

CHAPTER 2 The Beginning

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Computer network research and development projects started in the United States and United Kingdom among others in the 1950s and 60s [Waldrop 2001; Leiner 2003; Kleinrock 2010; Kleinrock 2012; Davies 2010; Computer 2012]. A demonstration of ARPANET was held during the first International Conference on Computer Communications (ICCC) in 1972 [Leiner 2003]. During the conference in Washington, D.C., it was decided to form an International Network Working Group (INWG) [McKenzie 2011].

In Asia, computer network research and development began in Australia, India, Japan, South Korea, and New Zealand among others in the 1970s with the influence of computer network research efforts in the United States and Europe. International collaboration on computer network research in Asia dates from the 1980s.

Many mainframe computer makers developed products for computer networking in the 1970s, including SNA and VNET at IBM. Some of the VNET protocols were later incorporated into BITNET in the 1970s. Many minicomputer makers also developed networking products in the 1970s, including DECNET at DEC, which was then used in building HEPnet around the world.

The computer network protocol called Unix-to-Unix Copy Program (UUCP) was also developed for computers running the Unix operating system in the USA in the late 1970s. Usenet, a system for managing newsgroups which runs on top of UUCP, was developed in the late 1970s. Various PC communications systems such as FidoNet were also developed from the late 1970s through the 1990s.

2.1 North America

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As previously mentioned, computer network research and developed started in the United States and the United Kingdom. JCR Licklider at Advanced Research Projects Agency (ARPA), which was later renamed the Defense Advanced Research Projects Agency (DARPA), proposed a Galactic Network in the early 1960s [Waldrop 2001]. He and his successors at ARPA funded computer network research and development projects in the 1960s, and ARPANET was born with four nodes: at UCLA, at SRI, at UCSB and at the University of Utah in 1969. It was the beginning of the Internet as we know it today. In 1972, a very successful live demonstration of ARPANET was organized at the First International Conference on Computer Communications (ICCC) in Washington, D.C. [ICCC 1972]. This was the first demonstration of ARPANET to the public outside of the United States Department of Defense.

Paul Baran at RAND Corporation, which is 10km away from the UCLA campus where ARPANET was being developed, was carrying out computer network research at around the same time, but did not develop a computer network [Baran 2002]. Xerox PARC made significant developments in computer networking including Ethernet and the PARC Universal Packet (PUP) in the 1970s. The Ethernet protocol is perhaps the world's most pervasive computer network technology in use today [Kleinrock 2010].

2.2 Europe

Kilnam Chon

Donald Davies at National Physical Laboratory (NPL) in the United Kingdom led a research team carrying out computer network research and development during the 1960s, and came up with the term "packet switching" [Davies 2010; Kirstein 2009]. A computer network, called MARK I, was developed to serve the NPL campus in 1970, but could not develop into a wide-area networking in the UK as Davies' project proposal was turned down by the UK government. Later, a network protocol suite called Coloured Book was developed in the 1970s, and its implementation was later realized as SERCnet and JANET in the United Kingdom [Kirstein 2025; Davies 2010].

Louis Pouzin led the research team into computer network research and development in 1972, and demonstrated a packet-switching network based on a datagram in 1973 with one packet network switch and three computers called CYCLADES in France [THINK 2002]. This network supported the concept of end-to-end connectivity based on the datagram for the first time in the world. The concept of the datagram was later used in ARPANET with IPv4 from its deployment in 1983.

2.3 Asia

Kilnam Chon

Computer network research and development projects began in several Asian countries in the 1970s, including Australia, India, Japan, South Korea and New Zealand. Many of these projects in Asia were influenced by the research and development efforts of ARPANET and other initiatives in North America and Europe. These research and development efforts undertaken in Asia had little contact with one another until the 1980s when we started to meet each other through regional and global workshops and conferences. Some of the seminal projects are introduced in the following sections.

(1) Australia

Bob Kummerfeld

Bob Kummerfeld and Piers Dick-Lauder of the University of Sydney started to develop the Australian Computer Science Network (ACSNET) with Robert Elz of the University of Melbourne and others from the mid-1970s. ACSNET became operational in 1980.

(2) India

Srinivasan Ramani

A team at the Tata Institution of Fundamental Research (TIFR) headed by Srinivasan Ramani was active in computer network research and development from the 1970s. Ramani had early exposure to ARPANET facilities at the Carnegie-Mellon University in the United States in the 1970s during his stay at the Carnegie-Mellon University. When he came back to India, he began looking at networking technology from a developing country point-of-view. The TIFR team developed communications software to create a remote station on a minicomputer produced in India and operationalized it by 1977.

The following three institutions worked together to run the computer network experiment (COMNEX) over a satellite built by India:

- National Centre for Software Development and Computer Techniques (NCSDDCT) at Tata Institute of Fundamental Research (TIFR),
- Space Application Centre (SAC), and
- Telecom Research Centre (TRC)

COMNEX used a packet switching protocol and connected three cities – Ahmedabad, Bombay (now Mumbai), and Delhi and gave demonstrations of it in 1980. It used satellite communications terminals designed by SAC and built by the participating institutions.

