and optical fiber systems for intra-city junctions and long distance communications.

4. Expand and fully automate telegraph and telex services, and set up data networks to use the existing telex network as a foundation at 50 and 300 bauds. The public telephone network will be used as a subsequent step for medium speed data at 1200 to 2400 bauds. Private lines will permit speeds up to 9600 bauds.

   Packet switching will be first established by the end of 1987 as a small experimental network linking Beijing, Shanghai, and Guangzhou. The network will have the switching node in Beijing, and statistical multipliers in the other cities using 9.6 kb/s transmission lines between the multiplexers and the switch. There are plans to adhere to CCITT data protocol standards, which means X.25 for access and X.75 for inter-network interfaces.

5. Continue to develop and expand international and domestic satellite communications systems primarily through use of the PRC's internal resources. Objectives within the plan include the establishment of twenty large earth stations as part of a domestic network.

   - In 1988, the PRC will launch its own domestic satellite, and television traffic will be transferred to that satellite. China will continue to lease three full and one half INTELSAT transponders, which are expected to be adequate for at least five years. The domsat will have four standard 36 MHz transponders at C-Band (4 and 6 GHz) with e.i.r.p. (equivalent isotropically radiated power) of 30 dBW and a linearly polarized elliptical coverage beam having 27 to 30 dB of polarization isolation.

   - The MPT expects to require three transponders by 1990 for telephony, medium speed data links, and leased line services, and expects to use twenty-five to thirty percent of total domestic satellite capacity. Thus, the MPT is not serving as a major force behind the installation of satellite communications. Some domestic satellite channels will be available for subscriber direct data transmission for computer communications and "automated office communications."

6. Introduce cellular radio technology for both fixed and mobile applications and expand the use of radio paging systems. Proper planning, budgeting, project control, and coordination principles must be followed to ensure that growth objectives are met. Project planning offices should be established, and all elements of development must be fully coordinated to ensure that expensive plant does not remain idle because some other part of the network is not yet ready.[45/]

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45/ For example, despite a backlog of 8,000 orders, in one location the U.S. team was told of 10,000 lines of spare exchange and transmission (SPC) capacity, which could not be utilized because of the absence of outside plant cable pairs.

## Long Range Planning

In addition to short term planning, a longer term view should be taken. Flexible long range planning based on assumptions and forecasts should outline a desirable sequence of events without a specific timetable. Long range plans should be developed as follows:

1. Local Service

   - Switching plans should be developed for each capital and major city. The general location, number and type of switching offices (host or remote units) required to serve each city by the year 2000 should be determined.
   - The quantity of local and tandem switches should be determined.
   - The type of transmission facilities should be specified for interoffice trunks (cable, PCM, optic fiber).

2. Subscriber Line Facilities

   - Underground conduit runs should be planned based on the switching office plans. The number of ducts in each conduit run should be specified, based on long term requirements.
   - The type of serving facility (cable, local PCM, local optic fiber) should be specified for each area and sub-area in the city.

3. Long Distance Service

   - New facility routes should be planned.
   - Types of transmission technology (PCM, microwave, optic fiber, and satellite) should be specified.

4. New Services

   - New services should be identified (DDD, IDDD, Paging, Cellular radio, etc.
   - The criteria for each new service should be established (minimum number of users, tariffs, geographic areas to be covered, etc.).

Implementation of the Development Program

There are several ways of implementing projects in the development program. For example, if new capacity is to be added, it may be possible:

1. To add lines to the existing exchange;

2. To keep the existing exchange, but start a new SPC exchange in the same building for growth;

3. To add a new SPC exchange for growth; and to replace the existing exchange;

4. To leave the existing exchange and start a new branch SPC office; or

5. To add a new SPC exchange and a Remote Switching Unit.

The best alternatives for implementing the development program in each area designated for improvement will not be found either in a cursory inspection of the plans or a comparison of initial costs. Economic selection studies must be used, which require identification of the costs and revenues associated with each alternative over a period of years. Such selection studies must include first costs (costs to purchase), maintenance, depreciation, taxes, revenue differences, and the cost of capital. Properly done, economic studies determine the most efficient use of resources in the long term.46/

Each administrative organization responsible for the development of any part of the network (rural, local, long distance, or radio, etc.) should be required to develop detailed current plans for each proposed activity in its sphere of responsibility. Each plan should include justification for the project, including a detailed explanation of the proposed manner in which it will be carried out, the material requirements and sources, the financial requirements and sources, the effect on labor, and the project schedules. The MPT can then summarize all of these plans to obtain a clear picture of total industry activity, and can provide a tool for controlling network growth.

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46/ Most U.S. universities and colleges offer courses in engineering economics, many U.S. businesses have available training courses, and there are several good textbooks available for self study.

# CHAPTER SIX

# RESEARCH IN SCIENCE AND TECHNOLOGY

## MPT's Jurisdiction over Telecommunications Research

Research in telecommunications is the responsibility of the Science and Technology Department of the Ministry of Posts and Telecommunications, which oversee thirty-five academies and research institutes employing 12,000 staff, of whom 5,000 are engineers and technicians. The main tasks of the MPT's Science and Technology Department are to carry out studies and research on policy and economic issues, network design, system standards, and electromagnetic propagation. In addition, research is devoted to development of equipment and facilities, which includes cables, microwave equipment, satellite earth stations, switching systems, optical fibers, Pulse Code Modulation equipment (PCM), telegraph switching and FAX terminals. Components are also studied.

Located in Beijing and Wuhan, the two major academies were established in 1957 and 1974, respectively. The academy at Beijing controls four subordinate research institutes in Shanghai, Chengdu, Xian, and Shaanxi, and has a staff of 8,500. Wuhan has a staff of 1,400, of whom forty percent are engineers and technicians.

## PRC's Current Research Projects

Research institutes under provincial and municipal administrations generally employ fewer than one hundred people and focus primarily on provincial operation and maintenance problems. Some planning and design work is also carried out.

Research projects which are underway at the various institutes can be summarized as follows:

- Fiber Optic Cable

  Research on fiber optic cable and devices began in the early 1970's, and subsequently, short wavelength 8 Mbits multimode experimental systems were introduced in Beijing and Shanghai for local service. In 1984, the capability had been developed to place multimode systems in service at 8 and 34 Mbits. Work is currently in progress on a 140 Mbits system which is supposed to be in service by 1990.

- Digital Equipment

  Research has been completed on a 2,000 line digital switch and also on 34 Mbits digital microwave equipment at the research institute in Beijing. Development of a 144 Mbits digital microwave system is in progress.

- Automatic Character Recognition

  Since scholars have concluded that the Chinese written language causes many problems in the learning process, as well as in printing, computerization, and communications, officials at the MPT Research Institute in Beijing consider computer-aided automatic character recognition (Han language) as one of the fundamental research areas. A 1,000 line SPC telex switch has been developed to expedite the project.

- Machine Translation

  In addition to character recognition, work is being carried out on the automated English to Chinese translation process at the Beijing Research Institute. Its purpose is to introduce western information to a society in which English language skill is generally lacking. The process requires manual intervention and correction for machine translation errors. A vocabulary of 5,000 to 7,000 words is available.

- Local Area Network (LAN) Systems

  At various research institutes, experiments are underway with both bus and ring architecture LAN systems. LAN systems are used locally within an organization or factory with no inter-communication via a network. Each local network can have several hundred terminals. There is criticism in the PRC of the incompatibility between the CCITT protocol standards and the ISO standards in regard to the use of LAN systems.

- Packet Switching and ISDN

  There is considerable interest in the area of packet switching and ISDN technologies in the PRC. These activities are being discussed in terms of R & D in MPT research institutes and universities. Topics of major interest include CSBSDC Local Area Network (Centralized Short Bus

Switch with Decentralized Control), integrated voice and data switches, integrated circuits and packet switches, etc. A definition of ISDN is still being sought, and the emerging CCITT standards have not yet been accepted.[47/]

o Satellite Technology

In Shanghai, work is in progress on the design of communications satellite antennas, microwave networks, amplifiers, and oscillators. In addition, work is being done in electromagnetic propagation and semiconductor research, which focuses primarily on silicon, with some theoretical work in gallium arsenide. A group is currently being set up to produce satellite receiving stations and electronic instrumentation.

Funding for Research

Funding for research is derived from central government sources. An additional source could be from factories providing R and D funds for the development of specific communication products.

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47/ In undertaking the task of developing technical standards and criteria, researchers at the MPT research centers work closely with the CCITT & CCIR, and follow international standards as often as possible, while ensuring that they are in harmony with the needs of the PRC.

