7.8 ARPANET in 1984 and JUNET from 1984 onward

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This article looks back on how I became involved with the Internet and describes some key events and background from 1984 onward. *I like to take this opportunity to express my deepest gratitude to the many people whose names appear in this article.*

In 1973, I completed my master's degree in mathematics at the University of Tokyo and began working at the Musashino Electrical Communication Laboratory (ECL), Nippon Telegraph and Telephone Public Corporation (NTT). While working there, I earned my Ph.D. in information engineering from the University of Tokyo in 1991. I then left NTT in 1996 and became a professor at Waseda University.

1. E-mail is indispensable

The following experience made me keenly aware of the indispensability of email for research activities.

In 1984, I was doing research on artificial intelligence at NTT Laboratories. My boss at the laboratories told me, "You can work abroad at a university or research institute for a year. However, you must find a place to stay by yourself." With the advice from Masahiko Sato, an associate professor at the University of Tokyo and my friend from our student days, I planned to stay with John McCarthy, a professor at Stanford University with whom I had some previous contact.

I immediately wrote a letter to Professor John McCarthy, but received no response. I worried that my letter might not have been delivered, so I called the professor's secretary directly to see if she had received my letter. The secretary replied, "He does not read paper letters. If you have something to say, it is best to send it by e-mail.

I understood the situation, but there was no way for me to send an e-mail to ARPANET at that time. After thinking for a while, I asked my friend Jiro Tanaka, who joined ICOT (the research institute for the Fifth Generation Computer Project) from Fujitsu. He had an account on the SUMEX-AIM (Stanford University Medical Experimental Computer - Artificial Intelligence in Medicine) project at Stanford University. I asked him to quote the contents of my letter in his e-mail to John McCarthy. I immediately received a reply accepting me as a visiting scholar. This showed the tremendous power of e-mail.

In August 1984, I arrived at Stanford University, where I was able to use ARPANET e-mail.

Firstly, I received a key to the lab in Margaret Jacks Hall, where the Computer Science Department was located at the time, together with a key to the nighttime entrance door to the building. I was also given an account on the host machine SAIL, which stood for Stanford Artificial Intelligence Laboratory. My e-mail account is sg@sail.arpa. Later, domain names were introduced to SAIL, and my email address changed to sg@sail.stanford.edu.

The ARPANET had already switched to the TCP/IP protocol in 1983, but it was during my stay that the domain name was introduced to SAIL and other machines at Stanford.

The laboratory was fully wired for accessing the SAIL host machine, and the terminal used by researchers was a video display with a so-called "AI keyboard". At that time, Margaret Jacks Hall had many researchers but not enough rooms, so I was assigned a research assistant room as a visiting scholar. Two research assistants shared one room. I shared a room with Les Earnest, a lecturer who had founded a successful company called IMAGEN in Silicon Valley. It seemed that John McCarthy had brought Les Earnest back to the staff to help him plan new projects.

2. Use of ARPANET and the AUP issues

Networking was an integral part of my life at Stanford University.

Margaret Jacks Hall faces the *Oval*, a large grassy area on campus. John McCarthy's faculty office is on the third floor of the building overlooking the Oval. Next to it were his secretary's office and a row of several research assistant offices. In the beginning period, when I had something to do with the professor, I would first go to the secretary's office, explain the situation to her, and ask the professor to take care of it. One day, the secretary said to me, "Why don't you send an e-mail message directly to him yourself? Well, she is right.

Just as I was getting accustomed to working at Stanford University, I received a telephone message from the NTT lab in Tokyo. I needed to share that message with Saburo Muroga, who was a professor at the University of Illinois. He was our former senior colleague at the NTT lab. I tried to call him, but unfortunately, while local calls could be made freely from the office phone, calling the University of Illinois was a long-distance call. I had to give the other party's phone number to a telephone operator on campus and ask her to make a long-distance call. I also need to provide her with information on which project's budget would be used to pay for the phone bill. Then I explained the situation to the secretary to get the project contract ID. She said to me, "John has multiple projects. It does not matter from which budget you pay your phone bill, but why are you calling? It's easier and zero dollars to send an e-mail to the University of Illinois." Again, she is right.

