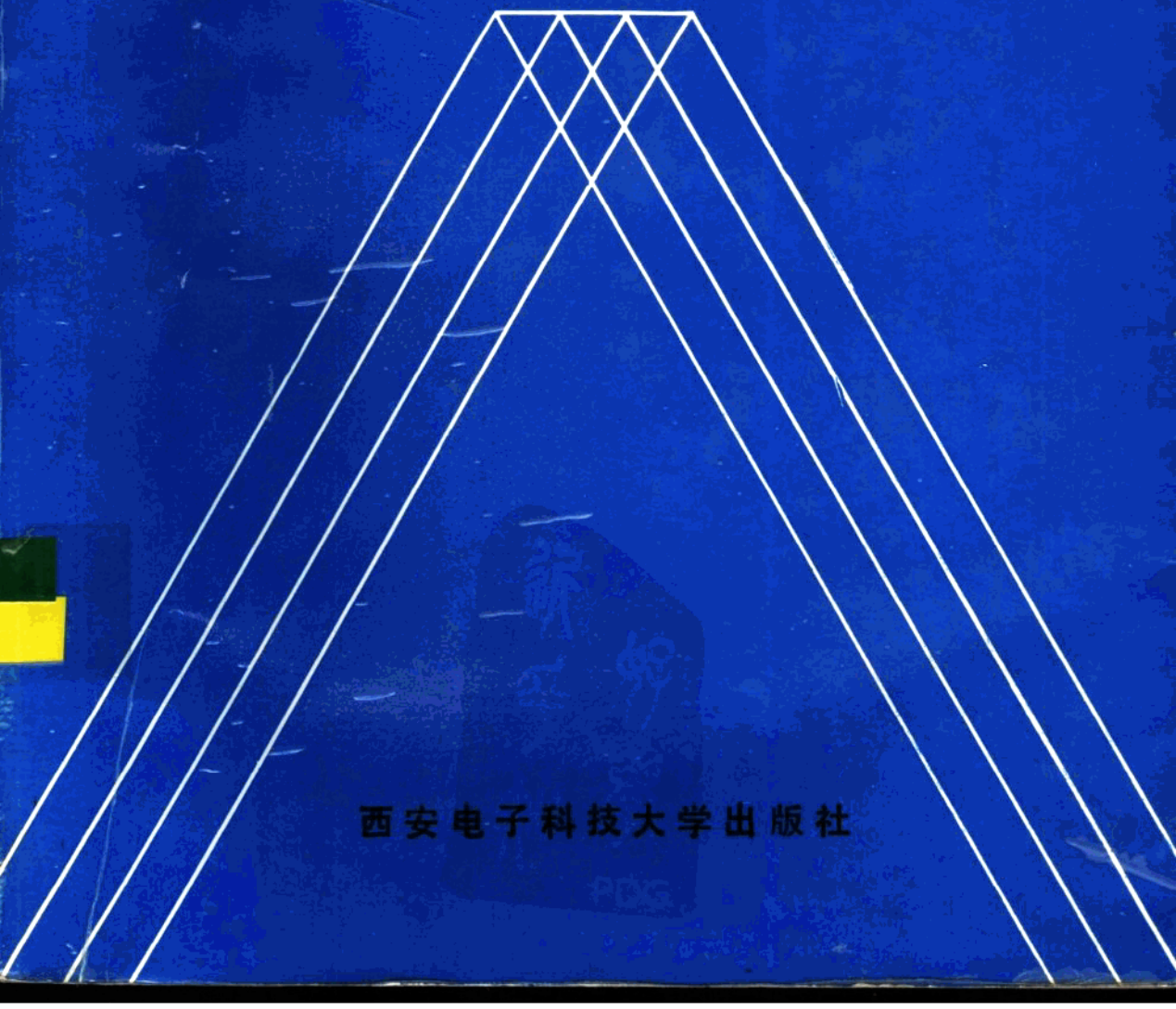
综合业务网理论与技术论文选编

（1991—1992）

综合业务网理论及关键技术国家重点实验室



西安电子科技大学出版社

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责任编辑　殷威安

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序

综合业务网理论及关键技术国家重点实验室在我国政府有关部门和西安电子科技大学的大力支持下，以及联合国的援助下，经过五年时间的筹办，现在已经初具规模。

在世界走向信息社会的今天，通信对人类社会的重要性日益增长。通信网的功能也日益增强。通信工具既是一种生活资料，也是一种生产工具。人们的日常活动似乎已经到了时刻离不开通信和通信网的地步。

