Computer Networking In The People's Republic Of China: A Trip Report

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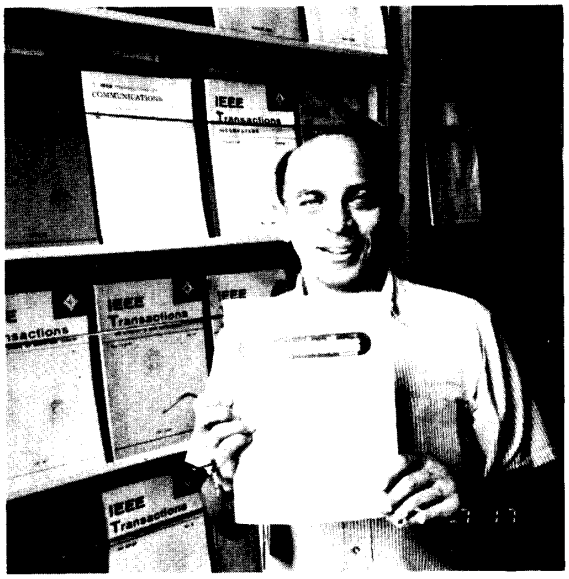
Introduction

As members of an international delegation of data communications professionals, we recently visited the People's Republic of China. This report on computer networking in China is based on our visits to four universities and 11 industrial/government organizations in four different cities of China.

The 18-member delegation, consisting of members from several educational and industrial institutions in the U.S.A., Australia, Belgium, and Italy, was led by Prof. Raymond L. Pickholtz of George Washington University, Washington, D. C. The delegates were selected from IEEE Communications Society membership and from ACM SIGCOMM membership. The names of the delegates, the institutions we visited, and the key Chinese professionals we met are listed in the appendix.



Delegation leader, Dr. Pickholtz, at the library, Northeast University of Technology, Shenyang.

The visit was organized by the People to People Citizen Ambassador Program, Seattle, Washington. In China, the delegation was sponsored by the China Association for Science and Technology (CAST), the Chinese Computer Federation, and the Chinese Institute of Communications. CAST is an umbrella organization of 138 national societies or associations in basic sciences, engineering, agriculture, and medicine. The Chinese Computer Federation consists of 28 local societies and 15 professional committees (special interest groups). It has approximately 24,000 members.

People and Culture

In order to understand the technological requirements of China, it is first necessary to understand the culture and working conditions of its people.

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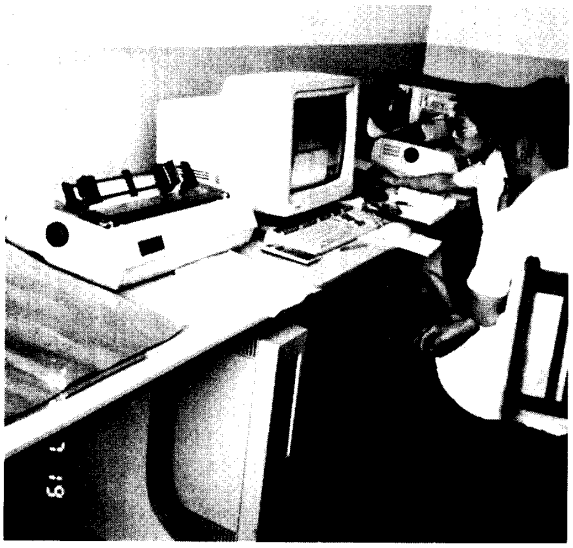
China has many well-qualified technical experts. The salary of most employees is between 80 and 120 yuans ($22–$33) per month. There is little difference between the salary of a dental surgeon and that of a factory worker. The benefit packages (housing, cash awards, etc.) for different educational levels are, of course, different. Therefore, most technical organizations try to accumulate a large number of qualified engineers and scientists. Productivity is limited by the availability of equipment and technical literature.

