TransPAC Annual Report
01 August 1999 – 31 July 2000

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A. Introduction

The following report provides a summary of the primary accomplishments and expenditures in the second year of funded activity under NSF Cooperative Agreement ANI-9730210, TransPAC: A High Performance Network Connection for Research and Education between the vBNS and the Asia-Pacific Advanced Network (APAN). A Program Plan and Budget for the third year (2000-2001) are presented.

B. TransPAC Organization and Management Committee

TransPAC Management Committee (TMC) is co-chaired by the TransPAC Principal Investigator (Michael A. McRobbie) and the APAN Deputy Chair (Shigeki Goto). This committee establishes policy and provides overall direction for the TransPAC Project. TransPAC Management Committee members for the reporting period include:

APAN

Australia
- Robin Stanton (The Australian National University)
- Markus Buchhorn (Advanced Computational Systems (CRC), ACSys)

Japan
- Shigeki Goto (Waseda University)
- Kazunori Konishi (Kokusai Denshin Denwa, Co. Ltd.)

Korea
- Yong-Jin Park (Hanyang University)
- Kyungpyo Hong (Korea Telecom)

Singapore
- Francis Lee (National Technological University)
- Tham Chen Khong (National University of Singapore)

APAN Chair
- Kilnam Chon (Korea Advanced Institute for Science and Technology)

Tokyo XP
- Akira Kato (University of Tokyo)

Management Liaison
- Mitsutoshi Wada (Japan Science and Technology Corporation)

United States

Indiana University
- Michael McRobbie
- Doug Pearson
- Steve Wallace
- Jim Williams
- Rick McMullen
- John Hicks
- Dennis Gannon
- Karen Adams

AT&T
- To be determined for the coming year

STAR TAP
- Linda Winkler (Argonne National Laboratories)

Management Liaison
- Steve Goldstein (National Science Foundation)

The TransPAC Management Committee met twice during this year (10 October 1999 in Seattle, Washington, USA, and 14 February 2000 in Tokyo, Japan).

C. Milestones

2000

June 21	TransPAC 70Mbps and 30Mbps links merged in preparation for iGrid 2000
May 16-17	TransPAC status report at NLANR Joint Techs meeting in Minneapolis and planning meeting for January 2001 NLANR Joint Techs meeting in Hawaii, co-sponsored by TransPAC and APAN
April 20	TransPAC/STAR TAP/Euro-Link NOC and Engineering meeting in Indianapolis
April 11	iGrid 2000 planning meeting in Chicago
March 27	Informal TransPAC engineering meetings held at the Internet2 meeting in Washington, DC
March 17	OARnet/APAN peering
February 15-18	IWS2000 and APAN meetings in Tsukuba, Japan
February 14	TransPAC meeting in Tokyo in conjunction with APAN meeting and IWS2000

1999

November	TransPAC bandwidth increased to 70+30 Mbps (2 PVP circuits)
October 10	TransPAC meeting in Seattle in conjunction with Internet 2
October 4	SURFNET/APAN peering
October 3	IUCC (Israel)/APAN peering
September 21-24	APAN meeting in Canberra, Australia
August 27	NORDUnet/APAN peering
April 28	APAN, UCAID, and TransPAC representatives meet to discuss terms of APAN/UCAID MoU and establish outline for APAN/Abilene peering via TransPAC agreement
April 6	First HPIIS Team Meeting in Chicago
March 22-26	TransPAC-based demonstrations at GOIN'99
March 14	JST funded TransPAC network upgrade to 73Mbps bandwidth completed

1998

November 25	APAN / ESnet peering
November 24	APAN / NREN peering

November 7-13	TransPAC-based iGrid demonstrations at SC'98
October 23	APAN / vBNS peering
October 18	24x7 IU TransPAC NOC operational
September 21	NSF TransPAC 5-year award to Indiana University formally announced in Washington, D.C.
September 21	Representatives of Indiana University and Japan Science and Technology Corporation sign MOU to establish link
September 8	Cooperative Agreement for TransPAC signed
August 18	IP routing KDD <-> IU via vBNS Downers Grove
July 30	ATM service established APAN Tokyo XP to STAR TAP

D. Progress Report

D.1. Progress Toward HPIIS Objectives in the Statement of Work and FY99-00 Program Plan

The following sections detail progress against HPIIS program objectives and objectives set in the "Program Plan" section of last year's TransPAC annual report (for FY98-99). The TransPAC proposal listed six activities critical to meeting the HPIIS program objectives:

- Furnish, operate, and maintain a direct connection for high-performance traffic between the vBNS and APAN networks via the STAR TAP (Chicago)
- Cooperate with STAR TAP and vBNS officials to ensure, to the extent supportable by prudent application of networking technology, that only approved institutions' traffic is permitted to use the high-performance connection
- Monitor the performance and use of the TransPAC connection
- Cooperate with the vBNS and the National Laboratory for Advanced Network Research (NLANR) Team (University of Illinois at Urbana (DAST), UCSD (MOAT) and Carnegie-Mellon University (NCNE) to develop testbed implementations and, as appropriate, production implementations of new versions of Internet networking protocols
- Maintain a publicly accessible TransPAC-HPIIS Web site containing information about the APAN-vBNS high-performance connection and research and education collaborations that it enables
- In concert with the methodologies developed by the NLANR Team, provide consultative user services supporting the use of TransPAC-HPIIS for high-performance computing and communications applications. Provide Web-based front-end tools and direct user support to enable direct access to differentiated network services

In addition to these primary objectives the Statement of Work for FY99-00 listed six areas in which work was to be focused to further the primary objectives:

- Distributed Network Operations Center for TransPAC
- Human resources
- Support for a distributed HPIIS team
- Core network services
- Performance measurement and analysis
- User services

Progress to date in each area against the global HPIIS goals and related elements in the statement of work in last year's annual report are discussed in detail in sections D.1.a through D.1.f below. Each section begins with the HPIIS objective for TransPAC and contains specific accomplishments against related goals set for this reporting period in sections labeled "Progress in X against FY99-00 Program Plan."

D.1.a. Network Provisioning, Operation, and Management

"Furnish, operate, and maintain a direct connection for high-performance traffic between the vBNS and APAN networks via the STAR TAP (Chicago)."

The TransPAC network continues to operate in the configuration below (Figure 1). Peering on both the Japanese and United States sides have increased in the past year. The network bandwidth was expanded from 73Mbps to 100Mbps in October 1999 at no increase in cost. Plans for 2000-2001 call for an additional increase in bandwidth with no increase in cost, anticipating decreasing costs of trans-Pacific connectivity.

