6.? Asia Pacific Advanced Network - Japan (APAN-JP)

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(1)NSF International Connection Program and APAN-JP

NSF's international connection program

Steve Goldstein oversaw the US National Science Foundation's (NSF) Internet connection program between the US and Europe. He would like to add the connections to the research and education institutions between the US and Asia in the successor program. He spoke at the following two meetings:
- June 1995: ISOC INET'95 in Hawaii; the program was chaired by Kilnam Chon
- March 1996: The Asia-Pacific Economic Cooperation (APEC) Symposium was held by the Science and Technology Agency (STA) in Tsukuba, Japan, where Steve Goldstein encouraged Asian research nets to unite and apply to his successor program.

At the time, the author oversaw the international connection of the Inter-Ministry Network (IMNet) administered by the STA, and later became involved in the NSF international connection program.

In June 1996, the APEC/APII Testbed Forum meeting was held in Seoul, Korea. Kilnam Chon and Michael A. McRobbie made the joint presentation "Towards an Asia Pacific Advanced Network" [McRobbie 2020].

[McRobbie 2020] https://www.youtube.com/watch?v=0lyNro9v2us

Organization of APAN and application for HPIIS

May 15, 1997 NSF initiated an open procurement for the High Performance International Internet Services (HPIIS) and set the deadline for submission of proposals as August 15, 1997 [NSF 1997].

[NSF 1997] https://mailman.nanog.org/pipermail/nanog/1997-May/120667.html

On June 2-3, 1997, the author hosted the APAN (Asia-Pacific Advanced Network) Consortium's inaugural meeting at KDD Tokyo Otemachi Building, where the following decisions were made
Chair: Kilnam Chon (KAIST, KR)
Director of Secretariat & NOC: Kazunori Konishi (KDD R&D Labs, JP)

After Michael A. McRobbie (then Vice President for Information Technology and CIO of Indiana University, USA) successfully negotiated a low-cost 35Mbps ATM line from AT&T, Konishi recommended Michael as a candidate for the HPIIS Program Principal Investigator (PI)

of the HPIIS program. Then he proceeded to compile a set of draft proposal documents (draft research proposal, APAN MoU, and Letter of Intent from sponsors) for the HPIIS program [Konishi 1998].

[Konishi 1998] Kazunori Konishi, History of the APAN-JP Council,.
http://www.jp.apan.net/APAN-JP_history.pdf

In San Francisco, July 1997.
Kilnam Chon, Konishi, etc. met with Michael A. McRobbie and others from IU to develop a draft research proposal to the HPIIS program, and entrusted IU with the task of editing, completing, and submitting the proposal to the NSF.

Organization of APAN-JP Council

On August 7, 1997, the APAN-JP Council was organized as the Japanese branch of the APAN Consortium, with Professor Shigeki Goto of Waseda University as the APAN-JP Council Chair and Kazunori Konishi of KDD R&D Labs as Secretary General.

Next, the subdomain.jp.apan.net under the APAN domain.apan.net was distributed by Kilnam Chon Laboratory in Korea, and the APAN-JP Council created two mailing lists:

- **apan-jp@jp.apan.net** which gathered representatives from member networks IMnet(STA), APII(NICT), SINET(NII), MAFFIN(MAFF), ETL(MITI) and WIDE.

- **noc@jp.apan.net** which gathers the network operators of the member networks.

Since the Network Operations Center (NOC) is responsible for day-to-day network operations, a large number of emails were exchanged through the mailing list of the APAN-JP NOC, which became the core organization of the APAN-JP Council [Konishi 1998].

[Konishi 1998] Kazunori Konishi, History of APAN-JP Council,.
http://www.jp.apan.net/APAN-JP_history.pdf

IU published a proposal with Michael A. McRobbie as Principal Investigator(PI) and Kilnam Chon, Kazunori Konishi, James Williams, and others as Investigators; "TransPAC: A High Performance Network Connection for Research and Education between the vBNS and the Asia-Pacific Advanced Network (APAN)" was submitted it to NSF on August 15, 1997.

NSF HPIIS Program Awarded and Japan-U.S. Line Began Operations

After a rigorous review process, NSF informally decided to award the fund to IU's TransPAC project, and a signing ceremony was held in Washington, D.C. on September 21, 1998.

After the signing ceremony, Steve Goldstein, in charge of the HPIIS program, made the press release from NSF [NSF 1998].