# PART THREE

## SUMMARY AND RECOMMENDATIONS

# PART THREE

## SUMMARY AND RECOMMENDATIONS

### Summary of the U.S. Team's Findings

The existing telephone plant in the PRC today is inadequate to meet current needs or to satisfy the rapid growth in customer demand resulting from the economic reform and open door policies of the late 1970's. At present, because of the high calling rate, severe overloading, and congestion of the network, the completion rate is less than forty percent on local calls and less than twenty-five percent on long distance calls made during the busiest hours. MPT representatives in each area the U.S.team visited reported a considerable backlog of applications for telephone service, and it was clear that the demand for new telephones and other services has continued to exceed the provision of new lines and equipment.

Massive expenditures and additional resources will be required to relieve the severely overloaded network and reach the objective of improving service and satisfying demand by 1990. The sources and allocations of funds must be identified, internal capabilities must be strengthened, and formal development plans will be absolutely necessary.

Since the existing numbering plans, network configuration, and interworking arrangements lack the necessary integrity for a modern telecommunications network, it is vital for immediate steps be taken to ensure that growth is governed by a nation-wide numbering, switching, and transmission plan. An excellent opportunity exists at present to move from a communications system characterized by low penetration and antiquated technology into a system that will be the finest available in terms of advanced technology and quality of service.

Current procedures for planning, pricing, monitoring, and controlling the network need strengthening. In the area of planning alone, the scale of work to be carried out is enormous. The subject of rates, tariffs, and revenue requirements needs to be thoroughly reviewed as well, and there must be a large scale training program for personnel to support the many needs of development.

In trying to reach a decision concerning the priority of the need to meet the unfilled demand for basic telephone service versus the need to modernize the network to provide up-to-date services, the MPT has taken a compromise position between the two, dedicating financial resources to each. Emphasis is being

placed on providing modern services in the most economically developed areas to help attract all forms of development. Although improving service in the less highly developed areas has been given a lower priority, the areas in which telephone development is necessary for industry and areas important to national interests should not be overlooked.

With dedication, the PRC's long range objectives of attaining parity with the developed nations in telecommunications service and technology and achieving self reliance in manufacturing can be reached. The intermediate goals which have been identified, however, may be overly ambitious.

At the provincial level, the established programs to achieve specific goals, which are based on estimates of financial capability, appear to be inadequate. Provincial administrations are involved in day-to-day operations, and only focus on project implementation and budgets for the current year, thereby creating a gap between long term planning and short term implementation. Thus, representatives of the local administrations, who are responsible for obtaining the financial, technical, and human resources for project implementation, indicated to the U.S. team that the goals seemed unrealistically high and could not be easily met.

## U.S. Team's Recommendations

The U.S. team makes the following recommendations to aid the PRC in attaining its goals to expand and improve the existing telecommunications infrastructure. In addition to the recommendations for changes in existing policies, there are recommendations for projects which are already under consideration or implementation by the MPT.

1. National Network Planning Process: Develop a standard, uniform, national planning process for use by national and regional authorities to ensure that the most economical plans are being developed in all areas of responsibility, and that all facets of network modernization and network operations are being properly considered in the analysis. The MPT must accept its role as the senior authority for overall national standards, including switching and transmission standards, interface standards, service level standards, etc. Decision-making should take place at the appropriate level of authority in each region, and the standards should be enforced.

2. Procedures for Setting Goals: Develop systematic procedures for setting attainable goals to improve and expand the telecommunications system. Some of the most important areas to be considered are:

   - Financial Capability: Evaluate each province's capability to obtain capital finances, including both internally generated capital and potential foreign investment. Evaluate the MPT's capability to contribute capital. Research new sources of capital, such as rate and tariff increases and joint operating ventures for exportable products.

   - Material Sources: Evaluate internal manufacturing capability, and when purchasing large systems, seek commitments for quantity-related discounts from foreign vendors.

   - Human Resources: Evaluate capability of local administrations to implement growth and modernization projects. These capabilities must include planning, engineering, construction, administration, and commercial operations.

3. National Numbering, Switching, and Transmission Plans: Design and implement national numbering, switching, and transmission plans as quickly as possible. A nation-wide plan will permit orderly and economical network growth, and will accelerate the provision of DDD and IDDD services. Interface plans should allow the use of various signaling protocols in the network prior to the resolution of the CCITT's rules regarding ISDN.

4. Standards for Local and Toll Networks: Establish, publish, and distribute standards for modern construction, maintenance, and service of local and toll networks. These standards should include the use of the appropriate tools and test equipment. People must be properly trained to construct and maintain the system in a manner that will allow the networks to reach the service levels established by the standards. Technical data required to establish standards for the local and toll networks should be acquired from an operating telephone company rather than from an equipment vendor.

5. Frequency Allocations: Develop a national table of frequency allocations for radio spectrum use, and consider adopting mobile allocations compatible with the U.S. allocation table. Plan adequate spectrum allocations now for the future growth of land mobile services.[48]

6. National Standards for Public Mobile Networks: Adopt TACS as the nationwide standard for all public mobile telephone networks, and evaluate the cost effectiveness of serving fixed subscribers with TACS technology. Encourage the use of mobile exchanges that can expand capacity as the number of network subscribers increases. The use of mobile exchanges will allow P & T's in small and medium-sized cities to begin cellular operation with low financial investment, thereby maximizing return on that investment during the crucial early years of commercial operation.

   Plan now for the future growth of land mobile networks. Although the number of land mobile users is currently small, users will increase along with the economy.[49] China has the opportunity to foster the growth of land mobile radio by planning sufficient allocations now.

7. Standards for Local Network Distribution: Establish standards for selection of materials measurements, and operation of junction cable and local feeder and distribution cable for local network distribution. In addition to weighing the initial cost, network compatibility and operational requirements must be considered in selecting cable plant of all types.

8. Plans for Equipment Replacement: Establish fundamental plans for replacement of equipment in the outside plant facilities in each province. Basing growth of facilities needed on five year economic plans is not sufficient, and planning periods need to be extended to include ten or twenty years. Longer planning periods

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[48] With an annual six percent increase in demand for these services, the U.S.has found it repeatedly necessary to increase its land mobile radio allocations.

[49] In the United States, private land mobile users have grown steadily at a rate of six percent per year, with the total number of licensees now approximately eight million. Cellular radio systems in the U.S. now serve approximately 750,000 subscribers, and are expected to reach one to three million by 1990. In response to this demand, the U.S. administration has found it repeatedly necessary to increase its land mobile radio allocatio

would reduce repetitive cable reenforcements. Replacements could be reduced if cable relief were considered when the cable is seventy percent operationally filled.

In addition to the locally produced 1,800 pair cables, accelerated conversion to plastic-insulated/sheathed filled cables and adoption of plastic sheathed cables up to 4,800 pair, will also reduce replacement costs. Focusing production on only one cable insulation/sheath configuration, and fewer cable types with longer lengths, will reduce the size of inventory and cable yards, will speed up emergency replacements, and increase intertransfer flexibility.

9. Consolidation of Manufacturing: Consolidate selected manufacturing operations, eliminating duplication of facilities and differences in prices of products produced at different manufacturing facilities with variable accounting costs. If the current MPT pricing authority were decentralized, allowing individual manufacturers to determine separate prices using correct cost and market concepts, the problem would be resolved.

10. Framework for Rates: Provide an economically sound framework for international, toll, and local rates. This goal can be accomplished through use of appropriate economic and accounting cost concepts and market factors to determine specific rates for existing and new services in support of the current five year plan objectives. The following steps are recommended:

    a) Specific revenue requirements and costs of service should be determined for each service in each locality.

    b) Prices (rates) for the specific services should reflect the needs of the different regions, as well as socio-economic objectives.

    c) Consider short term, temporary price increases for local (and other) services to reduce demand pressures for expansion. To the extent that demand does not decrease with such price increases, additional revenues will be available for network expansion.

d) Develop a uniform system of accounts to consolidate and standardize cost accounting categories and procedures.

11. Expansion of Public Telephone Services: Consider expansion of public telephone service centers for local and toll calling as a short term substitute for expansion of coin-operated telephones. As coin shortages decline, coin-operated telephones can be expanded. Expanding both public telephone service centers and coin-operated telephones will tend to lessen the demand for residential service, and may also tend to consolidate both business and residential demand in the short run.

12. Evaluation of Procurement Procedures: Review recommended procurement procedures for evaluating system and equipment investments from competitive foreign suppliers. Such procedures should include consideration of life cycle costs, with analysis of alternative terms, conditions, financing, equipment, and ancillary factors.

13. Expansion of Foreign Financial Support: Consider the availability of foreign financial support, which will increase foreign exchange revenues through expanded use of multinational bank financing, countertrade, and creative joint ventures. Using financial approaches, such as multinational bank financing, countertrade, and joint ventures, will make it possible to pay for foreign equipment investment using a percentage of new service revenues earned by the specific equipment.