随着通信理论和技术的发展，通信网正在从传统的电话网、电报网和数据网走向更高级的网络形式。随着通信业务种类的逐步增多，人们需求能够传输和处理多种业务的统一的通信网。这就是综合业务网出现的缘由。综合业务网有不同种类。二十多年来，人们讨论最多的是综合业务数字网(ISDN)。在70年代，人们发展ISDN有两个基本目标：1. 将现有的通信网加以改进，使之在用户终端之间能够传输数字信号；2. 使话音和数据能在同一个网络中综合传输，并制定相应的标准。自1984年CCITT发布I-系列建议以来，在世界各地已陆续开展公用ISDN业务。例如，在日本，于1988年开始有了公用ISDN，到1991年已有6.7万用户。至1991年，ISDN在欧洲已有8万用户，在美国已有8.8万用户。当然，这还只是较小的数目。例如，美国的这一ISDN用户数目不到其用户线路总数的千分之一。这说明尚有极大的发展前景。

由于ISDN的带宽有限，它一般只能为用户提供总速率达144kb/s(2B+D)数字话音和数据业务，为用户带来的好处不很突出，因而发展不够迅速。随着用户需求的业务种类增多，特别是各种视频业务需求的增长，以及光纤一类宽带信道的普及应用，近年来提出的宽带综合业务数字网(B-ISDN)是一种更加吸引人们注意的综合业务网。

B-ISDN利用各种可用网络资源，支持话音、视频、数据、图象以及多媒体等多种业务，能够满足人们对各种信息的需求。可以预期，B-ISDN将会比ISDN发展速度更快。在B-ISDN中，异步转移模式(ATM)将代替传统的同步转移模式(STM)占据主导地位。目前，对ATM的研究正处于方兴未艾。

这本论文选编收录了70多篇本重点实验室人员近两年发表于国内外主要刊物上的论文。论文内容主要涉及网络、交换、传送、信源编码和信道编码。这些论文凝聚着本实验室研究人员近几年来刻苦钻研、忘我劳动的心血和取得的成果。特别应该提到的是，论文作者之一，梁传甲教授，以他毕生精力奉献给通信领域科研和教学事业，终因劳累过度于今年过早地与世长辞。他的严谨治学、谦让勤奋、为事业而献身的精神，将永远铭记在我

们心中，并将成为我们，特别是年青一代学人，学习的典范。

这本论文选编是本重点实验室出版的第一本论文集。希望它既是一个里程碑，又将鞭策我们在今后的科研工作中取得更大的成绩。

西安电子科技大学

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内 容 简 介

本论文选编收集了西安电子科技大学综合业务网理论及关键技术国家重点实验室 1991～1992 年期间公开发表的重要学术论文或研究总结报告。大部分论文都具有一定的创见，从一个侧面反映了实验室在此期间取得的研究成果。内容包括通信网、信源编码、信道编码与密码等方面。在通信网方面，涉及综合业务局域网(ISLN)、综合业务数字网(ISDN)、基于异步转移模式(ATM)的宽带综合业务数字网(B－ISDN)以及移动通信网。在信源编码方面，主要涉及语音、图象编码(如矢量量化、混合量化)与数据压缩理论、窄带用户声码器实现技术等。在信道编码与密码方面有新的调制解调、差错控制、自适应均衡技术、信息的安全保密技术等。

本论文选编对于通信与电子系统学科的研究生和教师、有关研究机构的工程技术人员是一本具有重要学术价值和应用价值的参考书。

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第一部分

网络与交换

Development of Telecommunications Undertakings in China*

Changxin Fan

Telecommunications plays a very important role in today's information society. It is closely linked to the economic development and social progress of a country. In china, there has been a growing demand for information exchange in all asspects of life, especially in major and coastal cities, and special economics zones.

Brief History

When the People's Republic of China was founded in 1949, the telecommunications industry was very limited. There were only ten repair shops with 2, 800 workers and staff, engaging in maintenance and repair of imported telecommunications equipment, or assembly of imported components. Annual production was 1,000 radio stations, 20,000 telephone sets, and 14,000 lines of telephone exchanges (see Figure 1).

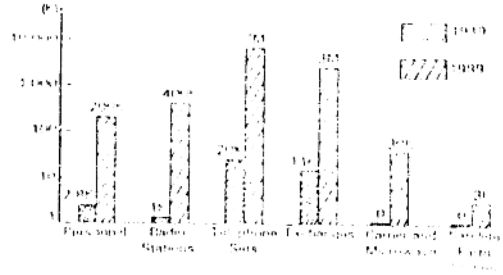

Fig. 1. Annual production capability.

During that period, the national telecommunications networks were underdeveloped; the total number of telephone sets in China wasonly about 263,000. The total capacity of exchanges was 310,000 lines, and the number of long distance circuits was about 2,800 (see Figure2).

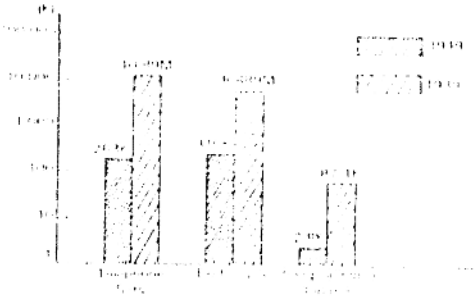

Fig. 2. Telecommunications services.