[NSF 1998] https://www.nsf.gov/news/news_summ.jsp?cntn_id=102917

APAN-JP and IU shared information with carriers KDD and AT&T and a 35 Mbps ATM line was set up between the KDD Otemachi Building in Tokyo and the StarTap Internet interconnection point in Chicago on October 1, 1998, 10 days after the signing ceremony. Through this TransPAC connection, APAN Consortium members could now comfortably conduct joint research with research institutions around the world.

(2) Bridging the U.S. and Asia

APAN-JP began exchanging research information via a 35 Mbps line between the U.S. and Japan, and began participating in R&D projects being actively promoted in the U.S. by attending the Internet2 meetings in the U.S. In addition, APAN-JP hosted the Network Engineering Workshop during the biannual APAN meetings to introduce new projects in the U.S. APAN members began to follow the U.S. in their research and development.

Internet2 QBone

The first part of an IP datagram (IP header) that contains control information has an 8-bit area called TOS (Type Of Service), which specifies the data transmission quality of service. The router is designed to control data transmission to neighboring routers based on this specification. At that time, network speeds were not yet sufficient, and adding QoS to packets was required in order to give priority to high-speed applications such as video. Differentiated Services(Diffserv) was being standardized by the IETF and was implemented by vendors.

Internet2 took on the role of testing the practicality of this DiffServ, and APAN-JP NOC encouraged Japanese vendors to participate in this test and confirmed the interoperability of Japanese products. After this compatibility test, Internet2 launched the DiffServ service on its network.

Similarly, APAN-JP invited KOREN Korea to conduct video communication experiments between Japan and Korea, and confirmed the effectiveness of DiffServ [Kubota 2000].

[Kubota 2000]
http://www.jp.apan.net/meetings/0002-tsukuba-meetings/QoS-WG/APAN-QBone.pdf

Network Performance Measurement Tool perfSONAR

perfSONAR is a network performance measurement tool created by a joint effort of Internet2, ESnet, GEANT, and RNP, with an initial version perfSONAR 1.0 released in July 2006.

The APAN-JP NOC adopted perfSONAR in the perl language version developed by Internet2. We also supported the implementation of perfSONAR in the APAN-JP members, and proceeded to measure its performance in the domestic network. Furthermore, through the APAN Network Engineering Workshop, APAN-JP NOC supported the implementation of perfSONAR in APAN member networks and prompted APAN's participation in international experiments, etc. [Ikeda 2008].

[Ikeda 2008] http://www.jp.apan.net/meetings/0808-NZ/NE-Dep-PerfSONAR.pdf

In conjunction with Grid Computing

Grid computing connects geographically distributed computer resources via the Internet to perform large-scale tasks and solve complex problems that are difficult to execute on a single computer.
APAN-JP has provided and supported a network environment for domestic and international grid computing researchers, and invited these researchers to APAN meetings; the Grid Workshop in APAN meetings supported the deployment of grid computing technology in Asia [Aida 2005].

[Aida 2005] http://www.jp.apan.net/meetings/0508-taipei/apan2005-taipei-grid.pdf

(3) Expansion of Community & Networks

APAN Meetings (1998 -now)

The APAN meetings are held twice a year, and the Network Engineering Workshop organized by the APAN-JP NOC was the most popular session, contributing to the expansion of the APAN community [Konishi 2000].

[Konishi 2000]: http://www.jp.apan.net/NetEngWS.html

DV over IEEE-1394 (Firewire)

High-quality real-time AV communication was achieved by connecting AV equipment with an IEEE-1394 interface to an IP host.

The highest quality communication consumed over 35 Mbps of network bandwidth, but the bandwidth could be adaptively changed depending on end-to-end network conditions. This DV communication was demonstrated among the U.S., Japan, and Korea using APAN and TransPAC

links [Kobayashi 2002].

[Kobayashi 2002] https://www.rfc-editor.org/rfc/rfc3189.html

TEIN/Asia@Connect (2000 - now)

The TEIN1 project was approved at the Asia-Europe meeting III (ASEM III) held in Seoul, Korea in October 2000, and connected research institutes in both countries via a 2Mbps ATM line between France (RENATAR) and Korea (KOREN) in December 2001. The speed was increased to 155 Mbps in December 2004 to cope with the increase in traffic.

GEANT, which operated the European backbone, was looking for a project to take over TEIN1, and also expected to expand the project to all of Asia. GEANT representatives participated in the APAN meeting and expected Japan to provide Asian backbone circuits that could be used widely by research and education institutions in Asia.