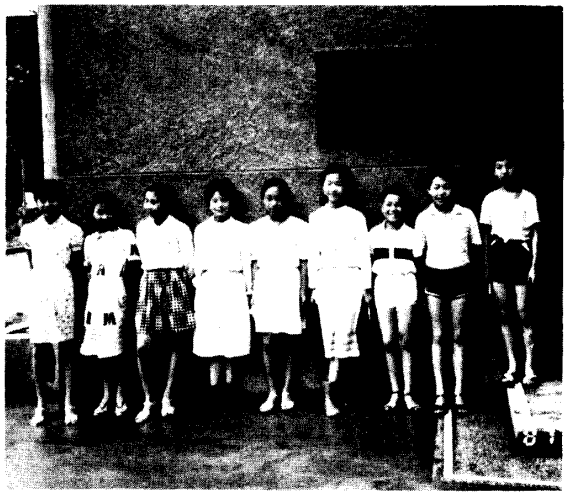
Computer Systems

We visited many computer centers. Among the computers we saw were: DEC (VAX-11/750, MicroVAX-II, PDP-11, VAX-11/780), IBM (370, 4381, PC), NEC, Cromemco (Z-2D, S-100), Hitachi, Honeywell (DPS8), and AT&T (3B2)[1] computers. There are a large number of IBM PCs and compatibles. We saw several IBM-PC compatibles running IBM-PC DOS release 2.10, developed and marketed by Great Wall Computer Corporation. Statistics gathered towards the end of 1985 showed that there were about 7,000 large, middle, and mini computers, and about 130,000 micro/personal computers in China at that time.

We saw a MicroVAX II computer being used for designing suits, a PDP-11 computer being used for image enhancement, and a VAX-11/780 computer being used for classroom instruction. In most of these systems, the user interface (DCL in VAX/VMS operating system) is replaced by its Chinese equivalent called CVMS (Chinese VMS) marketed by DEC. Other computers also had a Chinese language command interface.



A MicroVAX workstation used for Computer-Aided-Design of men's suits.



Students of BASIC at Fudan University Computer Center, Shanghai.

The image processing lab at Fudan University used a PDP-11 computer for processing 512 × 512 pixel images with a gray scale of 256. Both a television camera and a drum scanner were used for input. Image enhancement was demonstrated. We saw electron microscope photo images of a superconductor material, a cloud cover, and chromosomes. The purpose of the chromosome study, we were told, is to help ensure that the one child a couple has is a healthy child.

Computers are fast gaining popularity among kids. At Fudan University in Shanghai, we saw elementary-school children learning BASIC programming. The Chinese Computer Federation regularly sponsors a National Teenagers' Computer Programming Competition.

An interesting note: To prevent dust from entering computer rooms, everyone must take off their shoes before entering and wear clean slippers. This is because the buildings are constructed with concrete and stucco, and have much dust (which can impair disk operation).

The key factors that affect their choice of computers are cost and foreign government regulations. Most large systems are purchased with aid from the World Bank and other similar United Nations organizations. Therefore, the lowest bidder gets the contract.

Finally, the Chinese government does not allow foreign enterprises to remove profits from China. This has recently been relaxed by allowing different enterprises to trade their Chinese currency holdings among themselves.

[1] DEC, MicroVAX II, PDP-11, VAC, VAX-11/750, VAX-11/780, and VMS are trademarks of Digital Equipment Corporation AT&T is a trademark of American Telephone and Telegraph Company. IBM is a trademark of International Business Machines Corporation.

Telecommunications

The telecommunication systems of China are mostly electromechanical switching and analog transmission. China is in a quandary as to whether to invest in ultra-new technology or to upgrade and expand existing plants gradually. The telecommunication infrastructure is so unreliable, we were told, that a bicycle message is sometimes considered faster and more reliable than a phone call across town.

Optical Fiber

The literature distributed by the China Academy of Posts and Telecommunications listed the following areas of research: optical cable technology design, testing and splicing, and the physical and mechanical properties of fiber cables. The institute has also developed the first-, second-, third-, and fourth-order digital multiplexers of PCM hierarchy. They are implementing a fiber optical communication system for the railroads. However, fiber optics has not penetrated the telecommunications network on any large scale at this time.