Over the last forty years, tremendous changes have taken

• 本文选自《IEEE Communications Magazine》1991 年 7 月。

place,but during two different periods. Telecommunications undertakings in the first thirty yers,i. e. ,before 1980,developed slowly. The government paid little attention,so there was less investment from the central government. After 1980,when the government's policy of openling to the outside world started to be implemented,telecommunications construction began developing rapidly.

Current Status

Services

In the past ten years China's telecommunications networks registered considerable progress in terms of equipment capacity,level of technology,and reliability. By the end of 1989,telephone sets numbered 10. 89 million against 1. 749 million ten years before. Automatic local telephones were 90% of total capacity,and Stored Program Control (SPC) telephone exchanges had a capacity of 2. 28 million lines,covering one quarter of the country's local telephone exchanges (8. 889 million lines). The capacity of long distance communications saw a substantial increase with 87,137 long distance telephone circuits in total,compared with 18,800 ten years before (see Figure 2). Across the country,519 cities were able to access the national automatic switching network. The number of authorized users of Direct Distance Dialing (DDD) service reached 624,000. The building of coaxial cable carrier systems,microwave transmissions systems,and domestic satelite communications brought much improvement to domestic long distance telecommunications services.

In international telecommunications services,even greater changes have taken place. Various new communications technologies such as cable,microwave,and satellite systems have completely replaced shortwave radio stations and open—wire lines. satellite communications has become a major medium for international communications. International Direct Distance Dialing (IDDD) calls can be made to 182 countries and regions from more than 200 Chinese cities.

In 1990,the Ministry of Posts and Telecommunications (MPT) further expanded the construction of telecommunications facilities. The capacity of local telephone exchanges was increased by more than 1 million lines. The number of telephones installed reached about 13. 5 million. Long distance circuits increased by 20,000. The total number is now more than 100,000. The degree of network intelligence was enhanced. By the end of 1990, 40% of long distance circuits were connected to automatic exchanges.

Administration

China's rapid progress in telecommunications should also be attributed to the adoption of a P&T administrative system that conforms with the actual situation in China. Under this system,leadership of the functional hierarchy of the MPT works vertically with the aid of local governments at different levels. Each level performs its own duty to manage both the public and private networks within its area. It is believed that such an administra-

tive system suits the comprehensive and integrative nature of telecommunications networks. It facilitates technological and operational management of telecommunications services and unifies control, coordination, accounting, and local governments' support. In China, where the economy is not well - developed and development is unbalanced, this addministration approach makes it easier to concentrate limited financial resources on key communications projects.

Technology

Up to 1989, the telecommunications sector under the Ministry of Machinery and Electronic Industries (MMEI) had 250 manufacturing facilities and more than 20 research institutes employing about 200,000 people, including 25,000 technical personel. Annual capacities were 3 million lines of telephone exchanges, 7 million telephone sets, 400,000 radio stations, over 30,000 carrier and microwave equipments, and 3,000 satellite earth stations (see Figurre 1). The annual industrial output value amounts to over 4 billion Yuan (RMB).

China's telecommunications industry has taken steps toward assembly, copying, and seelf development. Now china can develop and manufactrue 21 categories of equipment such as satellite earth stations, optical - fiber systems, electronic exchanges, mobile communication systems, and terminals. Among the mass - production products are small coaxial cable carrier equipment below 3,600 channels, medium coaxial cable carrier equipment of 4,380 channels, 750 kV ultra - high tension electrical carrier equipment, and submarine cable carrier equipment of 120 channels. China has launched several communications satellites, and erected dozens of earth stations and hundreds of mobile earth stations. for optical - fiber communications, equipment below the fourth order group are manufactured and those of the fifth order have been developed. A number of pieces of equipment manufactured in China, such as 5 m diameter antenna shipborne earth stations, ship - to - shore rapid communications systems, 480 and 1,920 channel digital microwave relay systems, digital SPC exchanges of 10,000 lines, nad JKQ - 9 analog SPC Private Automatic Branch Exchange (PABX) have approached world state - of - the - art.

In a nutshell, China's telecommunications industry is made up of comprehensive subsectors dealing with relatively large scale high technologies. It can generally meet the demand of China's national economic development. It has fairly strong scientific and technological personnel strength capable of tracking the world's advanced technololgies and developing various kinds of advanced equipment. However, as compared to the economically developed countries, China needs long and arduous efforts to catch up with the advanced level of the world in terms of science and technology and communications networks.