14. Development of Satellite Communications: Develop a long term plan which considers the use of satellites and terrestrial facilities as an integrated system, taking into account the ability of satellite systems to provide service at early dates to rural communities. Develop plans for the provision of data services via satellite. Ensure that standards for these services are established with terrestrial compatibility and long term development goals in mind. Take strong proactive positions with the Ministry of Astronautics to influence their decisions on future satellite parameters and capacity.

# PART FOUR

# APPENDICES

# APPENDIX A

## U.S. TEAM MEMBERS

### U.S. Government Representatives

| | |
|---|---|
| Alfred Sikes | Assistant Secretary of Commerce for Communications and Information; Administrator of the National Telecommunications and Information Administration (NTIA) |
| Richard Parlow | Associate Administrator for Spectrum Management, NTIA |
| Harold Kimball | Chief Scientist, NTIA |
| Charles Hutchison | Program Manager, Spectrum Plans & Policies, NTIA |
| Eric Glasscott | Senior Technical Advisor, NTIA |

### U.S. Industry Representatives

| | |
|---|---|
| Gerald Breed | Bell South International |
| Robert Chen | AT&T |
| Daniel DiFonzo | Comsat Corporation |
| Bernard Hill | Hawaiian Telephone Co./GTE |
| Michael Kennedy | Motorola, Inc. |
| Walter Kirk | Pacific Telesis International |
| Norman Lerner | Transcomm, Inc. |
| Robert Ryan | United Technologies/Essex |

# APPENDIX B

## CHINESE AND U.S. OFFICIALS INTERVIEWED

# APPENDIX B

## CHINESE AND U.S. OFFICIALS INTERVIEWED

### I. BEIJING

**Ministry of Posts and Telecommunications (MPT)**

| | |
|---|---|
| Yang Taifang | Minister |
| Zhu Gaofeng | Vice Minister |

**Directorate General of Telecommunications**

| | |
|---|---|
| Xie Xiaoan | Deputy Director General |
| He Fuqi | Chief of Division |

**External Affairs Department**

| | |
|---|---|
| Liu Zhongen | Deputy Director |

**Planning Department**

| | |
|---|---|
| Ge Lei | Deputy Director |

**Science and Technology Department**

| | |
|---|---|
| Yun Jin | Deputy Director |
| Tan Xiuqing | Deputy Division Chief, International Operations |
| Guo Fenglin | Engineer |

**Beijing Telecommunications Administration** (Provincial Bureau)

| | |
|---|---|
| Ni Yilin | Deputy Director |

BEIJING (continued)

Corporations

China National Post and Telecommunications Industry Corporation (CNPTIC)

| | |
|---|---|
| Zhang Qingzhong | Vice President |
| Lin Kanling | Assistant Engineer (Interpreter) |

Academies, Research Institutes, and Universities

Academy of Posts and Telecommunications Sciences

| | |
|---|---|
| Li Zhengfu | Director |
| Chen Yunqian | Senior Engineer |

DataCom Technology Research Institute

| | |
|---|---|
| Liu Yunjie | Deputy Director |

U.S. Embassy, Beijing

| | |
|---|---|
| Peter Thompson | Deputy Chief of Mission |
| Kenneth Stephen Chen | Second Secretary of Embassy |
| Kent Wiedemann | Second Secretary of Embassy |
| Della Knox-Bennett | Science and Technology Officer |

National Council for U.S. - China Trade

| | |
|---|---|
| Martin Weil | Director, China Operations |
| Andrew Ness | Deputy Representative |

## II. CHENGDU

### Sichuan Province Post and Telecommunications Administration

| | |
|---|---|
| Zhou Guangyong | Deputy Director, Chief Engineer |
| Chen Zhongxing | Director, Construction Department |
| Wei Guozhen | Director, Engineer, Science and Technology Department |
| Wang Huiqing | Deputy Chief Engineer, Intro. Office Director |
| Wei Xinhe | Deputy Chief of Office |
| Zou Chongxin | Assistant (Interpreter) |

### Chengdu City Telecommunications Office

| | |
|---|---|
| Gao Xuanming | Deputy Director |
| Li Qizhe | Chief, Administration Service |
| Jiang Yuankang | Manager, Toll Telecommunications |

### Research Institutes

Sichuan Post and Telecommunications Research Institute of Science and Technology

| | |
|---|---|
| Zeng Huayi | Director, Engineer |

Chengdu Institute of Radio Engineering, Radio Technology Department

| | |
|---|---|
| Liu Houming | Assistant Professor of Telecommunications (Interpreter) |

### Chengdu Cable Plant

| | |
|---|---|
| Du Liangheng | Deputy Plant Director |
| Tian Hechen | Deputy Chief Engineer |

CHENGDU (continued)

U.S. Consulate, Chengdu

| | |
|---|---|
| William W. Thomas, Jr. | Consul General |
| John G. Cook | Consul |

III. SHANGHAI

Shanghai Post and Telecommunications Administration

| | |
|---|---|
| Xu Zhichao | Director |
| Cheng Xiyuan | Deputy Director |
| Xie Xi | Vice Chief, Engineer |
| Gong Zhiwang | Deputy Chief, Accountant |
| Yan Derong | Senior Engineer |
| Wu Shiqing | Chief, Administration Office |

External Affairs Department

| | |
|---|---|
| Zou Xingnan | Deputy Chief |
| Gu Xiaomin | Interpreter |

Planning Department

| | |
|---|---|
| Jin Shiqiao | Deputy Chief |

Telecommunications Department

| | |
|---|---|
| Ge Zhuogi | Deputy Director |
| Zhou Xingsheng | Chief Engineer, Satellite |

SHANGHAI (continued)

Shanghai Long Distance Telecommunications Office

| | |
|---|---|
| Lin Qiuni | Vice Chief, Engineer |

Shanghai Local Telecommunications Office

| | |
|---|---|
| Fan Liubin | Deputy Director |
| Tu Jiaqian | Chief Engineer |
| Zhang Jian | Assistant Director |

Shanghai Post and Telecommunications Industry Corporation

| | |
|---|---|
| Feng Yongyu | General Manager |

Shanghai Telecommunications Equipment Factory #1

| | |
|---|---|
| Liu Xiansheng | Vice Director |
| Xia Yongde | Deputy Director |

Jiaotong University

| | |
|---|---|
| Shi Zhentu | Associate Director, F/O Technology Institute |
| Shen Zhiguang | Professor |
| Chen Hongbin | Professor, Electrical Engineering |
| Li Binhong | Associate Professor |

U.S. Consulate, Shanghai

| | |
|---|---|
| Ira E. Kasoff | Commercial Officer |

IV. GUANGZHOU

Guangdong Post and Telecommunications Administration Bureau

| | |
|---|---|
| Cui Xun | Chief Engineer |
| Lin Xingming | Senior Engineer |
| Li Yisheng | Deputy Director |
| Yang Jiande | Deputy Chief Engineer |

MPT Technology Import/Export Corporation

| | |
|---|---|
| Lin Kanling | Assistant Engineer |

U.S. Consulate, Guangzhou

Barry I. Friedman

V. SHENZHEN

Shenzhen Post and Telecommunications Bureau

| | |
|---|---|
| Lei Jithuo | Director |
| Xu Fiyong | Director |
| Xia Yunkai | Deputy Chief |

Shenda Telco Ltd.

| | |
|---|---|
| Hou Dongying | General Manager - Director |

# APPENDIX C

## VISIT TO PRC TELECOMMUNICATIONS FACILITIES

The final section of the U.S. team's report, entitled "Visit to PRC Telecommunications Facilities," provides factual information regarding the workings of the telecommunications facilities in Beijing, Chengdu, Shanghai, Guangzhou, and Shenzhen, which the team saw in November, 1986. The sites examined and the information imparted at each of the five locations provided the material and conclusions contained in Chapters One through Six.

## BEIJING TELECOMMUNICATIONS AUTHORITY (BTA)

Despite the fact that the Ministry of Posts and Telecommunications (MPT), which is located in Beijing, has primary responsibility for telecommunications in the PRC, the provincial administrations, which control planning and development in this sector, have a considerable amount of local autonomy. Growth of service depends to a large extent on the general economic state of each individual province, which dictates the amount of capital available for development projects, as well as determining the political decisions regarding priorities in the distribution of development capital.[1/]

The Beijing Telecommunications Authority (BTA) oversees six bureaus, which are responsible for local service, long distance service, telegraph service, radio communications, rural and suburban service, and a general station and line maintenance office. With approximately 15,000 employees, the BTA has a switching capacity totaling 190,000 lines, of which forty-five percent are step-by-step, thirty-five percent crossbar, and twenty percent SPC. There are five SPC tandem exchanges.

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1/ In rural areas there are ten counties mostly served by crossbar with one or two SPC offices to be installed in the next two years.

There are eight hundred telephone operators and 360,000 telephones in service in the Beijing area.[2/] Direct dialing is possible to major cities throughout China.[3/] An average of 53,000 long distance calls are completed each day, and are switched through an SPC exchange and a crossbar exchange. By early 1987, there will be 60,000 lines of SPC in service and 100,000 lines of SPC capacity.