Figure 1 below illustrates the topology of TransPAC and networks with which it peers. TransPAC provides Layer 2 and Layer 3 connectivity to peer networks at the STAR TAP and the APAN Tokyo Exchange Point (Tokyo XP).

The Indiana University NOC provides operations and engineering services for TransPAC, the Abilene Internet2 network, and the IU network. This year, in parallel with providing NOC services to TransPAC, the IU NOC began providing NOC services for STAR TAP and the Euro-Link HPIIS networks. The STAR TAP and Euro-Link NOC operations are fully integrated within the existing 24x7 support that the IU NOC provides for TransPAC and Abilene. Designated NOC staff positions funded by these external networks comprise the primary support group for the various networks. Additional support is available from all NOC staff, regardless of designation, as needed. Separate external identities, support mechanisms, and NOC Web pages are maintained for each network.

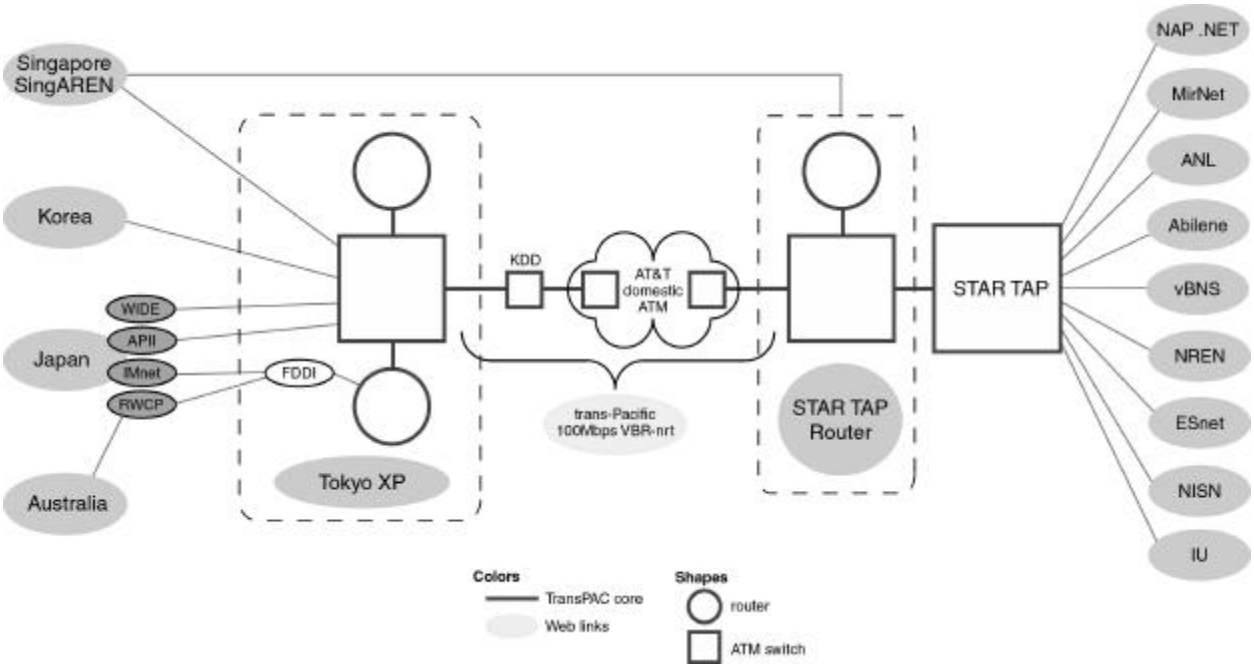

Figure 1

In the reporting year, the TransPAC router, co-located at STAR TAP, was transformed from a TransPAC-only layer 3 service to a STAR TAP layer 3 service. Note: The chassis of this router was originally donated to STAR TAP by Cisco Systems. In FY98-99, TransPAC added hardware to the router and deployed it on a TransPAC router. In FY99-00, following conversations between the TransPAC and STAR TAP engineers, it seemed most useful to the international community to transform the TransPAC router into a STAR TAP router again. The router provides a peering point for the interconnection of national research networks at STAR TAP including APAN, other international networks such as CAnet3, the vBNS, and other high performance research and education networks including Abilene, NREN, and ESnet. For a detailed configuration diagram of the Tokyo XP, see http://www.jp.apan.net/NOC/xpconf.html. For a detailed configuration design of STAR Tap, see http://www.startap.net/images/STLogicalMap.gif.

Following the same logic, the TransPAC switch, a Cisco LS-1010, has been redeployed to serve the broader needs of the international community as a STAR TAP device. It retains its full TransPAC functionality.

TransPAC NOC service was officially begun in October 1998. The TransPAC NOC is an evolving partnership between Indiana University (IU), APAN, and KDD (managers of the APAN Tokyo XP). The IU TransPAC NOC is physically located on the Indianapolis campus of Indiana University. Figure 2 illustrates the relationships among these NOCs and service providers.

