

The first permanent international computer network Connection between China and the USA *

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This paper discusses the events leading up to, the instantiation in 1994 of the first permanent network connection between mainland China and the USA, and some of the impact since.

Keywords: Template; Proceedings; World Scientific Publishing.

Contributed to the Symposium on 30 years of BES Physics September 5-6 2019, IHEP Beijing.

1. Prologue

There were many events leading up to improved relations between the People's Republic of China and the US, the increased interest in High Energy Physics (HEP) in China, followed by the collaboration between SLAC in the US and the Institute of High Energy Physics (IHEP) in Beijing China all of which led in turn led to the efforts and successful instantiation of the first permanent network connection between China and the USA. This paper draws heavily on an internal paper published at SLAC in 1994 [1]. It adds more recent information in particular that presented at a talk presented by the authors at the BES Symposium [2].

1.1. Early Chronology

- 1972: US president Nixon visited the People's Republic of China (PRC) ending 25 years of no diplomatic ties between the PRC and the US [3]. Following Nixon's visit Zhang Wenyu, the leading physicist in the PRC interested in HEP visited the director of SLAC Professor W. K. H. "Pief" Panofsky at SLAC [4].
- 1973: IHEP was officially established [5].
- 1976: Panofsky travelled to the PRC, making stops in Beijing, Guilin, Guangzhou, Shanghai and Nanjing [4].
- 1979: Deng Xiaoping visits the US.

* This material is based on work supported by the U.S. Department of Energy, Office of Science, Office of High Energy Physics, under Contract DE-AC02-76SF00515.

- 1981: Fang-Yi, Vice-Premier of the PRC visits SLAC [6]. This was to renew the agreement between the governments of the USA and the PRC on Cooperation in Science and Technology which was originally signed in 1979.
- 1983: The PRC State Council officially approved the proposal to construct the Beijing Electron Positron Collider (BEPC) at IHEP [5]. Six IHEP Computer center visitors visit SLAC for 1 month [5].
- 1984: Groundbreaking ceremony for the BEPC project was held [5]. Panofsky and Nobel prizewinner T. D. Lee [7] of Columbia University were in attendance at the ceremony.
- 1987: Computer networking at IHEP started by remotely linking one computer named BEPC2 (a VAX 785 [8]) at IHEP with CERN via the Packet Switched Data Network (PSDN). This provided email connectivity via the VXCERN node at CERN, Geneva, Switzerland
- 1988: The first electron-positron collisions took place at BEPC [5].
- 1989: Email link is established between SLAC and IHEP.

2. Initial Connections

2.1. Preparation

In 1990, Professor Burton Richter [9] the director of SLAC visited China and in his trip report [10] recommended a US Department of Energy (DoE) Energy Sciences network (ESnet) [11] connection to SLAC.

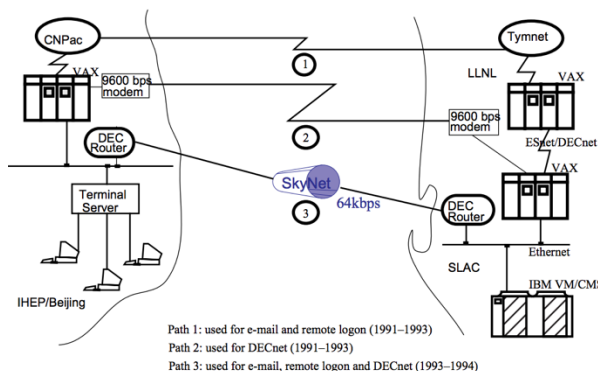
In the Spring of 1991, several Chinese physicists from IHEP visited SLAC to discuss the Beijing Spectrometer (BES) detector collaboration between IHEP and SLAC. They met with Dr. Cottrell the assistant director of computing at SLAC to discuss computing, networking and how to improve communications between the Chinese and US physicists working on the Beijing Spectrometer (BES). As a result of this meeting, Cottrell was invited to visit IHEP to assess the situation and make recommendations. Unsure of whether this was just a polite gesture and to get a better idea of how to assist, Cottrell visited Panofsky, then the Emeritus director of SLAC. Panofsky was very supportive and had the vision that excellent communications were critical to make this worldwide collaboration work really well and strongly encouraged the trip. At the time, the only way to make an international phone call from IHEP to the US required the assistance of a human operator, and there was no way to set up a computer link with such a phone line. Panofsky, therefore called T. D. Lee, who had a lot of influence in China, to: request top priority to install three phone lines (one for computer to computer networking, one for voice communications, and a backup) with unattended international access at IHEP; and expedite getting a visa for one of the authors (Cottrell) to visit the PRC.