International service is handled by three earth stations in the Beijing area, two of which transmit to the Indian and Pacific Ocean INTELSAT satellites, with the third used by the Ministry of Broadcasting and Television for internal broadcasting and television transmissions.[4/] The international service handles 5,000 calls daily, of which sixty percent originate in Beijing.

The transmission network in the urban area operates entirely by cable, with two hundred kilometers of fiber optic systems (six and twelve core) operating at 34 and 140 mb/s in service, which are used for trunk lines between tandems and from tandems to end offices. A cellular mobile system is currently under construction with five base stations, and seven hundred subscribers are expected next year. A paging system was installed in 1985, and now has 1,800 subscribers.

Currently only 7.2 percent of the population in Beijing and other cities served by the BTA has telephone service. The waiting list in Beijing alone is 66,000, despite the fact that in 1986, 25,000 new subscribers were added. In 1987, 100,000 new lines are under construction to relieve the backlog, and by 1990, the percentage of the population with telephone service is expected to increase to twelve percent. By the year 2000, 1.2 to 1.4 million lines will be in service in the greater Beijing area, and telephones will number 1.8 to 1.9 million.

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2/ Beijing covers an area of 17,000 square kilometers, and has a population of 9.57 million people, 5.6 million of whom reside in the central city, an area measuring 1,400 square kilometers.

3/ Transmission circuits are mainly four and eight-tube coaxial cable (with 1,800 channel capacity), analog microwave of 960 channels capacity, and five domestic satellite earth stations, which will increase to twenty in the current five year plan.

4/ In July, 1986, IDDD was introduced to thirteen countries, and by the end of the year the number of countries will increase to seventeen. Two hundred circuits are available now, which will increase to six hundred by June, 1987, and to 1,000 in 1988.

Beijing's telegraph switching center, which has three hundred fifty lines, is the largest in the PRC, and handles 120,000 messages daily via an automatic message switching center, which interconnects with eighteen other switching centers.[5/] The Beijing telex machine currently has a 7,000 line capacity and 1,600 subscribers, with an annual increase of four hundred to five hundred subscribers.

In terms of data services, leased lines and data retrieval are provided, and data bases in the U.S. and Europe can be accessed. Data traffic to the U.S., which is third in volume after data traffic to Japan and Hong Kong, is handled via International Telephone & Telegraph Corporation (ITT), American Telephone & Telegraph Company (AT&T), Radio Corporation of America (RCA), Western Union International (WUI), and Western Union Telegraph (WUT). Although there is currently only a small node for data retrieval in Beijing, by the end of 1987, a packet switch network connecting Shanghai, Guangzhou, and other cities is expected to be in service.[6/] Access to the packet switch will be via public switched network.

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5/ China's other telegraph switching centers, which are smaller than the Beijing switching center, vary from 64 to 256 lines.

6/ Data access from computer to computer uses X.75 protocol for international service, X.25 for domestic access and X.75 for city to city data transfer at a speed of 9.6 kb/s.

## SICHUAN PROVINCE POST AND TELECOMMUNICATIONS ADMINISTRATION

Sichuan Province covers a total area of 567,000 square kilometers, extending five hundred kilometers from east to west and nine hundred kilometers from north to south. It is seventy-eight percent mountainous, with a climate which varies from an average of 16 to 18 degrees centigrade in the east to 2 to 8 degrees centigrade in the mountains. With twenty major cities and two hundred fifteen counties, Sichuan Province has the largest provincial population in China, with ninety-five percent of its people living in the Sichuan basin area.

Postal, telephone, and telegraph services are administered and operated by the Sichuan Post and Telecommunications Administration, and with the exception of Chengdu and Chunching, telecommunications services are handled separately from postal services. The organization of the Post and Telecommunications Administration extends to the county and rural levels, with a Rural Telecommunications Bureau in charge of telecommunications affairs in outlying areas.

Growth rates in the province have been high, with toll traffic increasing almost sixteen percent annually and telegraph traffic at eighteen percent.[7/] Local service growth averages about ten percent annually, and is expected to continue at this rate. Although in the early 1950's, only local and long distance service were provided, now conference calls, FAX, television broadcasting, and low speed data are available, and all cities in China and one hundred forty countries can be reached from Chengdu via long distance service.

At the end of 1985, the total switching capacity in the province provided approximately 160,000 lines, most of which had step-by-step and crossbar connections on an analog network.[8/] Fiber optic cables now connect the Chengdu host office to the remote offices. The Sichuan Post and Telecommunications Administration has reached supply agreements with the Shanghai Bell/BTM joint venture for the future provision of SPC system 12 switching.

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7/ Forecast growth is for toll to continue to increase at eight percent, telegraph at fifteen percent, and telex at thirty-five percent.

8/ Some stored program control switching has been introduced, with 10,000 lines in Chengdu (8,000 in the host office and 2,000 in the remote offices); 10,000 lines in Chungching; and 7,000 lines in Zse-gong.

The cable network in Sichuan Province consists of 2,800 route kilometers of cable, and in the rural areas open wire is widely used, with approximately 130,000 kilometer pairs. In addition, plans have been made to install six hundred kilometers of digital microwave equipment to interconnect eight cities in the province using 140 Mbits systems for the backbone routes, and 34 Mbits for spur routes. Potential suppliers for this equipment are Nippon Electric Company (NEC), General Telephone & Electronics in Milan (GTE/MILANO), ALCATEL, and ITALTEL.

The present switching and distribution networks are full, and to meet demand and relieve congestion, 200,000 new lines are in the planning phase. Rural growth will include increased use of twelve and twenty-four channel open wire carriers.

## SHANGHAI POST AND TELECOMMUNICATIONS ADMINISTRATION

Shanghai is an industrial center with the largest seaport in China. Whereas the city itself covers three hundred fifty square kilometers, and has a population of six million, the greater Shanghai area covers 6,000 square kilometers with a population of twelve million. As a center for international telecommunications traffic, Shanghai has a research institute, a design institute, a technical training school, and an equipment factory, which provides optical fiber and crossbar telephone switching equipment.

Postal service was first started in 1871, with telephone service available since 1882. Today, 30,000 people are employed by the Shanghai Post and Telecommunications Administration, and 12,000 employees work in the telecommunications division. Currently the Shanghai Telecommunications Administration serves 270,000 lines, of which 200,000 are in the city and 70,000 in rural areas.9/

The city telephone network has ninety percent of its 200,000 line switching capacity in use, and because of overloading, the completion rate for telephone calls in the network is only about forty percent. The network itself comprises twenty local exchanges and ten tandem exchanges, with full trunk lines connecting the main cities, counties, and rural networks.

The inter-office trunk lines use voice grade copper cables, which are loaded, or use repeaters as necessary. Trunk lines from city exchanges to the county and rural networks employ twelve channel FDM systems. Switching systems are sixty-five percent crossbar, thirty percent BTM rotary, and five percent step-by-step. An ITT/BTM system 1240 SPC exchange has been installed, but problems with this machine have delayed its activation for more than a year, and no new start-up date has yet been established.

In addition to the congestion problem in the network, major problems created by conduit and cable vault congestion cause difficulty in new cable placement. Air pressure systems are used to help prevent outages in the cable network, but many problems result from damage caused by contractors, who are working on the system.

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9/ In Shanghai, the provision of telephone service increases at a rate of about twenty percent annually, and there is currently a recorded backlog of 60,000 subscribers.

Within Shanghai, cables are in conduit and the largest size used is 1800 pair 4 mm or 26 AWG. Cables in the suburban network are mostly aerial air core in rings. Discussions concerning the outside plant network revealed the use of about a fifty-fifty split between air core and filled cables. Plastic metallic cables for new construction are purchased from England and Japan because they are less expensive, but future procurement will probably come from the Chengdu cable factory.

The area outside the city is made up of ten counties in addition to the rural areas. Twenty thousand lines are in place in the counties, and 50,000 in the rural zones. Seventy percent of these lines have to reach an operator in order to attain access to the network for the city of Shanghai or beyond. By 1990, the number of installed lines is expected to increase to 850,000, providing six and a half percent of the population with telephone service. Eighty percent of these subscribers are supposed to have access to DDD, and trunk provision will be increased to 7,300 circuits.

## Shanghai Crossbar and Lead Cable Factory

The Shanghai Crossbar and Lead Cable factory, which began manufacturing lead cable and automatic switching equipment in 1973, has more than 1,000 employees, of whom one hundred twenty-eight are involved in technical jobs. The management staff includes a director, three vice-directors, an office director, and a chief engineer, who together administer eleven departments and four workshops dealing with crossbar, cable, components, and power.