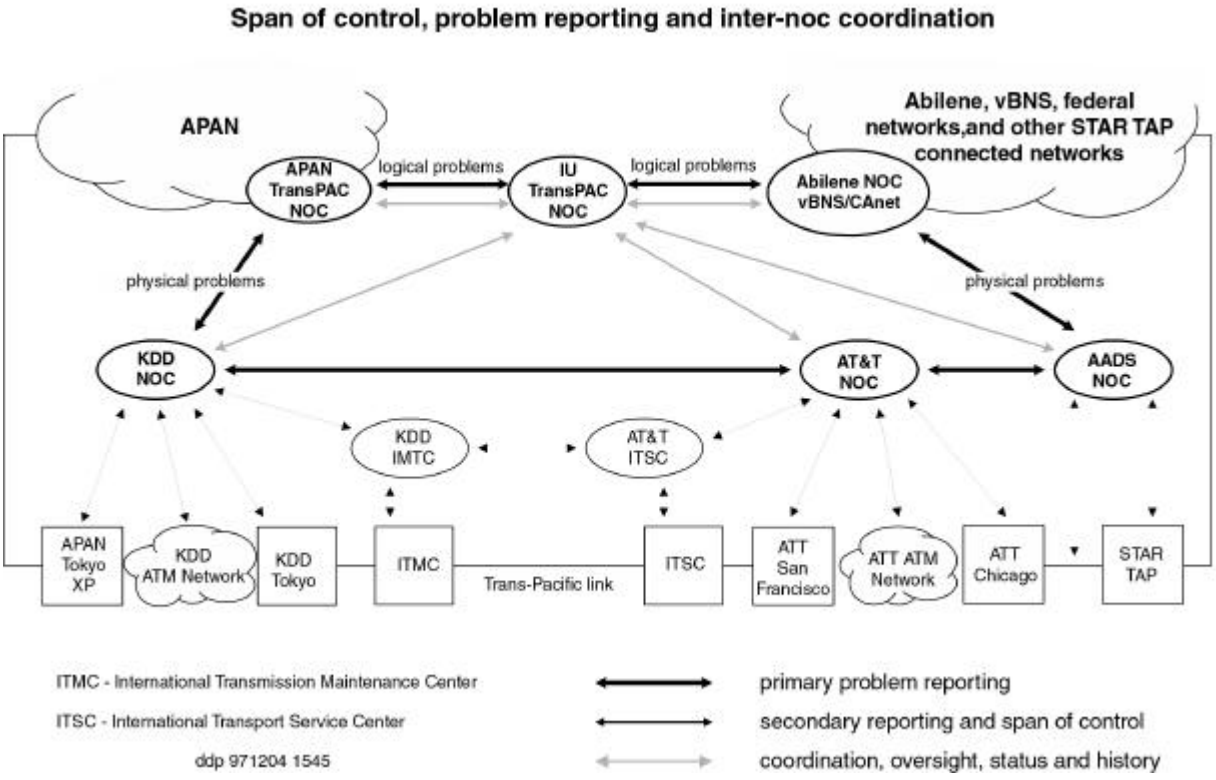

Figure 2

The IU TransPAC NOC continues to work closely with the APAN TransPAC NOC to deliver a high-quality coordinated NOC service both to US and Asia-Pacific investigators.

The current set of NOC-deployed tools range from basic tools such as ping, pathchar, traceroute, and MRTG, to more complex measurement tools such as OC3mon and Surveyor. Over the past reporting year, an advanced set of troubleshooting tools has been developed and deployed in the IU TransPAC NOC and made available to the APAN TransPAC NOC.

Progress in Network Operations Center Development Against FY99-00 Program Plan

The Indiana University NOC began providing operations services for STAR TAP and the Euro-Link HPIIS networks this past year. Existing NOC staff and positions funded by these external networks comprise the main support group for the various networks. Separate external identities and support mechanisms (such as Web pages), are maintained for each network.

Housed at the Indianapolis campus, the IU NOC tier-one support center is staffed by sixteen full-time employees. They work in conjunction with the IU engineering staff of five full-time engineers and a team of software and Web developers who work at the Bloomington or Indianapolis campuses.

The TransPAC NOC provides the following general NOC services:

- Problem Management (detection, tracking, resolution of network problems)
- Change Management (notification and control of changes to the network)
- Performance Management (monitoring of network performance)
- Configuration Management (hardware change monitoring)
- Security Management (IU is a member of FIRST, the Forum of Incident Response Security Teams)
- Scheduling and Allocation of Network Resources (not active at present)
- Quality Assurance
- Reporting (Regular reports supplied to all associated networks)
- Documentation

The paragraphs following describe management and reporting tools have been developed as a portion of the work performed by the NOC in the FY99-00 reporting period.

Network Management Station.[1] TransPAC / STAR TAP NOC has installed a Unix-based network performance and measurements workstation at the STAR TAP. This tool is integrated into NOC operations and serves as a platform for advanced performance and measurement analysis activities.

Weekly Report. The IU NOC now provides a weekly report reflecting the network availability of the supported International Networks, including TransPAC. This is sent out via e-mail every week, and will be soon posted to the TransPAC NOC Web pages.

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[1] *http://missinglink.transpac.org/*

Router Proxy. The router proxy allows users to submit show commands to the TransPAC/STAR TAP router. Select the router, pick a command of your choice, submit an electronic request form, and the output of the command is displayed in another frame.

BGP Session Monitor.[2] This program monitors the defined Boarder Gateway Protocol (BGP) sessions on the TransPAC/STAR TAP router. Failure alerts are tied in with the NOC's paging and notification systems

Log watcher.[2] System logs of the network components are automatically watched and reports of significant events are e-mailed to NOC operations and engineering. Also, a Syslog Monitor has been developed where individuals can view and search the current and past syslogs from the TransPAC/STAR TAP router.

Configuration management. A scheduled process that automatically archives network component configuration files has been implemented. Also, a scheduled process that automatically logs into network components and downloads the configurations and compares the existing and prior configurations and e-mails the differences to engineering personnel has been implemented.

Security. TACACS (Terminal Access Controller/Access Control System) based access control has been integrated into network components that provide varied levels of authorization for IU TransPAC NOC and engineering and APAN NOC personnel. At an organizational level, IU is an active member of Forum of Incident Response Security Teams (FIRST).[3]

Progress in Human Resources Objectives Against FY99-00 Program Plan

An offer for the position of TransPAC network engineer has been extended. We hope the candidate begins work in September 2000. An offer for the position of TransPAC communications and applications engineer has been extended an accepted. This candidate began work in July 2000. Filling these two positions will allow many technical and user support initiatives to move forward. Hiring for both these positions was seriously delayed by the very tight job market for strong technical staff.

Progress in Distributed HPIIS Team Development Against FY99-00 Program Plan

Video conferencing strengthens the communication and collaboration among HPIIS team members. IP-based video conferencing equipment has been deployed at Indiana University, Bloomington, the TransPAC NOC, UT/Knoxville, and University of Chicago. This equipment is being used to prepare for the joint HPIIS review scheduled for October 2000. Temporary H.323 and Access Grid Mbone video conferencing facilities were set up at iGrid 2000 in Yokohama and used extensively by iGrid engineering staff and researchers to interact directly with the TransPAC NOC.

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[2] See the "Network Monitoring" section in *http://noc.startap.net/*

[3] *http://www.first.org/*

Progress in Core Network Service Against FY99-00 Program Plan

Prompted by increased competition and an increase in supply, bandwidth prices continue to decrease while the demand for bandwidth continues to rise as collaborations increase. Built into the contract with AT&T (and into any subsequent contracts) is a clause that allows IU to "test the market" each year to ensure TransPAC is receiving the benefits of changes in the market. In the 99-00 reporting year, bandwidth increased to 100Mbps at no cost to the project through negotiations with AT&T. The intention is to continue to leverage the decreasing price of Trans-Pacific bandwidth to secure increasing TransPAC bandwidth at a constant price. An RFP for additional bandwidth was distributed to Trans-Pacific carriers in May 2000, the results of which are still being analyzed.