Microwave

The Fourth Research Institute of the Ministry of Posts and Telecommunications (MPT) has completed the development and implementation of large capacity 600-, 960-, and 1,800-channel analog microwave communications systems. Recently, it has succeeded in the development of the 34-Mb/s (480-channel) digital microwave system, and an 8-GHz microwave system for rural applications. Research on a 140-Mb/s (1,920-channel) digital system is currently in progress.

Satellite Links

The First Research Institute of the MPT has developed the complete set of equipment for a 4/6-GHz earth station, including the 6-meter and 11-meter reflector antennas, dual circular polarization feeder systems, FET low-noise amplifier circuits, 3-kW klystron power amplifiers, and other equipment for up/down links. These satellite links are more reliable for long-range communication than terrestrial facilities.

Integrated Circuits

The Research Institute of Semiconductors of the MPT has developed a number of semiconductor devices for use in large capacity carrier systems and microwave systems. The 3DA308 and 3DA309 transistors developed by the institute have a large dynamic range, low noise, superlinearity and higher-power characteristics. They have also played a very important role in the successful production of the 1,800- and 4,380-channel coaxial carrier systems.

Data Communications

In the area of data communications, the Chinese are very interested in advanced technology and want to learn about the latest ideas, but they are also realistic about their ability to adopt all these ideas in a short time. They want to focus their efforts now on what can be done with limited resources, such as developing their telephone network and initially using it for low speed (75–300 b/s) data networking.

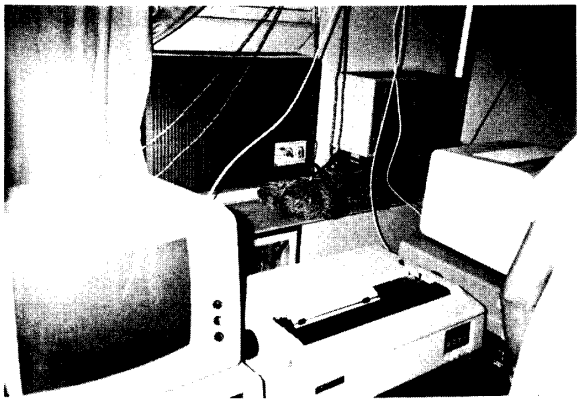
Protocols

The Research Institute of Data Communication Technology of the MPT, located in Beijing, conducts research on data-network systems, protocols, standards, interfacing techniques, development of software for computer-based information systems, local area networks, databases, and the digital transmission and color display of radar meteorologic charts.

Local Area Networks

We saw Ethernet and Omninet Local Area Networks (LANs) being used for computer communica-

Dr. Raj Jain (right) giving a talk at the Data Communications Research Institute, Beijing. It is being interpreted by Mr. Hai Wen-xue (left).



A testbed for experimenting with LANs (Ethernet, Omninet) at the Data Communications Research Institute, Beijing.

tion. The Omninet network allows data transmission over a twisted-pair at 1 Mb/s, at distances of up to 4,000 feet. The institute is also working in the area of communication network security. It has developed information management systems that can connect several remote terminals with LAN to form a wide-area multichannel data communication system.

Researchers at Shanghai Jiao-Tong University have implemented a CSMA/CD network called Chinese Etherseries Distributed Communication System (CEDCS). They are also working on a high-bandwidth fiber optic ring LAN.