The plant, which occupies 54,000 square meters, has 8,000,000 Yuan in fixed assets. Production reached 40,000,000 Yuan with an operating income of 10,000,000 Yuan in 1985. Current objectives are focused on increasing revenues three to seven percent each year in the seventh Five Year Plan.

Since its inception, the factory has produced 440,000 lines of switching equipment and 1.6 million sheath kilometers of cable, which supply more than ten provinces and cities in China with products. The objectives within seventh Five Year Plan include the following goals:

- production of 730,000 lines of crossbar switching equipment;
- production of 1.2 million kilometers of different types of cable; and
- creation of a manufacturing capability for SPC switching equipment and optical fiber cable.

Trial production of polyethylene-insulated and polyethylene-jacketed cables has taken place, which has shown how to manufacture these cables with material specifications from Essex/Chengdu and Fujikura of Japan, as well as from ICEA and REA. There are no joint ventures or technical transfer agreements currently dealing with the production of plastic cables. Problems experienced in manufacturing locally are the result of purchasing non-standardized domestic raw materials, such as wires with inconsistent diameters, and medium and high density polyethylene of substandard quality.

## GUANGDONG POST AND TELECOMMUNICATIONS ADMINISTRATION

Guangdong Province covers an area of 210,000 square kilometers and has a population of 63,000,000 people. Approximately seventy percent of the population lives in the subtropical coastal plains and delta region, with the remaining thirty percent living in the mountainous northern and central parts of the province. The capital, Guangzhou, which is an important industrial and foreign trade center, and its six surrounding counties, support a population of about 5.3 million on the northern bank of the Pearl River delta.

The Guangdong Post and Telecommunications Administration is responsible for postal and telecommunications services for all the cities and counties in the province, with the exception of Guangzhou, which has its own separate P & T administration. Prior to 1980, when all toll traffic was handled by operators, about sixty percent of the province was served by crossbar automatic exchanges, with the remaining forty percent of the province, which is primarily rural, served by manual switchboards. The percentage of the population receiving telephone service in the province at that time was only 0.3 percent.

Since 1980 the switching capacity has been increased one hundred percent, and by 1986 there were 4,000,000 lines in the province, half of which were in the city of Guangzhou. The average density of telephone service had increased to 0.62 percent, with 2.39 percent receiving service in Guangzhou. The percentage of lines served by automatic switches had increased to more than eighty percent.

Since 1980, industry has increased by 16.2 percent, agriculture by three percent, and three Special Economic Zones have been established. Despite this expansion, because of its rapid growth, Guangdong Province continues to have many telecommunications problems, among which is a backlog of 20,000 potential subscribers waiting for service.

The U.S. team visited the Special Economic Zone at Shenzhen, in which the population increased from 30,000 in 1979 to 250,000 in 1985. In 1979, in addition to twenty-one long distance circuits, there was one four hundred-line crossbar exchange, which increased to 27,000 lines of digital SPC switching (AXE-10) with 16,000 working lines by 1985. ALthough there is spare switching capacity, shortages of outside plant cable pairs have created a backlog of approximately 8,000 potential subscribers.

Telephone services in the Shenzhen area are operated by a joint venture created by Shenzhen Development Corporation and Cable & Wireless, Ltd. The joint venture, which was founded in 1983 with a capitalization of 20,000,000 Yuan, currently makes 66,000,000 Yuan.

Development of telecommunication facilities in Shenzhen during the seventh Five Year Plan will include construction of:

- a second local exchange with 25,000 lines;
- a toll switching system with 1,400 circuits;
- a rural tandem exchange system with 3,600 lines;
- an analog microwave system with 1,800 channels;
- a 140 Mbits optical single mode fiber system with eight cores;
- a 560 Mbits optical single mode fiber system with twelve cores;
- a mobile telephone network in the delta of the Pearl River; and
- data and facsimile services.

In addition, the seventh Five Year Plan calls for the introduction of SPC telephone exchanges and packet switches, optical fiber systems to Hong Kong and Macau, cellular radio systems for both fixed and mobile applications, and increasing the telephone density in the cities to ten percent.

# APPENDIX D

## U.S. - CHINA PROTOCOL

# PROTOCOL BETWEEN THE DEPARTMENT OF COMMERCE OF THE UNITED STATES OF AMERICA AND THE MINISTRY OF POSTS AND TELECOMMUNICATIONS OF THE PEOPLE'S REPUBLIC OF CHINA ON COOPERATION IN THE FIELD OF TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY

In accordance with the Agreement between the Governments of the United States of America and the People's Republic of China on Cooperation in Science and Technology, signed in Washington on January 31, 1979 and extended on January 12, 1984, and for the purpose of promoting scientific and technological cooperation in the field of telecommunications, the Department of Commerce of the United States of America and the Ministry of Posts and Telecommunications of the People's Republic of China (hereinafter referred to as the Parties) have agreed as follows:

## ARTICLE I

The Parties agree to conduct scientific and technological exchange and cooperation in the field of civil and commercial telecommunications on the basis of equality, mutual benefit, reciprocity and subject to the laws and regulations of the Parties.

## ARTICLE II

The Parties agree on cooperation which may include the following fields:

1. Electromagnetic wave propagation associated with telecommunications science and technology;

2. Standards and criteria for U.S. civilian terrestrial and space communications systems;

3. Civil emergency communication for natural disasters;

4. Practical telecommunications techniques in terrestrial and space communications for civilian applications; and

5. Other fields as may be mutually agreed.

ARTICLE III

The Parties agree on cooperation which may take the following forms:

1. Exchange of scientific and technological information on topics of mutual interest;

2. Exchange of specialists, scholars, scientific, and technical personnel, delegations and teams;

3. Joint research on subjects of mutual interest;

4. Joint organization of academic seminars, symposiums, courses and lectures;

5. Scientific and technological cooperation between governmental departments, industry enterprises, technical institutes and universities; and

6. Other forms of cooperation as mutually agreed.

ARTICLE IV

The cooperative activities carried out under this Protocol will be subject to the availability of funds and manpower to the Parties. The specific tasks, obligations and conditions with respect to each activity referred to in Article III of this Protocol shall be listed in the Annexes to this Protocol. It is agreed that, with respect to reciprocal expert study groups, the sending Party shall pay fares for international travel. The receiving side shall pay all the costs of board, lodging and transportation within its boundary and medical treatment in case of emergency. Otherwise non-reciprocal activity shall be decided by mutual agreement on a case-by-case basis.

ARTICLE V

Activities under this Protocol shall be conducted under the guidance of the U.S.-PRC Joint Commission on Scientific and Technological Cooperation.

In order to implement this Protocol, each Party shall designate a representative who shall be responsible for coordinating and assuring implementation of the provisions of this Protocol for its side. The designated representatives of the Parties shall consult with each other by correspondence and decide upon cooperative activities and other related matters. If needed, a meeting(s) may be convened with mutual consent to discuss matters related to the implementation of the Protocol.

ARTICLE VI

The scientific and technological information derived from the cooperative activities under this Protocol is not to be released to any other government or to the world scientific community without previous agreement by both Parties. If necessary, the information needs to be reviewed on a case-by-case basis.

ARTICLE VII

The scientific and technological information provided by one Party to the other under this Protocol shall be accurate to the best of the knowledge and belief of the providing Party, but the providing Party does not guarantee the suitability of the scientific and technological information provided for any particular use or application by the receiving Party.

ARTICLE VIII

The Parties recognize the need to agree upon provisions concerning the protection of copyrights and the treatment of inventions or discoveries made or conceived in the course of this Protocol in order to facilitate specific activities hereunder. Such provisions shall be made an annex to this Protocol.

ARTICLE IX

This Protocol shall enter into force upon signature, and shall remain effective for a five-year period. It may be amended or extended with the mutual written consent of the Parties. The Protocol may be terminated at any time at the discretion of either Party, upon six months' advance notification in writing by the Party seeking the termination.

The expiration and termination of this Protocol shall not affect the validity or duration of the specific activities under this Protocol which are initiated during its valid period.

Done at Washington this sixteenth day of May, 1986, in duplicate in the English and Chinese languages, both texts being equally authentic.

Malcolm Baldrige

For the Department of Commerce
of
the United States of America

For the Ministry of Posts
and Telecommunications of
the People's Republic of China

# ANNEX I

# TO THE PROTOCOL BETWEEN THE DEPARTMENT OF COMMERCE OF THE UNITED STATES OF AMERICA AND THE MINISTRY OF POSTS AND TELECOMMUNICATIONS OF THE PEOPLE'S REPUBLIC OF CHINA ON COOPERATION IN THE FIELD OF TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY

In accordance with Article VIII of the Protocol on cooperation in the field of telecommunications between the Department of Commerce of the United States of America and the Ministry of Posts and Telecommunications of the People's Republic of China (hereinafter referred to as the Protocol), signed in Washington on the eighteenth day of May, 1986, by the Department of Commerce of the United States of America and the Ministry of Posts and Telecommunications of the People's Republic of China (hereinafter referred to as the Parties), the Parties agree as follows:

I. The Parties agree that any information of a confidential nature exchanged under this Protocol or its Annexes (such as trade secrets and technical know-how or information with obligation concerning its confidentiality requested by either Party), shall be protected. A decision to introduce and furnish such information shall be made only by mutual agreement of the Parties which may be arrived at on a case-by-case basis through consultation between the representatives designated by both Parties (designated representatives) under Article V of the Protocol, or as otherwise agreed by the Parties.