The value of the TransPAC network to researchers is related to the number of research sites that can be reached via high performance network connections. TransPAC peer networks increased dramatically over the 99-00 reporting period. Following is a complete list of networks with which TransPAC peers as of 1 June 2000:

US Networks

- OARNET
- Merit
- vBNS/vBNS+
- ESnet
- Abilene
- NREN
- MREN
- NISN

Non-US Networks

- CA*net 2/3
- CERN (planned)
- SURFNET
- GEMnet
- NORDUnet
- SINET/NII
- RENATER2
- TANet2
- SingAREN
- APAN
- Israel (IUCC)
- MIRnet (planned)

The TransPAC layer 3 peering service located in Chicago at the STAR TAP has been transitioned to a STAR TAP layer 3 peering service. Layer 3 peering is now available to all STAR TAP participants.

D.1.b. HPIIS Approved Institutions, Traffic Segregation, and AUP

"Cooperate with STAR TAP and vBNS officials to ensure, to the extent supportable by prudent application of networking technology, that only approved institutions' traffic is permitted to use the high-performance connection."

The organizational and technical structures described in the 1998-1999 Annual Report remain in place and are functioning properly. New networks in both the Asia-Pacific area and the United States continue to be added to the list of routable networks, consistent with the TransPAC-established routing and traffic segregation policies. The TransPAC Acceptable Use and Authorization Policies remain as they were described in the 1998-1999 Annual Report. They are documented on the TransPAC Web site at http://www.transpac.org/aup.html. Networks that peer with TransPAC at STAR TAP include the vBNS, Abilene, NREN, NISN, and ESnet. An up-to-date list of the APAN institutions and peering networks is maintained on the TransPAC Web pages at http://www.transpac.org/applications/routing.html.

APAN institutions that are currently routed on TransPAC include:

Australia

Cooperative Research Center, Advanced Computational Systems (ACSys CRC)

Japan

Agency of Industrial Science and Technology (AIST)

Agriculture, Forestry, and Fisheries Research Council (AFFRC)

APAN JP Tokyo Exchange Point

Communications Research Laboratory (CRL)

Electrotechnical Laboratory (ETL)

Japan Advanced Institute of Science and Technology (JAIST)

Japan Science and Technology Corporation (JST)

Keio University

Kokusai Denshin Denwa Laboratory (network management)

Kyoto University

Nara Advanced Institute of Science and Technology (NAIST)

National Cancer Center

National Cardiovascular Center

National Institute of Genetics

National Space Development Agency of Japan (NASDA)

Osaka University

Real World Computing Partnership (RWCP)

The Institute of Physical and Chemical Research (RIKEN)

Tokyo Institute of Technology (TIT)

University of Tokyo

Waseda University

Korea

APAN KR NOC

Chungnam National University

Ewha University

Hanyang University

Information and Communications University

Inha University

Korea Advanced Institute of Science and Technology (KAIST)

Korean Meteorological Administration

KORNET

Kyungpook University

Postech

Seoul National University

Soongsil University

Singapore

Kent Ridge Digital Labs

Nanyang Technological University (NTU)

National University of Singapore

Thailand

Asian Institute of Technology (AIT)

To facilitate the use of TransPAC by APAN institutions that are on networks that contain a mix of authorized and unauthorized institutions, a two-router source/destination policy routing infrastructure was developed at the APAN Tokyo network exchange point. This routing structure remains in place and is functioning as designed. See Figure 3, below.

During the current year, the router labeled "Router B," a Cisco 7507, was replaced by a Juniper M20. The current M20 is functioning effectively as a replacement for the 7507. Juniper engineers feel that, with future hardware and software upgrades, the M20 will be able to completely perform the policy routing function and TransPAC will be able to eliminate "Router A." This will be an area of technology exploration for the 2000-2001 work plan. The Juniper M20 was purchased by APAN. The policy routing architecture outlined in Figure 3, below, is documented on the TransPAC Web pages at http://www.transpac.org/engineering.html.

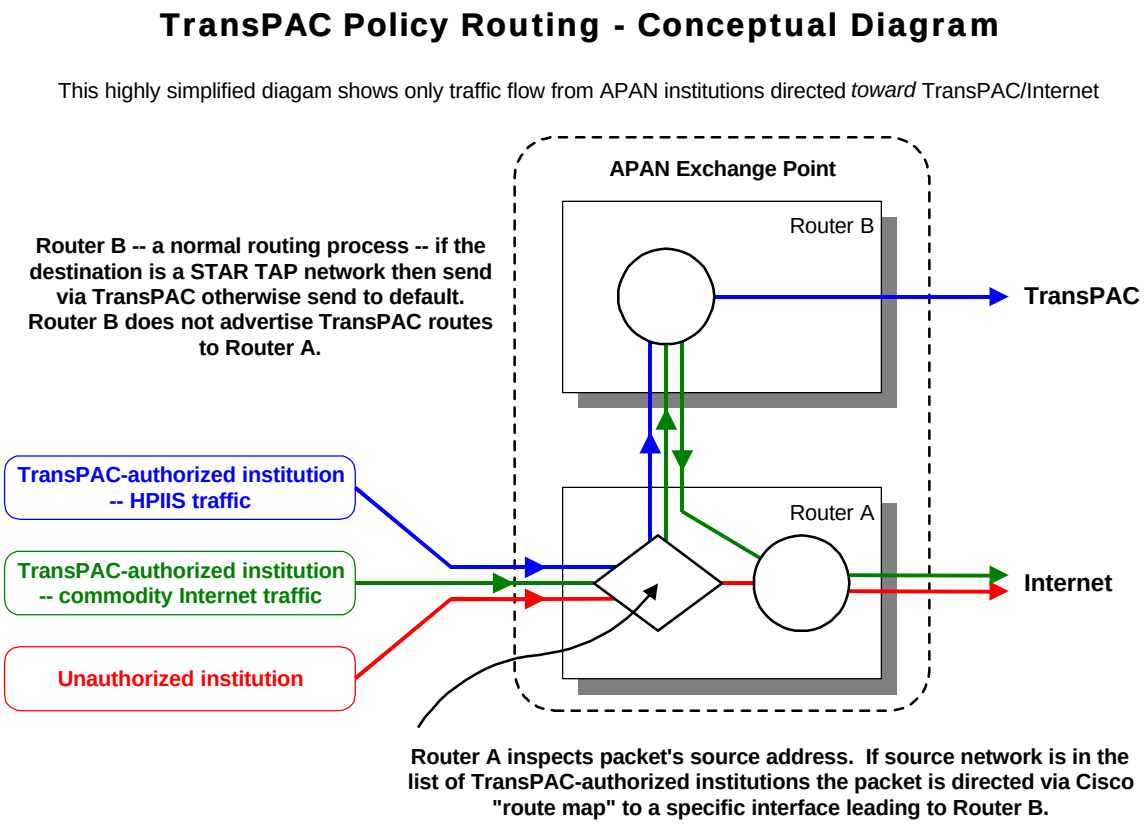

Figure 3

D.1.c. Traffic and Performance Monitoring

"Monitor the performance and use of the TransPAC connection."