In response to this request, APAN-JP asked SINET, and SINET finally agreed to provide both Tokyo-Hong Kong and Tokyo-Singapore circuits with 622Mbps, and TEIN2 was announced at the APAN Tokyo meeting [Jilong 2006].

[Jilong:2006] http://www.jp.apan.net/meetings/0601-tokyo/Jilong1.pdf

Since then, the TEIN network (TEIN2-4 and Asia@Connect) has become the core sub-network of the APAN and is managed by TEIN*CC in Korea [TEIN*CC 2024].

[TEIN*CC 2024] https://www.tein.asia/main/?mc=0#

Internationalized Domain Name (IDN)

In the Domain Name System (DNS), the rule is that alphabetic uppercase and lowercase letters are treated as the same, and this function is implemented within DNS.

Similarly, in CJK countries, there are many Chinese characters that have the same meaning and reading but different shapes. In this case, characters that have different glyphs in relation to the standard characters defined by the country are called "variant characters". For example, in Japan, "国" is the standard character for the country, and "國" is its variant.

The CJK engineers argued that the DNS should implement a process that treats variants as standard characters as well. However, for example, there are various variants of the same standard characters in CJK, and it was extremely difficult to define a unified variant character table set.

Under these circumstances, the author realized that APAN engineers in Asian countries are often involved in Network Information Center (NIC) activities, and that if he could call on these people, he could create a Joint Engineering Team (JET) for friendly discussions on CJK variant processing.

As a result of JET's discussions, the followings are agreed:
- no changes should be made to the current DNS,
- Each TLD (Top-Level Domain) registers its own variant character table with IANA,
- The application software should refer to the registered tables and convert the variants to standard characters.

This JET effort and agreement was recognized by the IETF and became RFC 3743, and each TLD registered its own variant character table with the IANA.

[Konishi 2004] https://www.rfc-editor.org/rfc/rfc3743.html

Compath, a route detection tool for intercontinental loops

With the development of optical communication technology, network owners were able to increase line speeds and expand the number of users within the same annual budget.

Being a research information network, some APAN members focused only on communication with networks for cutting-edge technologies, while others were indifferent to the communication with developing Asian countries.

In this situation, when research nets in Asian developing countries communicated with these APAN members, they passed through the U.S. and European networks, for example, choosing the route from Asia to the U.S. to Asia.
Noticing this situation, the U.S. research network objected to the Asia↔Asia communication passing through their country and asked APAN for improvements at international meetings.

In response, APAN-JP NOC developed a tool, Compath, which detects routes that cross continents and return to Asia, such as Asia-North America-Asia and Asia-Europe-Asia, by coloring the origin of each route as Asia, North America, or Europe. The APAN-JP NOC used the Compath tool to detect intercontinental loop routes and contacted the relevant NRENs to improve the routing table or to provide the routes within Asia, thereby drastically reducing the number of intercontinental loop routes [Kurokawa 2008].

[Kurokawa 2008] http://www.jp.apan.net/meetings/0808-NZ/kurokawa.pdf

GNA (Global Network Architecture)

Advanced North Atlantic (ANA) Collaboration between North America and Europe started in 2013 and improved the connectivity dramatically between them. The ANA consists of six leading R&E networks: CANARIE (Canada), ESnet (USA), GÉANT (Europe), Internet2 (USA), NORDUnet (European Nordics), and SURFnet (The Netherlands).

Jim William @Internet2 and Eric Jan Bos @NORDUnet co-chaired and led the development of GNA to expand ANA globally and continued to present at the APAN Network Engineering Workshop [William 2015], [Bos 2017].

[Williams 2015]
http://www.jp.apan.net/meetings/1503-fukuoka/APANGNAUpdateMarch2015-Final.pdf
[Bos 2017] http://www.jp.apan.net/meetings/1702-Delhi/erik-apan43.pdf

After Eric Jan Bos made a presentation about the GNA, APAN-JP hosted a dinner meeting following the Workshop. We agreed to establish an Asia-Pacific Ring (APR) network as a sub-network of GNA [Konishi 2017].

[Konishi 2017] https://temp.cgtf.net/apan-newsletter2/neteng.html

Asia-Pacific Europe Ring (AER) followed APR, and GNA was successfully realized; GNA was completed with inter-continental links among EU, US and Asia.

GNA facilitated the construction of Global eXchange Points (GXP) by creating a Checklist for self-assessing in realizing GXP [GNA 2017].