II. As to inventions or discoveries made or conceived under the Protocol or Annexes, the Parties agree:

1. If the invention or discovery is made or conceived by personnel of one Party as a result of the exchange of information between the Parties such as by joint meetings, seminars, or exchange of technical reports or papers:

(a) The Party whose personnel made the invention or discovery (the inventing Party) is entitled to obtain all rights and interests in the invention or discovery in all countries, subject to a nonexclusive, irrevocable, royalty-free license to the other Party, its government and nationals; and

(b) In the event the inventing Party decides not to obtain such rights and interests in the other Party's country, or a third country, the other Party may do so, subject to a nonexclusive, irrevocable, royalty-free license to the inventing Party, its government and nationals.

2. If the invention or discovery is solely or jointly made or conceived by personnel of one Party (the assigning Party) while assigned to the other Party (the receiving Party) during exchange of scientific and technical personnel:

(a) The receiving Party is entitled to obtain all rights and interests in the invention or discovery in its country, and third countries, and the assigning Party is entitled to all rights and interests in its country, and a nonexclusive, irrevocable, royalty-free license in third countries for use by the assigning Party, its government and nationals; and

(b) In the event the receiving Party decides not to obtain such rights and interests in third countries, or a particular third country, the assigning Party may do so, subject to a nonexclusive, irrevocable, royalty-free license to the receiving Party, its government and nationals.

3. If the invention or discovery is made or conceived as a result of other forms of cooperation such as joint research or under the circumstances as set forth in paragraph 1 above by personnel of both Parties (co-inventors), the Parties shall provide for appropriate distribution of the rights. In general, each Party shall normally own the rights to such inventions in its own country, and third country rights shall be agreed upon by the Parties on an equitable basis.

4. The Party whose personnel made the invention or discovery shall communicate to the other Party information disclosing the invention, any patent or other protection it elects to obtain, and furnish documentation necessary for the establishment of the other Party's rights in the invention. The communicating Party may ask the other Party to delay publication or public disclosure of such information, provided that this restriction does not extend beyond six months from the date of the communication of such information.

III. Either Party, or any entity acting under agreement with either Party, may obtain copyright protection in its own country and third countries on works which the Party or its entity originates under the Protocol or Annexes, in which event the non-originating Party, its government and nationals shall have a nonexclusive, irrevocable and royalty-free license under the copyrights to translate, reproduce, publish and distribute such works.

IV. Each Party shall assume the responsibility to pay awards or compensation required to be paid to nationals of its own country according to the laws of its country.

V. Other questions or issues that arise under this Annex shall be settled through consultation between the representatives designated by both Parties or their designated departments under Article V or as otherwise agreed by the Parties.

VI. This Annex shall enter into force upon signature of the Protocol by both Parties and shall remain in force for the duration of the Protocol.

# ANNEX II

## TO THE PROTOCOL BETWEEN THE DEPARTMENT OF COMMERCE OF THE UNITED STATES OF AMERICA AND THE MINISTRY OF POSTS AND TELECOMMUNICATIONS OF THE PEOPLE'S REPUBLIC OF CHINA ON COOPERATION IN THE FIELD OF TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY

In accordance with the Protocol between the Department of Commerce of the United States of America and the Ministry of Posts and Telecommunications of the People's Republic of China (hereinafter referred to as the Parties) on cooperation in the field of telecommunications, (hereinafter referred to as the Protocol), signed in Washington on the sixteenth day of May, 1986, the Parties have agreed to conduct the following activities.

I. The United States side will send a study group of technical experts from its government and telecommunication industry enterprises to visit China in the second half of the year 1986. The specific areas of study will include:

1. The status of development of Chinese civil telecommunications and its needs;

2. The status of the operation of Chinese civil telecommunications facilities;

3. The status of Chinese scientific and technological development in telecommunications; and

4. The establishment and promulgation of Chinese telecommunication standards and the establishment of tariffs for communication services.

II. The Chinese side will send a study group of experts to visit the United States in the first half of the year 1987. The specific areas of study will include:

1. The status of development of American civil telecommunications;

2. The status of the operation of American civil telecommunications facilities;

3. The development of American telecommunication science and technology and production; and

4. Exploration of specific details in bilateral cooperation in telecommunications technology and the application of communication systems in the field of civil and commercial communication.

III. It is agreed that with respect to the above mentioned exchange of expert study groups:

1. The sending Party shall pay fares for international travel. The receiving side shall pay all the costs of board, lodging and transportation within its boundary and medical treatment in case of emergency.

2. The specific details concerning the number of personnel in each study group, studies to be undertaken and the schedule to be followed will be decided through consultation by the Parties' representatives.

IV. It is agreed by the Parties that, depending on practical considerations by each Party, the following programs will be undertaken during the effective period of the Protocol:

1. The Chinese side will send two experts to study electromagnetic wave propagation at the Institute for Telecommunication Sciences (hereinafter referred to as ITS) affiliated with the U.S. National Telecommunications and Information Administration; the United States side will send two experts to China to lecture on the subject of satellite communication and electromagnetic wave propagation of microwave communications;

2. The Chinese side will send two experts to the United States for joint research on the subject of system analysis and technical standards criteria. The United States side will send two experts to China to lecture on the same subject;

3. The United States side will provide the Chinese side with relevant information on civil emergency communications for natural disasters, and the Parties will consult on specific cooperation in this field; and

4. The Parties agree that, with respect to expense matters relating to the implementation of activities described in Paragraph IV of this Annex, the sending side shall pay fares for international travel and the receiving side shall pay all the costs of board, lodging and transportation within its boundary and medical treatment in case of emergency.

5. This Annex shall enter into force upon signature of the Protocol by both Parties.

# APPENDIX E

## FIGURES AND TABLES

TABLE 1

Cellular System Parameters

| | AMPS | TACS | NMT-900 | NMT-450 |
|---|---|---|---|---|
| Transmit Frequency Band (MHz) | | | | |
| - Base Station | 820-890 | 935-960 | 890-915 | 463-467.5 |
| - Mobile Station | 825-845 | 890-915 | 935-960 | 453-457.5 |
| Channel Spacing (kHz) | 30 | 25 | 25 | 25 |
| Voice Signals | | | | |
| - Type of Modulation | FM | FM | FM | FM |
| - Peak Deviation (kHz) | ± 12 | ± 9.5 | ± 5 | ± 5 |
| - Comapnding | Yes | Yes | Yes | No |
| Control Signals | | | | |
| - Transmission Rate (kbps) | 10 | 8 | 1.2 | 1.2 |
| - Peak Deviation (kHz) | ± 8.0 | ± 6.4 | ± 3.5 | ± 3.5 |
| - Effective Data Rate (bps) | 270-1200 | 220-960 | 460 | 460 |
| - Error Detection | Yes | Yes | No | No |
| Paging Capacity (Single Word Messages, 50% loading) | 77,760/hour | 62,000/hour | 13,000/hour | 13,000/hour |

| Service Category | | Over 1000 Lines | | 2000 - 10,000 Lines | | 501 - 2,000 Lines | | Up to 500 lines | |
|---|---|---|---|---|---|---|---|---|---|
| Class of Service | | Res. | Bus. | Res. | Bus. | Res. | Bus. | Res. | Bus. |
| Single Line | | 12.00 | 20.00 | 11.00 | 18.00 | 8.00 | 12.00 | 5.00 | 8.00 |
| Exentsion | | 4.00 | 6.50 | 3.50 | 6.00 | 3.00 | 4.50 | 2.00 | 3.00 |
| Party Line | | 16.00 | | 14.50 | | 10.80 | | 6.50 | |
| Multiple Subscriber Using One Set | 2 Subs | 14.00 | | 12.50 | | 9.00 | | 5.50 | |
| | 3 Subs | 12.00 | | 11.00 | | 8.00 | | 5.00 | |
| | 4 Subs | 10.00 | | 9.00 | | 6.50 | | 4.00 | |
| Trunk | | 60.00 | | 54.00 | | 39.00 | | 24.00 | |
| Leased | | 30.00 | | 27.00 | | 19.50 | | 12.00 | |
| Leased Term. | TP Set | 1.00 | | | | | | | |
| | RCVR | 2.00 | | | | | | | |
| | JK. BL. SW. | 1.00 | | | | | | | |
| Outside Boundary | | Per Km. 5.00 | | | | | | | |
| Beyond Boundary | | Per Km. 10.00 | | | | | | | |
| Public Telephone | | Per Call 0.04 | | | | | | | |