Network utilization is monitored with Multi Router Traffic Grapher (MRTG). The five-minute moving average bits-per-second statistic for input and output is collected on the STAR TAP Cisco LS1010 ATM switch. Daily statistics and weekly, monthly, and yearly summaries are displayed on the TransPAC Web page at http://www.transpac.org/noc/utilization.html.

Actual daily and yearly graphs of the interface to the trans-Pacific ATM service appear below. The time scale advances to the left as indicated by the red arrow. Green represents input bits-per-second (traffic coming from APAN). Blue represents output bits-per-second (traffic headed toward APAN). On the yearly graph, the additional colors of dark green and magenta represent the maximal 5-minute input and output rates that occurred during the summarization period, green and blue represent the average of the summarization period.

The daily graph for Thursday, July 13, 2000:

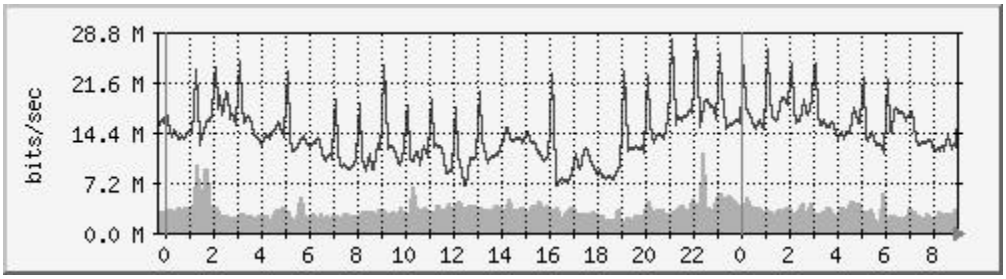

Figure 4

The yearly graph for June '99 — June '00:

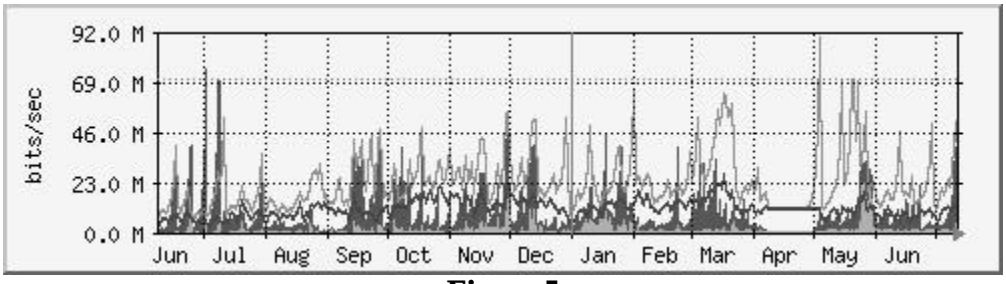

Figure 5

ANS Surveyor is employed to measure one-way delay and packet loss across the TransPAC and APAN networks. Surveyors have been installed at the Indiana GigaPoP, Korea Advanced Institute of Science and Technology, and the APAN Tokyo network exchange point. Additional Surveyors will be installed in Australia and Singapore. Surveyor statistics can be viewed at http://www.advanced.org/csg-ippm/. NLANR maintains an OC3mon for TransPAC, installed at the STAR TAP facility. Statistics are available in the NLANR Datacube at http://moat.nlanr.net/Datacube. Over the reporting period, the TransPAC network was very stable. Specific network outages are detailed in the monthly reports submitted to the NSF.[4] Downtime totals for TransPAC follow.

Downtime totals for the year (July 1999 to May 2000):

TransPAC/STAR TAP router - 1 h 53 min
TransPAC switch - 1 h 13 min
TransPAC router –Tokyo - 6 h 23 min

Number of TransPAC-related tickets created and closed in last year: 77

[4] *http://www.transpac.org/documents.html*

Progress in Performance Analysis and Measurement Against FY99-00 Program Plan

iGrid 2000[5] was used as a measurement ground for additional network performance and measurement studies for TransPAC, Abilene, and other international networks. The results of this study will be presented at the August 2000 APAN meetings in Beijing.

ANS Surveyor[6] systems, which provide measurement of one-way delay and packet loss in a community of surveyors, have been installed at the Korea Advanced Institute of Science and Technology and at the APAN Tokyo network exchange point. Additional Surveyors will be available soon in Australia and Singapore. TransPAC will continue to work with ANS to develop real-time and longitudinal analysis and display software for information collected by the Surveyors. TransPAC will also continue to work with NLANR in the operation and analysis and display of data from an OC3mon for TransPAC installed at the STAR TAP facility.

In mid-June when the bandwidth on the TransPAC service was merged into a single 100 Mbps PVP from the existing 30 and 70 Mbps PVPs TransPAC engineers verified the service level provided by AT&T/KDD utilizing the OC3PORT ATM cell generator located in Chicago for a 24-hour period. TransPAC engineers continue to work with applications developers to verify TransPAC service and measure performance at the applications level. A much clearer understanding of the characteristics of high bandwidth delay networks has allowed researchers to make much more effective use of TransPAC. The hiring of an additional full-time TransPAC network engineer and an application support engineer will greatly facilitate TransPAC involvement in more detailed performance analysis.

D.1.d. Internet Protocol Development

"Cooperate with the vBNS and the National Laboratory for Advanced Network Research (NLANR) Team (University of Illinois at Urbana (DAST), UCSD (MOAT) and Carnegie-Mellon University (NCNE), to develop testbed implementations and, as appropriate, production implementations of new versions of Internet networking protocols."