My office had a desk and chair, a SAIL terminal, and a small bookshelf. The bookshelf was almost empty, but on the shelf was the ARPANET Directory 1983. There was the name and e-mail address of Saburo Muroga of the University of Illinois. E-mail is convenient. My errand was easily completed. The only regret is that the Directory was the 1983 edition. When I said to a fellow research assistant that I wanted the 1984 edition of the Directory, he explained to me: "The number of ARPANET hosts is doubling every year. If we were to make a latest 1984 edition, it would not fit into the format of a booklet like the 1983 edition."

Not only is e-mail useful for personal communication, but it can also be used for broadcast communication via mailing lists. One time, I tried to borrow a book from the university library. However, the book had already been borrowed by someone else. According to library rules, the name of the person borrowing the book is kept confidential for two weeks from the date of borrowing. I have no way of knowing who is borrowing the book, but considering the book's content, it is likely that someone in the Computer Science Department has borrowed it. Then I sent a message to the mailing list, "If anyone has borrowed this book, please contact me." Immediately, an assistant in the department brought the book to my room and showed it to me.

The mailing list also had postings from outside the university. One vendor posted an invitation for a summer job addressed to students in the department. I was aware that ARPANET has the AUP (Acceptable Use Policy), so I thought that this vendor's post was not allowed because it was for business purposes. What I was told at the time was that some corporate organizations are approved to connect to ARPANET. They cannot use it for commercial purposes, but they can use it to promote university research and education. For example, summer job guidance is acceptable because it can be considered part of the student's education. Offering academic discount prices for their products is an act of helping the university. Likewise, it is acceptable to use it to maintain the products installed at the university remotely from the company.

I became aware of the AUP because of the following incident. One day, a student club at Stanford University, named the Gay and Lesbian Club, sent an announcement message to the University of California, Berkeley (UCB) and asked them to publicize it. When UCB received it, they refused the request, stating that the activity was neither university research nor education, and warned: "This action violates the ARPANET AUP. Stanford University might be cut off from ARPANET." A lot of Stanford students discussed this "incident" online. At that time, there was neither the Web nor Wikis. They used an electronic bulletin board system called bboard (bulletin board), in which the posted articles were appended to the end of a single file. The users read the file. There were so many posts that I couldn't read them all, and about a week later, the Stanford club apologized to UCB and retracted the announcement.

3. Workstations and Personal Computers

The name "SUN Workstation" comes from "Stanford University Network."

The hardware for the host machine, SAIL, is a Digital Equipment Corporation (DEC) PDP-10, a proven machine that had been widely used on ARPANET. DEC's new machines included the VAX minicomputers, and many universities began using VAX in combination with the free UNIX operating system, rather than DEC's standard VAX/VMS OS. SUN Microsystems' workstations captured this trend. According to a company sales representative, their workstations sell well without detailed explanations if they illustrate SUN with VAX and UNIX: "Whatever you want to do with VAX and UNIX, you can do it with SUN, but at a cheaper price."

Personal computers were becoming popular during my time at Stanford University. For example, Apple released the Macintosh 128K (MAC) in January 1984. MAC was popular because Stanford students could purchase it at a discount. The IBM PC, which was the origin of modern Windows PCs, was released as IBM 5150 in 1981, and many companies released similar products, such as Compaq's IBM PC compatible machine in 1983, which led to their popularity. However, early personal computers, including MAC and IBM PC compatibles, didn't support TCP/IP. To connect to a network, they were connected to the host machine via a serial line or a modem. In contrast, SUN workstations were equipped with an Ethernet interface as standard.

Stanford University used CISCO routers in its campus network. At the time, CISCO was a startup company run by Len Bosack, his friend, and his wife. Len Bosack visited my roommate Les Earnest several times, so I had several occasions to meet him in person.

During my stay in the U.S., there was a groundbreaking in Japanese networking.