2.2. Trip to China

As a result of this, when Cottrell arrived in China on March 15th, about three weeks later and entered the IHEP computer room, he found three just-installed live phone lines with international access on the floor. The IHEP team consisted of about a dozen people who were very enthusiastic. However, only a couple of them spoke some English and Cottrell spoke no Chinese. It thus soon became apparent that despite nods and smiles we needed to write everything down, both to slow the conversation down and to provide a written record. Voice communications with Charley Granieri, a computer systems specialist who was at the SLAC end, was by using a second of the phone lines.

Cottrell bought two modems with him, an older 2400 bits/sec one, and a brand new Telebit T2500 9600 bit/sec modem [12]. They installed the 2400 bits/sec modem on a second phone line, thinking the lower speed, less sophisticated modem would be more likely to work. However, it did not work. Fortunately the 9600 bits/sec modem worked and we were able to logon from IHEP to a Digital Equipment VAX computer [13] at SLAC. The effective transmission rate was about 400 bits/sec. The cost was \$1/minute if initiated from SLAC and \$3/minute if initiated from IHEP.

After more experimenting, the use of these dial up links was extended to support an asynchronous dynamic DECnet [14] circuit between SLAC and IHEP, and IHEP was moved into the SLAC HEP DECnet area which potentially provided more capabilities (see Path 2 in Figure 1). In general the dial up links were noisy, difficult to use, often connections could not be made since no international lines were available and there were frequent



disconnects in mid-session. Figure 1: Network connections between SLAC and IHEP 1991-1994.

2.3. Return to SLAC

After returning to SLAC we worked with the Lawrence Livermore National Laboratory (LLNL) and CNPac [15] to set up a Tymnet [16] connection to the ESnet [17] DECnet (see Path 2 in Figure 1). The connection cost was about \$100/hour. It was used for email, which was costing about \$100/email item, and remote logon email. By September 1991, it was being used to send about 5-10 emails/day, and between 5 and 20 minutes/day for remote logon. It was satisfactory for email, but sluggish for interactive use with typical response times of 1.5 second / character typed, and transfer rates of a few hundred bits/sec. The cost was about \$3000-5000/month for the US end and \$7000/month for the Chinese end.

In the beginning, about 300 of China's top professors and scientists had access to IHEP's computers over dial-up connections. While these connections between SLAC and IHEP offered significant improvements, the experiment being conducted by the collaboration required better connectivity.

Thus, we put together a proposal to the US Department of Energy (DoE) requesting funding to set up a permanent link between SLAC and IHEP utilizing an AT&T geostationary satellite and the Skynet network [18]. This was approved to be funded in late 1991 by the DoE, including SLAC and the Super Conducting Collider [19] in the US, with SLAC taking the lead. The contract was signed with AT&T in January 1992. The US costs were about \$5500 for the installation and \$5000 / month, with similar costs at the PRC end.

3. Permanent Link

The down-stations for the link were located at Point Reyes, California in the US (about 60 km from SLAC) and Beijing airport in the PRC. The connection from the Beijing airport was by microwave to the Long Distance Telephone building 801 in the center of Beijing, about 30 km away. From there, they tried an infra-red connections and then a microwave connection to the 821 Exchange building about 15 km away and two blocks from IHEP. The error rates were too high, thus neither attempt was successful and eventually a fibre optics connection was successfully used. There was copper cable connecting building 821 to IHEP, however, there were problems with connecting the fibre to the copper. On March 1st, 1993 at 15:19 pm acceptable error rates were achieved and the circuit was handed over to IHEP. Seconds later a monitor program showed node 44.393 (the SLAC DECnet router) adjacent to IHEP.

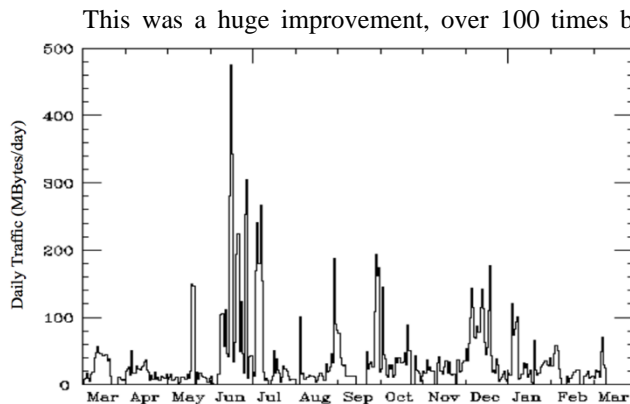


Figure 2: Utilization of the SLAC-IHEP link 1993-1994.