Work in this area is focused on IPv6, native multicast, QoS, and Web cache. Additional information about the development of protocol and service testbeds across TransPAC can be found in Section D.2.c.

IPv6. TransPAC is fully participating in IPv6 efforts. An IPv6-based demonstration between Osaka University and SDSC was successfully held at iGrid 2000.

Multicast. Multicast is an important component of collaborative environments and digital video services. Activities undertaken in FY99-00 to strengthen multicast support across TransPAC are detailed in Section D.2.c below.

[5] *http://www.startap.net/igrid2000*

[6] *http://www.advanced.org/csg-ippm/*

QoS. TransPAC and APAN are participants in the Internet2 Quality of Service Backbone (QBone) project within the context of a Joint Proposal organized by the International Center for Advanced Internet Research (iCAIR). As a part of iGrid 2000, TransPAC will participate in a DiffServ experiment coordinated by iCAIR. TransPAC has suspended efforts to investigate RSVP as a method to provide backbone QoS and is tracking and implementing the DiffServ standard.

Cache. The APAN Cache Working Group maintains a root Squid cache server at the APAN Tokyo XP. Reference to the service is at http://cache.jp.apan.net/.

D.1.e. TransPAC Web Site and Online Documentation

"Maintain a publicly accessible TransPAC-HPIIS Web site containing information about the APAN-vBNS high-performance connection and research and education collaborations that it enables."

The TransPAC Web site[7] went online in fall 1998. It is currently being redesigned, new equipment has been purchased, and the site will be expanded and updated by September 1, 2000.

D.1.f. User Services and Training

"In concert with the methodologies developed by the NLANR Team, provide consultative user services supporting the use of TransPAC-HPIIS for high-performance computing and communications applications. Provide Web-based front-end tools and direct user support to enable direct access to differentiated network services."

Performance tuning work undertaken in Year 1 and the two bandwidth expansions in Year 2 (35->70; 70->100) has reduced the immediate need for QoS as an integral part of day-to-day TransPAC operations. TransPAC continues to participate in the QBone testbed and will participate in a QoS trial at iGrid 2000.

TransPAC engineering staff are actively engaged with NLANR activities and participated in fall 1999 and spring 2000 NLANR Joint Techs meetings. TransPAC and APAN will be joint hosts (in conjunction with Internet2 and NLANR) of the January Joint Techs meeting in Hawaii. This meeting will focus on presenting a balanced Asia-Pacific/United States view of technology development. Jim Williams is representing TransPAC on the Program and Arrangements Committees.

[7] *http://www.transpac.org*

Progress in User Services Development Against FY99-00 Program Plan

Testbed support. TransPAC played a key role in iGrid 2000 computing demonstrations held in conjunction with INET2000 in Yokohama, Japan. iGrid 2000 involved 24 demonstrations of international applications ranging from remote operation of a microscope using IPv6 to real-time video transmission of the conference demonstrations to selected sites worldwide. Members of the IU staff attended iGrid preparation meetings and TransPAC staff traveled to Japan to assist with iGrid hot-staging, set-up, and operations. A list of iGrid 2000 applications can be found at http://www.startap.net/igrid2000/.

As mentioned, TransPAC and APAN will co-sponsor the NLANR/Internet2 Joint Techs meeting in Hawaii in January 2001. The focus of the meeting will be joint US/Asia-Pacific collaborations in the network research and applications areas (IPv6, multicast, Web cache, and QoS).

Training activities. NLANR training activities have made a valuable contribution to the expertise of the high performance network user community. With the hiring of both the TransPAC network engineer and the TransPAC applications engineer, this will be a focus for the next reporting period FY00-01.

Application database. TransPAC conducts an annual census of the research and education users of the TransPAC network. We obtain detailed project information, classify projects according to type and area, offer assistance, and solicit project status and feedback regarding the TransPAC network service. A database containing this project information is updated regularly.

Bandwidth scheduling. Our ability to increase bandwidth has enabled us to remain ahead of bandwidth demands. No scheduling of bandwidth was required. TransPAC participated in a DiffServ application at iGrid 2000.

D.2. Collaboration and Application Testbeds

A key mission of the TransPAC project is to support international collaborative research and to facilitate the development of innovative network-based applications that are critical to the success of these collaborations. The cultivation of testbeds to foster application development and to meet the specific needs of research collaborations is one aspect of this mission. During the 1999-2000 fiscal year TransPAC has facilitated the development of research community testbeds in several areas, including digital video distribution (GiVDN), earth observation (GOIN and CEOS), high performance computing, and visualization and virtual environments (iGrid 2000). Projects in each of these areas are described in more detail in the following paragraphs.

D.2.a. Advanced Application Services Testbeds

A key enabling component for widely distributed applications is a set of middleware services for resource discovery, user authentication and authorization, resource scheduling, and execution control. The Globus toolkit provides these middleware services and was used in several iGrid demonstrations at SC98. We had envisioned wider deployment this year. Collaborations have been limited, so production-level resource sharing was not a requirement this year. Two collaborations, however, stand out. The first, a telemicroscopy experiment between Osaka University and SDSC,[8] was redesigned using Globus for resource allocation, and a large-scale computational phylogeny code with interactive real-time visualization was reengineered for use in a Globus environment. The second set of collaborations involve applications of CAVERNSoft,[9] a package for building remote interactive shared virtual spaces, used to develop several interactive simulations shown at iGrid 2000.

Other middleware projects started this year that are expected to be engineered into the next generation of several existing projects include:

- The "Consumer Grid Toolkit" (CogKit),[10] which provides Globus services to Java applications
- A QoS API (GARA; General-purpose Architecture for Reservation and Allocation),[11] and a DiffServ testbed that can be extended across TransPAC
- Componentized HPSS data movers for real-time instrument data transport[12]
- Common Component Architecture Toolkit (CCAT)[13]

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[8] Ellisman, Kesselman, and Foster, *http://www.npaci.edu/online/v3.10/telemicroscopy.html*

[9] Leigh, *http://www.evl.uic.edu/cavern/cavernsoft/*

[10] von Laszewski, *http://www.globus.org/cog/*

[11] Sander and Roy, *http://www-fp.mcs.anl.gov/qos/*

[12] McMullen, *http://www.cs.indiana.edu/ngi*

[13] Gannon and Bramley, *http://www.extreme.indiana.edu/*

D.2.b. Application Collaborations and Demonstrations

Collaborations of many types are needed to develop and field international high performance network applications. International conference demonstrations offer an ideal environment to stress test new applications, both for the application developers and network engineers. Two major demonstrations of TransPAC applications were held this reporting period, iGrid 2000 at INET2000, and the GOIN demonstrations at CEOS99.

iGrid 2000[15]

As mentioned previously, Indiana University and the Electronic Visualization Laboratory of the University of Illinois at Chicago jointly sponsored iGrid 2000 at INET2000 in Yokohama, Japan, 18-21 July 2000. TransPAC played a key role (the key role) in supplying network capacity for these demonstrations. The iGrid 2000 was one of the major global events during the year 2000 to facilitate and showcase international collaborative advanced network-based applications.