In October 1984, JUNET (Japan University NET, also Japan Unix NET) was launched. This was the beginning of the Internet in Japan. However, the protocol of JUNET was UUCP. NTT Laboratories, which I temporarily left, joined JUNET in March 1985. KDD Laboratory provided international connectivity for JUNET. As a result, I could exchange e-mail messages with my colleagues at NTT Laboratories. I felt quite happy because I could use e-mail after returning to Japan.

I also experienced the limitations of email.

Apple's Macintosh had enthusiastic users in Japan as well. Hisao Nojima of NTT Research Laboratories was a MAC user who was diligently researching information. He sent an e-mail to me at Stanford. He wanted to obtain files from the Info-Mac Archive, a MAC software library. Any organization in the U.S. connected to the ARPANET can instantly transfer the contents of Info-Mac using FTP. The size of these Info-Mac files is so huge that it is not practical to send them over the UUCP link between Japan and the U.S. In the end, I asked the SAIL operations staff to dump the contents of Info-Mac into a magnetic tape, which I sent to Hisao Nojima via postal parcel.

4. Japan's JUNET and IP connection between Japan and the U.S.

I returned to Japan from the U.S. in August 1985. Earlier that year, in April, NTT changed its organizational structure from a public corporation to a private company, but my research activities remained unchanged. After returning to Japan, I visited Hisao Nojima, with whom I had been in contact regarding the Info-Mac. I learned that a VAX minicomputer, part of his research group's equipment, had the host name "nttlab" and played a central role in domestic JUNET connections. Figure 1 is a slightly revised version of the JUNET connection diagram that Takehiro Tokuda published in a special issue of the journal *bit* in 1986 [1].
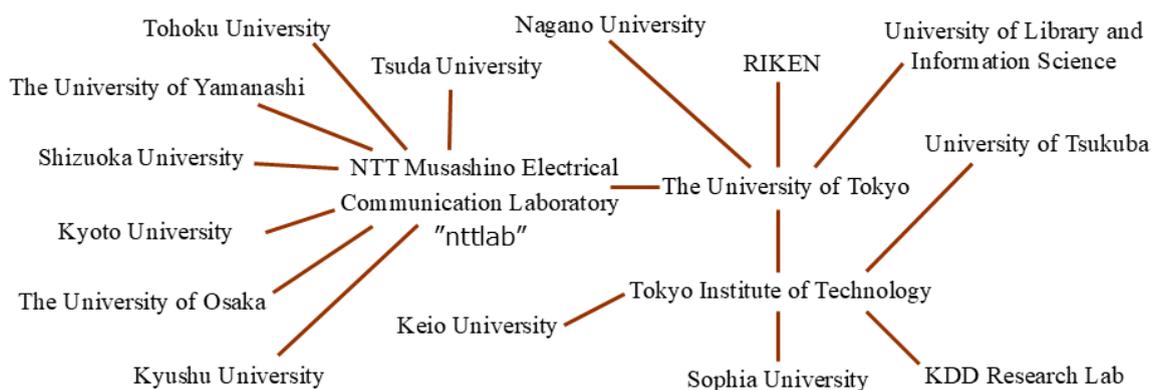

Fig.1 Domestic connection diagram in JUNET

To support JUNET activities in Japan, I subscribed to the mailing list of the volunteer network administration group "junet-admin". I also attended the meetings held by Jun Murai, a research assistant at Tokyo Institute of Technology.

At NTT Labs, many machines around my research group had already been connected via Ethernet. Previously, various protocols were used over Ethernet, including MIT's Chaosnet,

Xerox's IPX/SPX, and DEC's LAT. I thought it would be better to follow the smooth TCP/IP network operation at Stanford University, so I decided to purchase CISCO equipment, the company founded by Len Bosack, whom I had met before. I first acquired a line concentrator, then a router called AGS (Advanced Gateway Server). At that time, there was no distributor for CISCO products in Japan, so I asked him directly to obtain export permission for individual shipments to Japan.