Table 2

Local Telephone Tariff Monthly

| Service Category | Over 10,0000 Lines | | | Less Than 10,000 Lines | | |
|---|---|---|---|---|---|---|
| Class of Service | Res A | Res B | TRNK | Res A | Res B | TRNK |
| Monthly Charge (Yuan) | 10.00 | 16.00 | 48.00 | 8.00 | 13.00 | 39.00 |
| Free Unit Calls Per Month | 60 | 100 | 300 | 60 | 100 | 300 |
| Each Additional Call | 4 Fen Per Call | | | | | |

Table 3

Local Telephone Tariff, Monthly Metering

| | Service Fee (Yuan) | Materials |
|---|---|---|
| Single Line | 8.00 | As Required |
| Extension | 8.00 | " " |
| Party Line | 8.00 | " " |
| Private or Leased Line | 8.00 | " " |
| Jack/Block | 3.00 | " " |



Table 4

Local Telephone Tariff
Move and Installation

TABLE 5

# Rates for Some of the Countries and Territories

# 部份国家和地区电信价目表

RMB Yuan
人民币 元

| Destination 通达地点 | Telegram per word 电报 每字 | Telex per min. 用户电报 每分钟 | Telephone | |
|---|---|---|---|---|
| | | | per min. 每分钟 | surcharge 附加费 |
| Argentina 阿根廷 | 2.90 | 12.20 | 14.50 | |
| Australia 澳大利亚 | 1.90 | 9.20 | 9.70 | 9.70 |
| Austria 奥地利 | 1.90 | 9.20 | 14.50 | |
| Belgium 比利时 | 2.00 | 9.20 | 14.50 | 14.50 |
| Brazil 巴西 | 3.20 | 12.20 | 14.50 | |
| Canada 加拿大 | 1.90 | 9.20 | 13.60 | |
| Denmark 丹麦 | 1.90 | 9.20 | 10.90 | 10.90 |
| Finland 芬兰 | 1.90 | 9.20 | 10.90 | 10.90 |
| France 法国 | 1.90 | 9.20 | 14.50 | |
| Germany (Fed. Rep.) 联邦德国 | 1.70 | 9.20 | 10.90 | 10.90 |
| Greece 希腊 | 1.90 | 9.20 | 14.50 | |
| Hongkong 香港 | Chinese 0.24 中文 others 0.48 其它 | 7.20 | 6.00 | 6.80 |
| Indonesia 印度尼西亚 | 0.90 | 9.20 | 10.90 | |
| Italy 意大利 | 1.90 | 9.20 | 10.90 | 10.90 |
| Japan 日本 | 1.10 | 9.20 | 6.60 | 6.60 |
| Kuwait 科威特 | 1.40 | 9.20 | 9.70 | |
| Malaysia 马来西亚 | 2.20 | 9.20 | 10.90 | |
| Mexico 墨西哥 | 3.30 | 12.20 | 14.50 | |
| Netherlands 荷兰 | 1.90 | 9.20 | 10.90 | 10.90 |
| New Zealand 新西兰 | 1.90 | 9.20 | 10.90 | 10.90 |
| Norway 挪威 | 1.90 | 9.20 | 10.90 | 10.90 |
| Philippines 菲律宾 | 1.20 | 9.20 | 12.70 | |
| Singapore 新加坡 | 1.20 | 9.20 | 9.00 | 18.00 |
| Spain 西班牙 | 1.40 | 9.20 | 10.90 | 10.90 |
| Sweden 瑞典 | 1.90 | 9.20 | 10.90 | 10.90 |
| Switzerland 瑞士 | 1.90 | 9.20 | 10.90 | |
| Thailand 泰国 | 2.00 | 9.20 | 10.90 | 10.90 |
| United Kingdom 英国 | 1.90 | 9.20 | 10.90 | 10.90 |
| United States 美国 | 2.20 | 9.20 | 10.90 | 15.70 |
| Yugoslavia 南斯拉夫 | 1.80 | 9.20 | 10.90 | 10.90 |

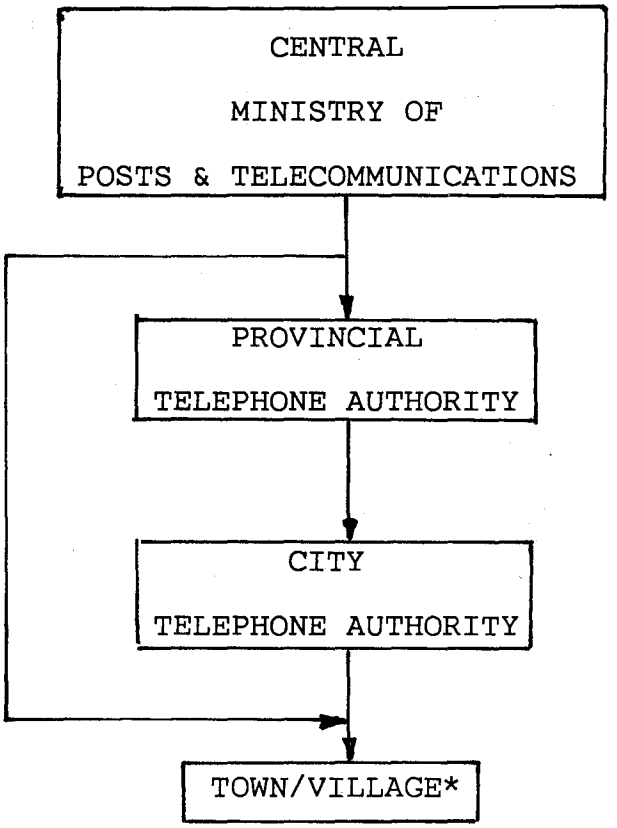
Table 6

ECONOMIC PRIORITY CITIES, ZONES AND REGIONS

| | | |
|---|---|---|
| Municipalities: | Beijing | |
| | Shanghai | |
| | Tianjin | |
| Special Economic Zones: | Zhuhai | |
| | Shenzhen | |
| | Xiamen | |
| | Shantou | |
| Coastal Cities: | Dalian | Shanghai |
| | Qinghuangdao | Ningbo |
| | Tianjin | Wenzhou |
| | Yantai | Fuzhou |
| | Qingdao | Guangzhou |
| | Lianyungang | Zhanjiang |
| | Nantong | Beihai |
| Coastal Regions: | Long River Delta | |
| | Pearl River Delta | |
| | Xiamen-Zhangjian-Chuanzhou Delta | |

Figure 1

TELECOMMUNICATIONS HIERARCHY




* Jurisdiction for Rural Telecommunications varies by region.