Quoting from the iGrid 2000 Web site[16]: "The complementary nature of research being conducted in countries worldwide and the ability to access unique data and computing resources are compelling reasons for constructing and maintaining global interoperable broadband networks. Conversely, the demands that applications put on these networks demonstrate increased expectations for bandwidth, quality of service and interoperability."

Below is a sample of iGrid2000 projects enabled in part or in whole by TransPAC with descriptions taken from the iGrid brochure.

- *MediaZine*, a combination of Television, WWW, Telecommunications, and 3D Computer Graphics; a joint project between Germany, Japan, and Singapore.

  "The *MediaZine* is an interactive multimedia magazine on the Internet including text, images, live audio, live video, animations, 3D computer graphics, and embedded electronic commerce and communication functions. It represents all applications where the multimedia capacities of the Web could be combined with the immersive perception performances provided by streamed media. Presently, TV provides poor interactivity and the Web remains static in comparison. This new interactive Internet broadcast service will merge the best aspects of both."

- Steering and Visualization of a Finite-Difference Code on a Computational Grid; a joint project between Sweden, the United States, and Japan.

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[14] Gannon and Bramley, *http://www.extreme.indiana.edu/*

[15] *http://www.startap.net/igrid2000*

[16] *http://www.startap.net/igrid2000*

"This is an application for computational steering of a finite difference code for electromagnetic simulation. In computational steering we need to develop software that allows the user to enter an interactive visualization or VR environment and from there control the computation. To handle the large computational requirements of both simulation and visualization, the system can be distributed across multiple machines. This is possible through the use of the Globus toolkit for communication, data handling, and resource co-allocation. The program also makes use of VTK for data filtering and the generation of visualization elements, and IRIS Performer with pfCAVELib for 3D interactive rendering on CAVE devices."

- Distributed Simulation Analysis Among Scientists Located in Germany, the United States, and Japan; a joint project among the three mentioned countries.

  "The High Performance Computing Center Stuttgart and Sandia National Laboratories have been researching, prototyping, and applying a distributed parallel supercomputing and a collaborative virtual-reality computation steering environment since 1996. The output of a metacomputing simulation is visualized by means of a distributed virtual collaborative environment. People and machines have the potential to interact via a virtual-reality based, online, on-demand service anywhere in the world. This project recognizes the unique combination of high-end resources and high-speed connectivity to networks spanning multiple continents that iGrid participation provides."

- Advanced Networking for Telemicroscopy; an IPv6 collaboration between the United States and Japan.

  "This project has developed two telemicroscopy systems that use international research networks to provide interactive remote control of high power microscopes. This work has been carried out between the National Center for Microscopy and Imaging Research in San Diego and the Research Center for Ultra-High Voltage Electron Microscopy in Osaka, Japan. These telemicroscopy systems allow scientists to harness the capabilities of powerful microscopes without having to travel to the microscope site, resulting in a savings in time and money. Also, telemicroscopy systems facilitate training and education by enabling collaboration with experts in the field. For iGrid 2000, this project will demonstrate remote control of an electron microscope in San Diego from Yokohama using the IPv6 protocol end-to-end."

- GiDVN (Global Internet Digital Video Network); a collaboration among many participants worldwide.

  "With its research partners throughout the world, iCAIR is active in a number of advanced digital video projects that are directed at enhancing the state of the art as well as enabling research through the development of new media capabilities. At SC98, the iGrid GiDVN project demonstrated selected capabilities of advanced digital video. This demonstration will present the next phase of the GiDVN, including those related to media applications and capabilities built on those applications as well as underlying technologies."

Additional details of all iGrid 2000 applications are available at http://www.startap.net/igrid2000.

GOIN demonstrations at CEOS99[17]

The Committee of Earth Observation Satellites (CEOS) is the worldwide technical coordination body for all agencies that develop and operate satellites that observe the earth from space. The Global Observation Information Network (GOIN) began in 1994 as a US-Japan initiative aimed at providing scientific cooperation in the focus areas related to global observation of the earth: land, atmosphere, oceans, and solar-terrestrial interactions.

In November 1999, NORDUnet — cooperating with the NASA Research and Education Network (NREN), the Asia Pacific Advanced Network (APAN), and TransPAC — supported demonstrations to the CEOS 1999 Plenary hosted by the European Meteorological Satellite (EUMETSAT) organization with the support of the Swedish Space Corporation (SSC).

The GOIN demonstrations at CEOS99 included:

- The Data and Information Access Link (DIAL), a software system for finding, accessing and manipulating global observation data
- Distributed Solar Activity Prediction Model, providing comparison of the results of multiple solar activity models based upon shared data inputs, with the ability to adjust models according to comparison findings
- Real-Time Teleseminar of TRMM Data, utilizing team collaboration and teleseminar to support discussions and seminars regarding global change issues
- Data Access and 3D Visualization via the WWW (VRML), a desktop JAVA applet connecting to distributed servers in PMEL Seattle and JAMSTEC Yokosuka, Japan to make interactive data plots of atmospheric and oceanic profiles

D.2.c. Advanced Network Services Testbeds

Multicast. Multicast is an important component of collaborative environments and digital video services. Activities completed in FY99-00 to strengthen multicast support by TransPAC include:

- Moving from PIM-DM to PIM-SM/MSDP across TransPAC and inter-domain connections
- Establishing multicast interconnect with Abilene
- Deploying tools for debugging, monitoring, and measuring multicast traffic
- Coordinating additional native IP multicast interconnectivity in conjunction with other STAR TAP participants

In addition, significant progress was made in multicast tool development (see below). Additional information regarding these tools is currently available at http://www.abilene.iu.edu in the "Multicast Information" section. This information will be integrated into the TransPAC NOC Web site over the next reporting period.

Multicast Route View. This tool maps the shortest-path tree of a given mroute tree across the network backbone.