For NTT Labs' IP address, I consulted Mark Crispin, a research assistant at Stanford. He strongly recommended using a global IP address. My colleague Yaski Saito handled the application to SRI-NIC. They assigned a *Class C* IP address, 192.5.216.0, which is recorded in RFC 990 [2] together with the name of Yaski Saito.

On the other hand, I was able to use my SAIL account for a while after returning to Japan. However, it was too expensive to log in to SAIL from Japan by international phone calls. I planned to set up a dedicated UUCP link between NTT Lab and Stanford University and forward my e-mail messages under my control. Fortunately, I was able to connect to a UNIX machine named Shasta at Stanford from Japan. When I tried calling Shasta's modem from nttlab via the telephone line, the communication quality was very low due to noise on the line. I tried one modem after another that were available, but even the latest modem with error correction function frequently stopped and aborted in the middle of the communication.

As a workaround, we attempted a new method: instead of dialing Shasta directly, we first connected from nttlab to SUMEX-AIM via packet communication (X.25) and then from SUMEX-AIM to Shasta using *telnet*. Mark Crispin taught us a technique using telnet's debug mode to ensure 8-bit transparency. With this setup, we finally achieved stable communication.

At that time, more researchers at NTT Labs began needing connections to U.S. universities and institutions. Several people came to me for advice, but managing these requests with individual links was infeasible.

At that time, in addition to ARPANET, there was CSNET (Computer Science Network) in the U.S. Although NTT Laboratories could not directly connect to ARPANET, CSNET was actively promoting international connections. However, the CSNET allowed only one organization from each country to participate as an affiliate. In the case of Japan, the University of Tokyo was already connected to CSNET, so we were told that additional participation from Japan would be infeasible.

Nevertheless, we did not give up, and Hiroshi Okuno, who was staying at Stanford University after me, explained the Japanese situation to David Faber and Larry Landweber, who were key figures in CSNET, and persuaded them enthusiastically. As a result, five Japanese organizations, in addition to the University of Tokyo, were able to connect to CSNET. The specific names are (1) Electrotechnical Laboratory (ETL), (2) ICOT, (3) NTT Laboratories, (4) NTTDATA, and (5) SONY.

We chose NEARNET (New England Academic and Research Network), a regional network established in 1988 by a consortium led by Boston University, Harvard University, and MIT, as our connection point to CSNET. Specifically, we connected nttlab to BBN via X.25. Initially, we used CSNET's standard protocol, MMDF, but our real goal was IP connectivity. My colleague Ken-ichiro Murakami worked hard toward this goal. He exchanged frequent

emails with CISCO and realized IP over international X.25 packet communication in August 1988. This became the first Japan–U.S. IP connection listed in the Internet history timeline [3]. At that time, CISCO was still a small company, and they kindly modified their router OS (IOS) to accommodate individual customer needs. I truly appreciate their support.

With this, my long-held dream of Japan–U.S. IP connectivity was finally realized. However, two challenges remained.

One issue was cost. Although it was technically possible to use IP over X.25 — and theoretically correct from the standpoint of protocol layering — in practice, when we tried to run FTP, frequent packet retransmissions occurred. At NTT Labs, we had to pay international packet communication fees to KDD, the overseas telecom carrier. After establishing IP connectivity with CSNET, the communication bill for nttlab exceeded 4 million yen (about $28,000) in one month. If we had used a 64 Kbps leased line instead, the monthly cost would have been just over 1 million yen. A representative from KDD even came to see why NTT Labs was paying such a large amount in packet fees.

We responded by suspending our IP connection over packet-switched lines and switching to a leased line. After making the switch, we resumed the connection. This resolved the first issue.

The second issue was coordinating international routing. Simply establishing an IP connection wasn't enough — there was a risk that domestic communication within Japan could be diverted via the U.S. To prevent this, we had to configure the routing settings carefully on NTT Labs' router. We were advised that we need to explain our routing configuration at the Internet Engineering Planning Group (IEPG) meeting. However, no one from NTT Labs participates in the IEPG, so I asked Jun Murai to explain this on our behalf. This solved the second issue.