[GNA 2017] https://www.gna-g.net/wp-content/uploads/2022/06/GXP-Checklist-v1.1.pdf

Japanese NRENs (SINET, JGN, MAFFIN, WIDE) and overseas nets (TransPAC, SG, HK, CN, TW, PH) were already connected to the APAN-JP eXchange Point (XP). APAN-JP NOC established GXP-Tokyo according to the GNA's GXP Checklist and started 24x7x365 operation with perfSONAR measurement among global GXPs, with the cooperation of Eric Jan Bos, the leader of the GNA [Ikeda 2021].

[Ikeda 2021] GXP-Tokyo http://www.jp.apan.net/meetings/2102-PK/APAN51-ikeda.pdf

(4) Next Generation Technologies

Experiments on state-of-the-art networking technologies at the Supercomputing Conference (SC)

The Supercomputing Conference (SC) is an international conference organized by the ACM and the IEEE Computer Society every year, where cutting-edge networks (SCinet) are constructed,

supercomputing-related technologies are competitively exhibited, and international experiments are conducted [SCinet 2023].

[SCinet 2023] https://sc23.supercomputing.org/scinet/

The Bandwidth Challenge, an event to compete for the fastest file transfer speed, has been held in this SC, and Japan has demonstrated the world's fastest file transfer technologies.

First, at SC2004, the highest transfer speed was recorded for a single TCP connection [Hiraki 2004].

[Hiraki 2004] http://data-reservoir.adm.s.u-tokyo.ac.jp/press-20041116.html

Furthermore, at SC19, five 100Gbps lines were set up between Japan and the U.S. In addition, a large number of TCP connections were set up and the number of these connections were dynamically adjusted according to network conditions to transfer large amounts of data at high speed [Yamanaka 2019].

[Yamanaka 2019] https://www.ieice.org/publications/ken/summary.php?contribution_id=107776

SDN (Software Defined Network) and Automated GOLE

The trend of virtualization, which is rapidly advancing in the server, storage, and even cloud domains, has extended to the world of networking, and SDN (Software Define Network), which uses software to flexibly and dynamically build and manage virtual networks on top of diverse networks, has been studied.

Since SDN is a concept and there are various concrete implementation methods,
APAN-JP experimented and compared representative methods among them [Tanaka 2012].

[Tanaka 2012]
http://www.jp.apan.net/meetings/1208-Colombo/APAN-Colombo-tanaka-rev05.pdf

On the other hand, the Open Grid Forum (OGF) has been trying to realize high-speed data transfer by configuring virtual networks directly on top of layer 1 or layer 2 networks, avoiding the burden of IP protocols. The OGF developed a standard interface (NSI: Network Service Interface) to provide dynamic networks in multiple domains, and the Automated GOLE project, which employs this interface, is experimenting with the dynamic construction of Layer 1 and Layer 2 networks around the world. The APAN-JP NOC participated in the Automated GOLE project that adopted the NSI.

A working group has since been formed within the newly formed GNA (Global Network Architecture) to expand OGF's Automated GOLE activities, and technology to accommodate end-to-end high-speed data transfer node (DTN) terminals is currently under development

[GNA-G 2021].

[GNA-G 2021] https://www.gna-g.net/join-working-group/autogole-sense/

Participation in Global Network Testbed Projects

GEANT P4Lab (GP4Lab)

P4 is a programming language that describes data plane processing in an SDN environment and can be used to specify packet rewriting and destruction.

With the development of commercial Ethernet switches that can program packet processing in the data plane using the P4 language, activities to implement and test next-generation routing and control technologies were initiated.

GEANT, the backbone of the research and education net in Europe, implemented an open routing program on a Linux server and created an experimental router that can finely control packet processing in the P4 language. And to create a research and development community for the next generation net, a global testbed GEANT P4Lab (GP4Lab) is being deployed, and APAN-JP has joined it [GEANT 2023].

[GEANT 2023]
https://symposium.geant.org/wp-content/uploads/2023/12/Pavle-Vuletic-Network-Developments-Update.pdf

FABRIC Testbed

NSF, in cooperation with ESnet, has created a new research infrastructure, Fabric Testbed, for the computer science and networking communities to collaborate to develop and test architectures for a fast and secure Internet.

Research on computer networks, distributed computing, and next-generation applications is being performed on a large scale using this adaptive and programmable research infrastructure. Four additional foreign research institutions, including the University of Tokyo in Japan and CERN in Switzerland, will be added to the international testbed, and APAN-JP will support the University of Tokyo in connecting and experimenting [NSF 2021].

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