This was a huge improvement, over 100 times better than anything we had seen previously. The effective data transfer rates were ~ 42 kbits/sec, the echo time was < 1 second, the error rate $\sim 1E^{-7}$, with typically 1 to 2 unscheduled outages in a month. There was also a twice yearly occultation when the sun was directly in-line with the satellite. With such data transfer rates, we were able to routinely transfer 200 Mbytes / day (equivalent to that era's IBM 3480 tape cartridge medium). Typical utilization was 2500 emails / day involving 400 sites in 21 countries

with a relay at SLAC. In addition it was used for news groups, collaboration coordination, code management, remote login and real-time communications. Figure 2 shows the daily utilization. It peaked at just under 100% utilization over a 24 hour period during a conference held at IHEP.

4. Internet Connection

The dedicated connection soon drew interest from other academic and research institutions and raised hopes for a dedicated connection from China to the Internet. To prepare for this we decided to add IP connectivity and replace the DEC routers at SLAC and IHEP with Cisco routers. A Management Plan for ESnet Network Access to the People's Republic of China was created by a task force of the ESnet Steering Committee, and as a result export licenses for Cisco routers to go to IHEP were obtained from the US Department of Commerce (DOC) at the end of 1993. The routers were received in Beijing in February 1994, installed in March 1994 replacing the DECnet routers, and DECnet connectivity was opened up to the worldwide HEP DECnet. At this time management of the link was turned over to ESnet.

A visit to IHEP by US Congressman George Brown [20] in December 1993 also increased interest in the link at higher US government levels. A meeting was held in January 1994, with attendees from universities and computing institutes in Beijing, to discuss and come up with a recommendation for domain naming in China. It was decided that IHEP nodes would appear as for example as node.ihep.ac.cn and IHEP was assigned two class C Internet address blocks by the Internet's regional registrar (APNIC [21]). Agreement was obtained to allow the Internet to carry PRC traffic contingent on some conditions being met. One major condition was to make a wide-area electronic mail announcement that the Internet would be carrying PRC IP traffic. This announcement was made to ESnet, and the US Departments of Defense and Commerce sites on April 18, 1994 and stated that ESnet would begin to carry Chinese IP traffic on April 25, 1994. Opening of the link to full Internet connectivity happened on May 17, 1994 when a connection was established via ESnet from SLAC to FIX-West, which was the US West Coast interconnection point for all of the major TCP/IP networks. IHEP thus became the first PRC institution to have a fully operational world-wide networking connection.

5. Some Impacts

5.1. Benefits

After connecting to the Internet, the BES collaboration group made significant progress including:

- Installed and utilized CODEMAN a BES :source code management system.
- Put together and updated a publication on the Tau mass measurement.
- Provided online video for the 1995 Beijing International Symposium on Lepton-Photon Physics.

- Enabled the first China-US VoIP video conference between Joe Izen of UT Dallas and Yu Minjian of IHEP July 20, 1995.
- Supporting the SLAC based BES News group.
- Supporting the BES collaboration group communications in particular for members and interested parties at BNL, FNAL, CERN, KEK, as well as sharing information with other HEP experiments such as L3, ALEPH, CMS, LHC, B-Factory etc.
- A UNESCO organization, and the Beijing US Embassy applied for and were provided with an Email account at IHEP.

5.2. China's First web site

In 1994 R. S. Xu attended the first International WWW Tech Forum held at CERN. Following this IHEP launched the first WWW server in China (www.ihep.ac.cn). An i486 PC running the Linux operating system hosted the web server. See Figure 3 for a picture of the server and a copy of the top web page.



Figure 3: First PRC WWW server and web site.

5.3. Growth in PRC Internet Utilization

Figure 4 shows the growth of Internet utilization by PRC users since the PRC was connected to the Internet in 1994 [22]. In 2018 the number of users in China exceeded 800 million. This is a many orders of magnitude increase since the initial Internet connection in 1994.

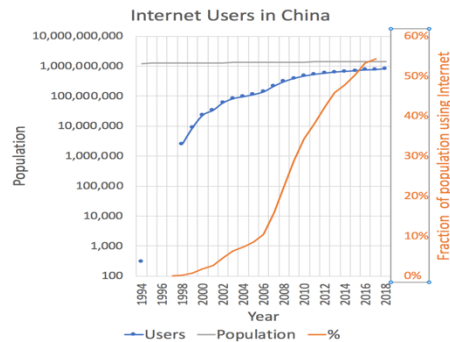


Figure 4: PRC Internet User growth. [22]

6. Acknowledgements

We would like to acknowledge the considerable efforts of Charles Granieri of SLAC, Fan Lan of IHEP, and ESnet in setting up this link and the web page. Also thanks to Walter Toki of the University of Colorado, Joe Izen of UT Dallas, Zheng Zhipeng of IHEP, T.D. Lee, Panofsky and Richter for their support and encouragement.

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