5. Interop Tokyo 1994 and related activities in Asia Pacific

In the 1990s, the Internet began to expand internationally. In Japan, JNIC (later renamed JPNIC) was established in 1991 to manage Internet resources, i.e., domain names and IP addresses. It took over responsibility for assigning JP domain names, a task previously handled by junet-admin. I became a member of the steering committee in JNIC.

A symbolic event during this period was an International Conference, INET 92, held in Kobe, Japan, in 1992. At the time, I was teaching a class on artificial intelligence as an adjunct lecturer at Keio University SFC (Shonan Fujisawa Campus). After finishing a lecture, I took a taxi from the campus to Shin-Yokohama Station and caught a bullet train to the conference venue in Kobe.

In 1992, AT&T Jens launched the first commercial Internet ISP service in Japan. IIJ (Internet Initiative Japan) was also established and began service the following year in 1993. The Internet started to draw public attention. It was against this backdrop that Interop was decided to be held in Japan. The official title of the event was "Networld+Interop Tokyo 1992". I was asked to participate in the program committee chaired by Haruhisa Ishida, a professor at the University of Tokyo, and we discussed the layout of the conference.

In preparation for Interop in Japan, we were given a behind-the-scenes tour of the U.S. Interop held in San Francisco in 1993. What we saw backstage was fascinating. Following

that visit, I had an opportunity to attend a joint meeting of CCIRN and IEPG held in Bodega Bay near San Francisco. Please refer to Figure 2 for the full spelling of CCIRN.
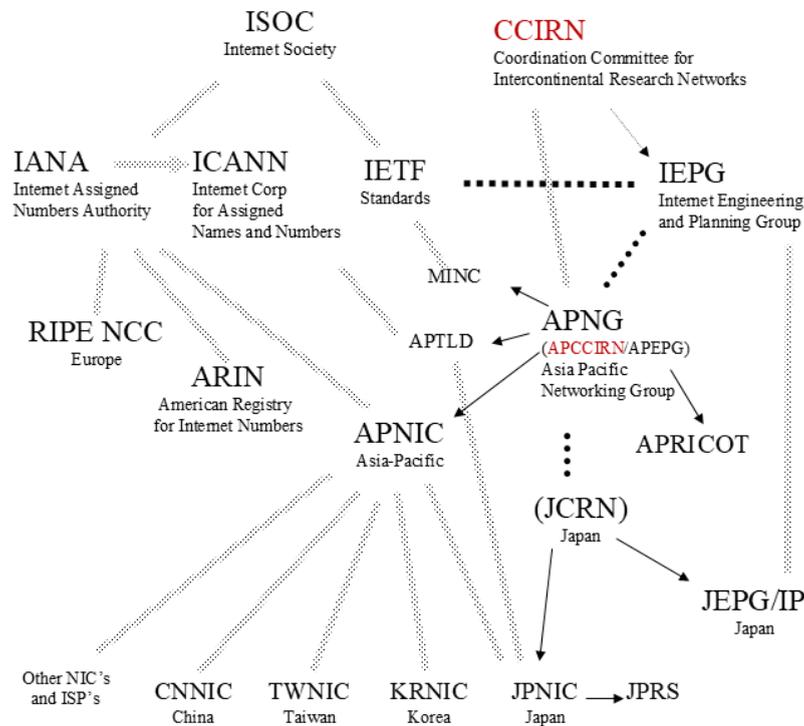

Fig. 2 The Internet-related organizations and activities [5]

These joint meetings consist of separate sessions for CCIRN and IEPG, but they also hold some joint sessions. This was the first time I fully understood the role of CCIRN. Although I understood IEPG's role for some time, this was my first time attending in person.

At the CCIRN meeting, Professor Kilnam Chon of KAIST played a leading role for the Asia-Pacific region. Inspired by the Bodega Bay meeting, I began participating in the Asia-Pacific CCIRN (APCCIRN). The first APCCIRN meeting I attended was held in Taipei in December 1993. In the list of participants, my affiliation is listed as JPNIC [4]. As shown in Figure 2, a wide range of organizations and initiatives were born from the foundation laid by APCCIRN, which was later renamed APNG.

References

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