Wide Area Networks

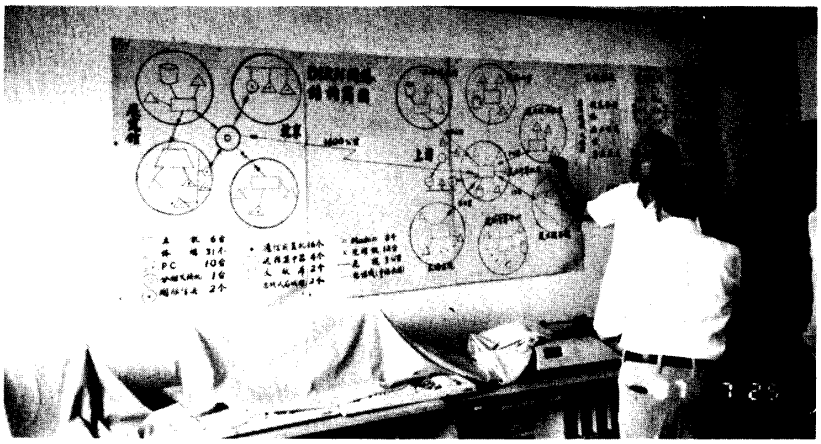
Researchers at Fudan University are developing a wide-area network called Distributed Retrieval Network (DIRN) using all seven layers of ISO/OSI protocols. The network connects several LANs in Beijing and Shanghai. The eventual goal is to develop something like the ARPAnet, linking several universities for research. Telephone lines are used for inter-city connections, and optical fiber cable has been installed for these connections. The services provided include: information retrieval, file transfer and access, electronic mail, and real-time dialogue. These services can use end-to-end data encryption, using either Data Encryption Standard (DES) or RSA public key systems. The encryption software runs at 4 kbytes/s on the PDP-11 series computers. They are planning to implement Common Application Service Elements (CASE), Management Information protocols and Directory Access protocols (MI&DA), Job Transfer and Manipulation protocols (JTM), Remote Database Access protocols (RDA), and Virtual Chinese Terminal protocols (VCT).

The computer network laboratory at Jiao-Tong University at Shanghai has developed an inter-university network connecting it to Fudan University. They also have an encryption software product called Datacode. Current research topics include: satellite digital communication networks, ISDN, heterogeneous computer networking techniques, and gateway design.

Public Packet Switched Data Networks

The MPT is planning to offer a videotex service in the near future. China has launched a communications satellite and plans to set up a satellite-based data network. Among the data services currently available in China are: 9,600-b/s leased circuits, a combined 50 baud telex service, a 300-b/s data service called "telex/low speed data," international information retrieval via a satellite link to ITALPAC, and telefax. An X.25 data transmission service called DATEL is also planned. The data rate for this service will initially be 1,200 b/s.

The MPT is also implementing a country-wide public Packet Switched Data Network (PSDN) called CHIPAC. It comprises three packet exchanges installed in Beijing, Shanghai, and Guangzhou. The exchanges are interconnected by 9.6–72 kb/s trunk lines. A network management center located in Beijing will be used for management and control of the whole network. The Beijing node will be connected to foreign packet networks using 9,600-b/s satellite links.



Professor Zhang Shi-yong of Fudan University explaining the DIRN network.

Technical Publications

The Chinese Computer Federation publishes eight academic journals, namely:

- Chinese Journal of Computers
- Computer Research and Development
- Computer Technology
- Computer Engineering and Applications
- Mini-Micro Systems
- Microelectronics and Computers
- Computer Applications and Software
- Journal of Computer Science and Technology

Of these, the first seven are in Chinese and the eighth is in English. To provide an idea of the technical depth of these journals, the table of contents from a sample journal is included here. The Journal of Computer Science and Technology, vol. 2, no. 2, April 1987 (published in English[2]), contains:

- Proof Techniques for Port-Directed Communication and Broadcast
- A Routing Algorithm for Distributed Optimal Double Loop Computer Networks
- Three-Valued Diagnosable Systems: Diagnosability, Optimal Design and Fault Identification Algorithm
- A General and Formal Method for the Program Static Analysis
- Shape Grammars and Shape Rules
- Two Algorithms for Variable Allocation in an Interpreted Scheme
- An Analysis of WS and PFF Algorithms
- The Duodirun Merging Algorithm

Other technical journals in the area of computer systems and electronics (in Chinese) are as follows:

- Electronic Techniques
- Electronic Science
- Electronic Science Techniques
- Electronics World
- Electronic System Communications
- Electronics
- Electronics Communications
- Communication Techniques
- Communication Science
- Fiber Optic Communications
- Computers
- Computer Science
- Computer Applications

All technical education is in Chinese, although many technical professionals also know English, Russian, and Japanese. The libraries have journals and books in these four languages. We saw copies of IEEE Journals that were printed in China and distributed to different libraries and organizations (see the first photo in this article). It takes about six months to a year before they receive U. S. journals.