Policy

The basic idea for the development of China's telecommunications undertakings is based on its self - reliance and international cooperation. China has imported a large number of advanced communications facilities, such as local and long distance SPC telephone

exchanges, optical - fiber systems, and satellite communications equipment. These equip telecommunications networks and renovate existing ones. On the other hand, adhering to the principle of self - reliance, Chian has devoted its efforts to the research and development of indigenous technologies in all the above areas.

In march 1989, China's central government reiterated that telecommunications is one of the key sectors in the development of the national economy. Efforts should be focused on:

- Growth of services such as local and long distance telephones, and telex
- Construction of long distance communicatioons facilities and telecommunications hubs
- Application of new and high technologies in infromation communications
- Research and development of new technologies in communications
- Local procuction of advanced systems for SPC exchanges, mobile telephone, microwave, optical - fiber, and satellite communications systems

Future Plans

Though China has enjoyed rapid growth in the communications capacity, there remains a very large demand for services. Take local telephone sevvices as an example. Despite an average annual increase of 1 million lines in recent years, the imbalance between demand and supply is getting even worse. At presennt, there is a waiting list of more than 500,000 subscribers for telephone installation. Serious shortage of long distance telephone circuits has resulted in low call completion rates. Lack of momentum in the construction of national transmission facilities on backbone routes has become a seriour problem, leading to hampered interative capability of telecommunications networks.

In order to realize the goal of quadrupling China's Gross National Product (GNP) by the end of the century, the MPT of China has set the target of octupling the capabillity of posts and communications and the amount of traffic carried by the year 2000 (compared to 1980). The number of telephone sets in China will reach 33.6 million compared with 4.2 million in 1980. Telecommunications networsk will be mostly automated nationwide, with long distance automatic direct dialing available in cities above the county level. New technologies such as optica - fiber and satellite communications will be used extensively between major cities. Computers and databases in large cities will be interconnected into networks and various data communications services will be introduced. After reaching the target, telephone penetration in China will stand at 3% against 0.38% in 1980, about 25% in major cities such as Beijing, Tianjin, Shanghai, and Guangzhou, 20% in provincial capitals, economic centers, and large coastal citiess, above 5% in medium - sized cities and county seats, and an average of 1% in rural areas all over the country.

At present, the Chinese government is drafting the 8th five year plan (1991—1995)

and the medium - and long - range development programs for the nations' science and technology up to the year 2020. For telecommunications. the major efforts will focus on digital systems especially optical—fiber, satellite communications, microwave, SPC exchanges and mobile communications. Emphasis will be placed on application research and ASIC development. Great efforts will be taken to achieve high - reliability large - scale integration, all solid - state, and computerization. Improvement of manufacturing facilities will be made to achieve economy of scale with mass production and development capabilities established to meet domestic as well as world market demands.

宽带综合业务数字网的应用前景与技术基础*

刘增基　邱智亮

摘要　本文从B—ISDN提供的业务类型说明其具有广阔的应用前景，指出发展B—ISDN所依赖的技术基础是：宽带传输、快速分组交换、VLSI技术及软件工程，当前应着重研究异步转移模式（ATM）及适应于该体制的信令系统。

1990年我们曾发表了题为“宽带综合业务数字网的由来与发展”的综述文章[1]，着重论述了通信网由电话网、数据网分立的局面发展到综合业务数字网(ISDN)，再由窄带ISDN发展到宽带ISDN（B—ISDN）的过程，指出B—ISDN是真正通用的数字网络，是通信网发展的方向。

然而，B—ISDN何时成为现实将取决于用户需求和技术基础的情形。所以本文着重从这两方面讨论研究和发展B—ISDN的必要性和可能性。

1　B—ISDN的业务类型和应用前景

B—ISDN作为一种通用的数字网络将提供范围广泛的业务，以支持各种各样的应用。这些业务按信息的形式分类，有话音、数据、静止图象、活动图象等业务；按信号的带宽（速率）分类，有窄带业务和宽带业务；按网络给予支持的通信能力分类，有承载业务（网络只支持低三层功能）和用户终端业务（网络支持整个七层功能）；按连接类型分类，有点对点业务，多点业务和广播业务；按应用形式分类，有交互型业务和分配式业务。

下面从应用角度介绍几种宽带业务。

1. 高速数据通信

（1）高速数据传送（High—Speed Data Transfer）

为了高速传输数据，透明的承载业务是必要的。这些业务的比特率尚待确定，预计为30～40或130～140 Mbps。选择这样的比特率是为了适应以下应用：

·计算机和存贮系统分布式结构（如分担负荷系统、备份系统、分布式数据库等）内的数据文件传送；

·测量数据、遥感数据和控制信息的大容量或高速率传输；

·计算机辅助设计和制造（CAD、CAM）、电子图形编辑等。

（2）高速文书传送（High—Speed Document Transifer）

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* 本文选自《电子瞭望》1992年第6期。