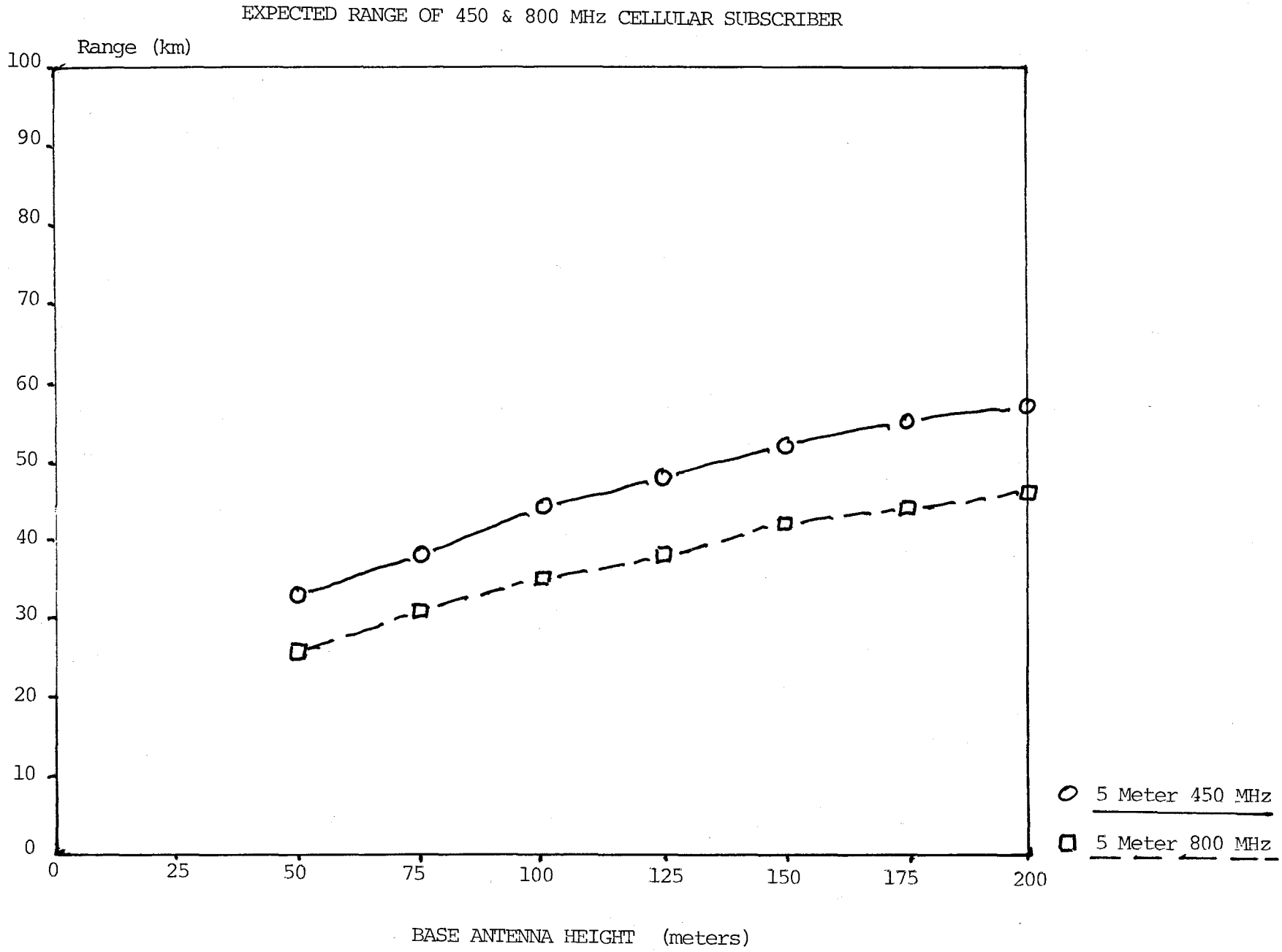
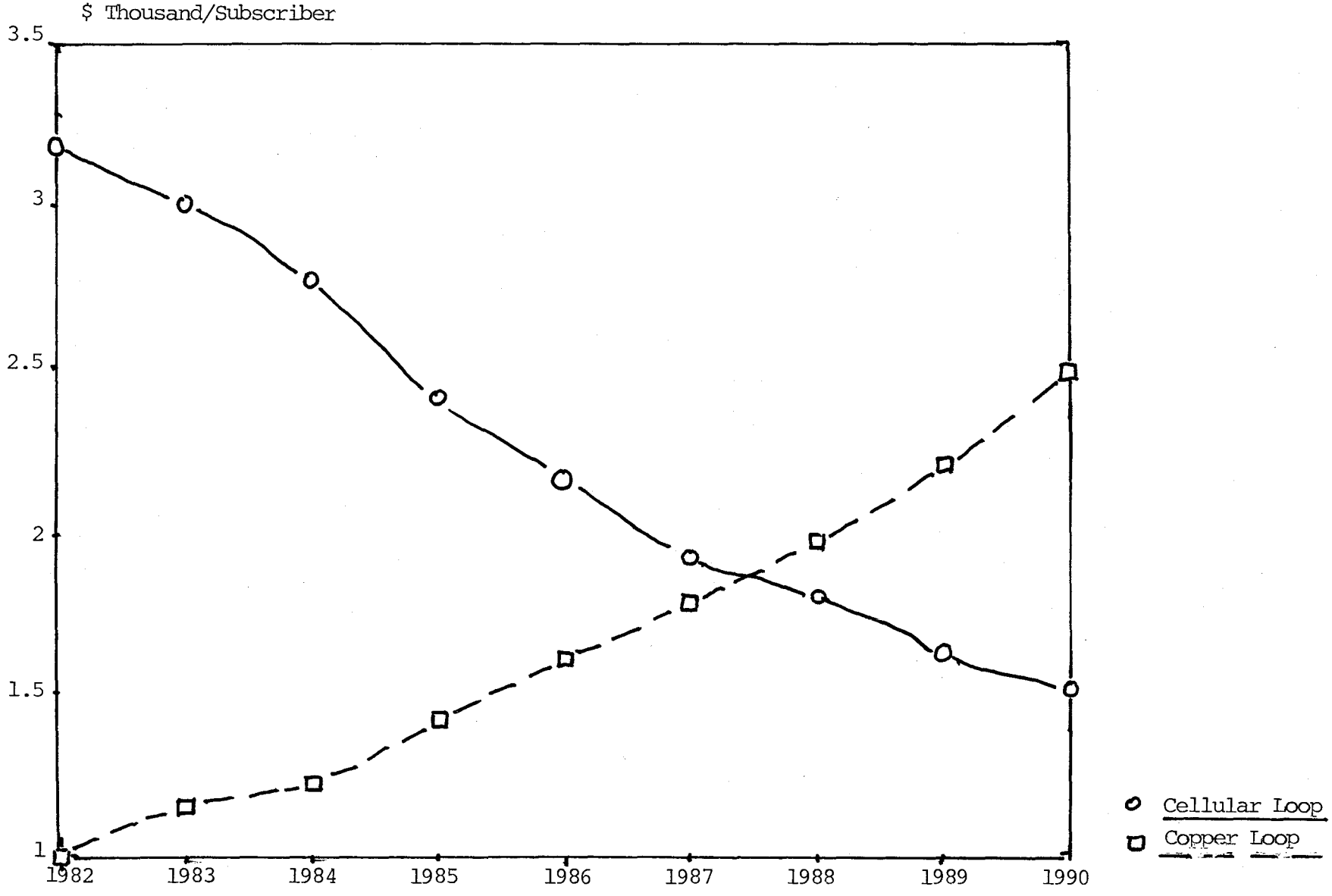

EXPECTED RANGE OF 450 & 800 MHz CELLULAR SUBSCRIBER
Range (km)
100
90
80
70
60
50
40
30
20
10
0
0
25
50
75
100
125
150
175
200
BASE ANTENNA HEIGHT (meters)
5 Meter 450 MHz
5 Meter 800 MHz

Figure 2

SUBSCRIBER LOOP COSTS



## APPENDIX F

LIST OF ABBREVIATIONS

| | |
|---|---|
| AMPS | Advanced Mobile Phone Service |
| AT&T | American Telephone & Telegraph Company |
| AWG | American Wire Gauge |
| BTA | Beijing Telecommunications Authority |
| BTM | Bell Telephone Manufacturing Company (Belgian ITT subsidiary) |
| CCIR | International Radio Consultative Committee of ITU |
| CCITT | International Telephone & Telegraph Consultative Committee of ITU |
| CSBSDC | Centralized Short Bus Switch with Decentralized Control |
| dB | Decibel |
| dBW | Decibel Watts |
| DDD | Direct Distance Dialing |
| e.i.r.p. | Effective Isotropic Radiated Power |
| FAX | Facsimile |
| FDM | Frequency Division Multiplex |
| GHz | Gigahertz |
| GTE | General Telephone & Electronics |
| ICEA | Insulated Cable Engineers Association |
| IDDD | International Direct Distance Dialing |
| ISDN | Integrated Services Digital Network |

| | |
|---|---|
| ISO | International Standards Organization |
| ITT | International Telephone & Telegraph Corporation |
| ITU | International Telecommunication Union |
| kb/s | Kilobits per second |
| kw | Kilowatts |
| LAN | Local Area Network |
| Mbits | Megabits |
| MHz | Megahertz |
| mm | Millimeter |
| MPT | Ministry of Post and Telecommunications |
| NEC | Nippon Electric Company |
| NMT 450 | Nordic Mobile Telephone Technology |
| PABX | Private Automatic Business Exchange |
| PCM | Pulse Code Modulation Equipment |
| P & T | Post & Telecommunications Administration |
| RCA | Radio Corporation of America |
| R & D | Research & Development |
| REA | Rural Electrification Administration |
| SEC | Special Economic Zone |
| SPC | Stored Program Control Technology |
| TACS | Total Access Coverage System for cellular radio |
| UHF | Ultra High Frequency |
| WUI | Western Union International |
| WUT | Western Union Telegraph |

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report, an assessment of the telecommunications system in the Peoples' Republic of China (PRC), identifies areas of technical cooperation in telecommunications sciences between the U.S. and China and recommends strategies for improvement and expansion of China's telecommunication system. This assessment was made during a visit by an NTIA-led U.S. Government/industry technical team to the Ministry of Posts and Telecommunications (MPT) in the PRC during November, 1986. Topics covered in the report include analysis of the existing network and its operation, possibilities for and approaches to its expansion, and long-term planning for an integrated system. Conclusions focus on needed improvements in manufacturing capability, improved cooperation and coordination among the various involved institutional entities, innovative development financing, and more effective rates and tariff structures to cover operating and development costs.

16. Key Words *(Alphabetical order, separated by semicolons)*

Peoples' Republic of China (PRC); telecommunications; communications satellites; telephone; rates and tariffs

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