Conclusions

Our key observations from the trip can be summarized as follows:

- China has many qualified technical professionals who attempt to keep abreast of research in the western world. However, a shortage of technical equipment and literature has impeded their progress.
- Chinese scientists are not especially interested in proprietary protocols. They are more interested in ISO/OSI protocols and have a variety of computer systems from different vendors. A commonly asked question is: How do I connect my DEC, IBM, NEC, or Hitachi computers with other computers?
- Human resources are inexpensive in China. Therefore, they are interested in developing their own communications software. Many research institutions are implementing ISO/OSI protocols, such as X.400, FTAM, etc.
- The future of computer communications depends heavily on the services offered by the MPT. Therefore, there is considerable interest in networking using X.25 and ISDN. They are inquisitive about different vendors' plans for supporting ISDN.
- Input, output, and the recognition and translation of Chinese characters are popular areas of research at almost all research institutions in China. Most computer systems, including VAX/VMS, have a mixed Chinese/English language user interface.
- Computer literacy is increasing quickly, although there is some social resistance to replacing human resources with computers.
- Inexpensive technical manpower in China provides an opportunity for foreign vendors to set up cooperative ventures with Chinese organizations and to develop software and applications (and sometimes hardware) for the Chinese market. An example of this is the 3,000-character Chinese keyboard developed by the MPT and now marketed by NEC of Japan.
- Chinese technical societies are interested in increasing their contacts with their western counterparts such as IEEE and ACM. Recently, the Chinese Computer Federation has set up a liaison group with the IEEE Singapore Chapter for strengthening connection, linking up information, enhancing friendship, and promoting cooperation.

[2] The Journal of Computer Science and Technology is distributed outside China by Allerton Press, Inc., 150 Fifth Avenue, New York, N.Y. 10011, U.S.A.

Appendix I: List of Delegates

The delegation consisted of 18 data communications professionals. Their names and affiliations are as follows:

Prof. Raymond L. Pickholtz, George Wash. Univ., Washington, D. C.
Mr. Mark J. Abel, US West Advanced Technologies, Englewood, Colorado
Mr. Palmer W. Agnew, IBM, Endicott, New York
Prof. Paul D. Amer, University of Delaware, Newark, Delaware
Mr. Robert R. Cooney, Tele Processing Sys. Solutions, Houston, Texas
Ms. Sheila K. Craig, MITRE Corporation, McLean, Virginia
Dr. Rudy J. Cypser, IBM, Thornwood, New York
Mr. Timothy J. DeBaun, Martin Marietta Data Systems, Orlando, Florida
Mr. Walter J. Doherty, IBM Research, Yorktown Heights, New York
Mr. Bela Erdelyi, Eagle Technology, Inc., Ocean, New Jersey
Dr. Fabrizio M. Ferrara, GESI, S.R.L., Rome, Italy
Mr. Luis E. Gonzalez, ITEMS, Rio Piedras, Puerto Rico
Mr. Joel M. Halpern, Network Systems Corp., Minneapolis, Minnesota
Dr. Raj Jain, Digital Equipment Corp., Littleton, Massachusetts
Mr. Edward O. Jerden, Philadelphia Newspapers, Philadelphia, Pennsylvania
Ms. Anne S. Kellerman, IBM, Endicott, New York
Mr. Johan Moerman, National Bank of Belgium, Brussels, Belgium
Mr. Richard J. Sharpe, Austek Microsystems, Ingle Farm, Australia

Appendix II: List of Institutions

We visited four universities and 11 industrial/government organizations, as listed below:

China Academy of Posts and Telecommunications, Beijing
The Research Institute of Data Communications Technology, Beijing
The Research Center of Technical Economics of MPT, Beijing
Northeast University of Technology, Shenyang
Shenyang Automation Institute, Shenyang
Liaoning Province Posts and Telecommunications, Shenyang
The North Computer Application and Development Corp, Shenyang
Liaoning Province Electronic Computer Center, Shenyang
Nanjing Institute of Technology, Nanjing
Shanghai Science Hall, Shanghai
Shanghai Computer Research Institute, Shanghai
Fudan University, Shanghai
Jiao-Tong University, Shanghai
Bank of China, Shanghai
Shanghai Economic Information Center, Shanghai

The meetings arranged at these places were widely publicized and people from many other local organizations also attended.