Later, the networks team at NCSDDCT, headed by Srinivasan Ramani, partnered with a government-owned company, CMC Ltd., headed by Prem P. Gupta. This partnership fostered some projects including the joint development of a message switch that was later commercialized. The partnership also led to the organization of an IFIP TC-6 international conference named Networks 80, held in February 1980 in Mumbai [Ramani 1981].

(3) Japan

Haruhisa Ishida, "Current status of N-1 Network with supercomputer access," Proc. PCCS, Oct. 1985.

In 1973, planning was initiated for an inter-university computer network by the University of Tokyo Computer Center. Following a preliminary study, a network development project was organized by the members of the University of Tokyo Computer Center, Kyoto University Computer Center, and Nippon Telegraph & Telephone Company (NTT). Three Japanese mainframe computer manufacturers – Hitachi, Fujitsu, and NEC – as well as the Tohoku University Computer Center were invited to join the project, bringing the number of development partners to seven.

Somewhat modeled after ARPANET in the United States, a decision was made to use a packet switching service being planned by NTT at the time. Table 2-1 summarizes the development of the N1 network that resulted from the project. The Digital Data eXchange (DDX) was a digital packet switching network operated by NTT beginning in 1980. (A line-switching service was also available on DDX). TL1 and TL2 were the early experimental versions of DDX.

By the summer of 1981 when NTT started offering a packet-switched service on DDX as a commercial product, nearly all of the seven large-scale university computer centers had joined the N1 network. The features of the N1 network were as follows:

1. It was a heterogeneous network based on a proprietary protocol call the "N1 protocol" and linked mainframe computers from Hitachi, Fujitsu, NEC, and Mitsubishi. The protocol specification was available to all universities.
2. An all-digital packet-switching network (DDX) was used to connect thirty-three computers. Thus, communications costs were allocated proportionally to each site based upon the number of packets transmitted. However, since DDX was economical only for long distance and infrequent use, eighteen university computers in the Tokyo area were linked to the Tokyo center via leased lines.
3. The transmission speed was typically 48 kilobits per second, high for the time. Data was compressed prior to transmission.
4. Packet switching allowed the multiplexed use of communications lines. A number of TSS terminals and RJE facilities could thus share the same line.
5. Users would access the Tokyo center from a telephone terminal via the PAD (packet assembly/disassembly) service on DDV and through Venus-P. The latter was an overseas packet switching sub-network operated by KDD.
6. Network reliability was high.

Table 2-1. History of the N1 (inter-university) Network in Japan

1973	Tokyo University, Kyoto University, and NTT started development of an experimental network
1975	Tokyo University started TSS service via telephone
1976	Tokyo and Kyoto connected via RJE on N1/TL1
1977	Tokyo and Kyoto connected via TSS on N1/TL1
1978	Tokyo and Kyoto connected via TSS on N1/TL2
1980	NTT started a commercial digital line switching service on DDX (Digital Data Exchange)
1981	Seven university centers join the N1 network using packet switching on DDX

1981-1983	Connected the N1 network with NTT's DCNA via protocol conversion (Tokyo, Kyoto, Tohoku & NTT)
1984	Tokyo University tested PAD for DDX through 300/1200 bps telephone couplers/modems
1984-1985	Extended the N1-NVT protocol for Kanji data exchange. Mail facility introduced into the N1 network

1985	NTT started commercial service for PAD/DDX
1985	Universities began international mail exchange through KDDI's Venus-P and Usenet

(4) South Korea

Kilnam Chon

South Korea's TCP/IP network began with a small computer network research group headed by Kilnam Chon in 1979 [Chon 1985c; Chon 2013]. The group was formed at the Korea Institute of Electronics Technology (KIET), the national laboratory for research and development on computer and semiconductors founded in the late 1970s, and which forms part of the Electronics and Telecommunications Research Institute (ETRI) now. The group led by Chon started researching computer networks and, concurrently, a graduate course on computer networking was offered for the first time at Seoul National University (SNU).

In 1980, a research proposal to develop the first computer network in South Korea was made to the Ministry of Commerce and Industry of the South Korean government, but it was rejected. A revised proposal was made to the same ministry in 1981 as part of the National Project on Computer Research and Development, and in that guise, was approved. An implementation plan was developed for the project in 1981 and the network based on the TCP/IP protocol was initially named the Software Development Network (SDN). Later, the network was renamed the System Development Network.

(5) New Zealand

Brian Carpenter

Brian Carpenter's first involvement in a wide-area networking project was during the period 1974- 76 at Massey University, Palmerston North, New Zealand. At the time, all universities in New Zealand had installed the same make and model of mainframe computer – the Burroughs B6700. By 1975, ARPANET was quite well known and had grown to include 99 computers in

the USA, Norway, and the UK so there was naturally a high interest in data communications in New Zealand as well. Partly inspired by this, Massey University joined with Victoria University in Wellington in a project they called KIWINET. At the outset, there was some debate over the choice of network protocols. Carpenter recalls there were two contenders, the Experimental Packet Switching System (EPSS) developed by the British Post Office which was the precursor of X.25 or, of course, ARPANET, unless they decided to develop their own. As a Commonwealth country, the New Zealand Post Office usually followed the lead of the British, so the only way for KIWINET to get official support and funding was to select X.25. Unfortunately, the project met with many practical difficulties. New Zealand finally connected to the Internet in 1989, thirteen years after Brian Carpenter left.

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