Appendix III: List of Key Chinese Professionals

Some of the key professionals that we met are as follows:

Mr. Chen Shukai, Gen. Secretary, Chinese Comp. Federation, Beijing
Mr. Fang Cai-Hui, Chief Engr., Admin. of P&T of Liaoning Prov., Shenyang
Prof. Gu Guan-Qun, Vice President, Nanjing Inst. of Tech., Nanjing
Prof. Ho Wen-Xing, Dean of Comp. Sc., Northeast Univ. of Tech., Shenyang

Mr. Huang Qi-Fan, Director, Shanghai Economic Info. Center, Shanghai
Mr. Li Hong, Dir. & Sr. Engr., Data Comm. Tech. Res. Inst. MPT, Beijing
Mr. Li Song-Qiao, Chief Dir., Inst. of Comm. of Liaoning Prov., Shenyang
Mr. Li Yu-Qi, Secretary General, China Institute of Comm., Beijing
Mr. Luan Gui-Xing, Director, Shenyang Inst. of Computing Tech., Shenyang
Mr. Mu Rui-Lin, Dir.-in-Chief, North Comp. Appl. & Dev. Corp., Shenyang
Prof. Pan Jin-Ping, Dir., Comp. Software Lab, Fudan Univ., Shanghai
Prof. Qiu Cheng-Jian, Pres., Liaoning Assoc. for Sci. & Tech., Shenyang
Prof. Wang Qi-Yi, Dean, Northeast University of Tech., Shenyang
Mr. Xu Jun-Yi, Vice Chairman, Computer Sc. Dept., Fudan Univ., Shanghai
Mr. Xu Kongshi, Director, Inst. of Software, Academia Sinica, Beijing
Prof. Yang Chuan-Hou, Dir., Comp; Net. Lab, Jiao-Tong Univ., Shanghai
Mr. Zhu Yi, Director, Comp. Center, Shanghai Jiao-Tong Univ., Shanghai

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Raj Jain (S '73 – M '78 – SM '86) received the B.E. degree from A.P.S. University, Rewa, India, the M.E. degree from Indian Institute of Science, Bangalore, India, and the Ph.D. degree from Harvard University, Cambridge, MA, in 1972, 1974, and 1978, respectively.

His Ph.D. dissertation, entitled "Control Theoretic Formulation of Operating Systems Resource Management Policies," was published by Garland Publishing, Inc. of New York in their "Outstanding Dissertations in the Computer Sciences" series. Since 1978, he has been with Digital Equipment Corporation, where he has been involved in performance modeling and analysis of a number of computer systems and networks including VAX Clusters, DECnet, and Ethernet. Currently, he is a Consulting Engineer in the Distributed Systems Architecture and Performance Group. He spent the 1983–1984 academic year on a sabbatical at the Massachusetts Institute of Technology doing research on the performance of networks and local area systems. For three years he also taught a graduate course on computer systems performance techniques at MIT and is writing a textbook on this subject, to be published by Wiley-Interscience.

Dr. Jain is a member of the Association for Computing Machinery.

Raymond L. Pickholtz received his Ph.D. in electrical engineering from the Polytechnic Institute of Brooklyn (now New York) in 1966.

He is a Professor in and former Chairman of the Department of Electrical Engineering and Computer Science at George Washington University. He is also President of Telecommunications Associates, a research and consulting firm specializing in communication system disciplines. He was a researcher at RCA Laboratories and at ITT Laboratories. He has been on the faculty of the Polytechnic Institute of Brooklyn and of Brooklyn College, and has been a Visiting Professor at the Universite du Quebec and the University of California. He is the editor of the Telecommunication Series for Computer Science Press. He was an editor of *IEEE Transactions on Communications* and guest editor for special issues on Computer Communications and Military Communications.

Dr. Pickholtz is a fellow of the IEEE and of the American Association for the Advancement of Science (AAAS). In 1986, he was elected Vice President of the IEEE Communications Society. Also in that year, he was elected a member of the Cosmos Club and a fellow of the Washington Academy of Sciences.

He is a recipient of the IEEE Centennial Medal. He has published scores of papers and holds six U.S. patents. ■