[17] *http://www.ceos.org/ceos99/CEOS99.html*

MSDP Logger. The Multicast Source Discovery Protocol (MSDP) logger presents a view and allows search a log of the MSDP SA (source active) messages received from the network backbone. This indicates active (broadcasting) sources on the network.

Multicast monitoring. Multicast session directory reporting will be hosted on the TransPAC management station to be installed at STAR TAP.

IPv6. TransPAC is a participant in the 6REN/6TAP. In order to facilitate the easy interconnection of 6REN participants, STAR TAP, CANARIE, and ESnet jointly sponsor an IPv6 Exchange "6TAP" project to provide routing and route serving services at the STAR TAP in Chicago. A 6TAP IPv6 capable router is co-located at STAR TAP to experiment with early route administration and peering services to assist in the development of IPv6 operational procedures. The IPv6 efforts are a prime example of collaboration across projects, agencies, and countries.

Digital Video. Digital video services on next generation networks are employed as tools to empower the global research community. Interactive and real-time video facilitates collaboration by providing researchers interactive access to their peers and access to remote scientific instruments. Streaming video provides dissemination of information, education, and outreach of research activities.

TransPAC researchers are engaged in activities to promote the use of digital video as a tool for researchers, and to develop the underlying advanced network capabilities such as pervasive multicast and network quality of service that are necessary to support advanced video services. iGrid 2000 demonstrators were provided with core video services including advanced IP-based videoconferencing and multicast, broadcast-quality streaming video for outreach. Outreach broadcast was widely disseminated, including global high-performance research and education networks and bridged to community cable educational television and satellite direct broadcast via the Research Channel.

iGrid 2000 showcased numerous video-based applications including:

- The Global Internet Digital Video Network, the International Center for Advanced Internet Research (iCAIR), along with research partners throughout the world, is active in a number of advanced digital video projects directed at enhancing the state-of-the-art as well as enabling research through the development of new media capabilities
- Use of the Access Grid for wide-area group collaborative visualization
- Advanced Networking for Telemicroscopy, using advanced real-time video for control and visualization remote high-power electronic microscopes

D.3. Papers and Presentations, International Meetings and Conferences, June 1999 through May 2000

Meetings, papers, and presentations from previous years are included in Appendix A. Many of these papers and presentations are available at http://www.transpac.org.

1999, June 22
San Jose, California, USA
STAR TAP International Advisory Committee Meeting

1999, June 22
San Jose, California, USA
STAR TAP Technical Advisory Committee Meeting
Presentation: IU NOC; Doug Pearson

1999, June 22-25
San Jose, California, USA
INET'99 Conference
Joint Communications Research Laboratory, Japan, and Indiana University demonstration of IEEE1394 Digital Video over IP

1999, October 10
Seattle, Washington, USA
Internet2 Meeting
TransPAC Management Committee Meeting

2000, February 14
Tokyo, Japan
TransPAC Management Committee Meeting

2000, February 15-18
Tsukuba, Japan
IWS2000 and APAN Meetings

2000, March 27-29
Washington, DC, USA
Internet2 Meeting
TransPAC Technical Meetings

2000, April 11
Chicago, Illinois, USA
iGrid 2000 Planning Meeting

2000, April 20
Indianapolis, Indiana, USA
TransPAC/STAR TAP/Euro-Link NOC and Engineering Meeting

2000, May 16
Minneapolis, Minnesota, USA
Internet2/NLANR Joint Techs Meeting
Presentation: TransPAC Infrastructure Update; Jim Williams

2000, May 17
Minneapolis, Minnesota, USA
Internet2/NLANR Joint Techs Meeting
Planning for Joint Techs in Hawaii, jointly sponsored by APAN and TransPAC
Williams on Program and Planning Committee

2000, May 18
San Diego, California, USA
CENIC 2000
Presentation: Internet2 and Global Development: Institutional Impact
Michael McRobbie

2000, May 27
Beijing, China
Chinese-American Networking Symposium
Presentation: The Need for Global High Performance Networks
Michael McRobbie

2000, June 14
Trondheim, Norway
Joint Meeting of the Association of European Universities and European Science Foundation
|Presentation: Strategic Planning for IT & High Performance Networking in America Universities
Michael McRobbie

D.4. Application Status

Research communities using TransPAC include biomedical applications (distributed genome databases and remote instrumentation), high performance distributed computation and visualization for the physical sciences (primarily high energy physics, astronomy, and space science), earth observation and resource analysis, high quality digital video live and on-demand, and shared virtual spaces for education and cultural exchange.

As in previous years the TransPAC team surveyed investigators and projects known to be using the network (either listed in the initial TransPAC grant submission or added subsequently). All project contacts were asked to outline the progress of their investigation, their current use of the TransPAC network and their future plans and needs for international connectivity. Projects that are significant users of TransPAC are listed below and more fully described in Appendix B.

Projects new to TransPAC during the 99-00 fiscal year

- Joint program for Arctic atmosphere observation between GI/UAF and CRL/MPT
- *MediaZine* (includes participants from Europe and Asia via the STAR TAP)
- Steering and Visualization of a Finite-Difference Code on a Computational Grid
- Distributed Simulation Analysis among Scientists Located in Germany, the United States, and Japan
- Transoceanic Exploration of Cultural Heritage in Virtual Reality (EVL and the University of Tokyo)
- Global Internet Digital Video Network (GiDVN)
- High-quality video broadcast on high-performance research and education networks (IU)
- Trans-Pacific Telemicroscopy (SDSC and Osaka) Ipv6 implementation

Projects listed in previous reports that continue to use TransPAC

The following projects were either included in the original TransPAC proposal or added during the 1998-1999 fiscal year, and are actively using the TransPAC network. Appendix B provides further detail on the projects and the scientific content.

- Asia-US-Australia Collaboration in the Silicon Vertex Detector Project for the BELLE High Energy Physics Experiment at KEK
- RHIC Pioneering High-Energy Nuclear Interaction Experiment (PHENIX) High-energy Heavy-ion experiment
- Japan-US Collaboration on ICRF Heating and Current Drive Experiments and Modeling
- APBionet: Asia-Pacific Bioinformatics Network (genomic data, computation, and community support)
- Bio-Mirror globally distributed database for high-speed access to genetic sequence data
- Japan-US Collaboration in Sloan Digital Sky Survey over the Network

- Trans-Pacific Tele-microscopy (SDSC and Osaka) IPv4 implementation.
- Applications of Networked Virtual Reality Systems
- Web Cache Meta Network
- Ipv6 applications and network

NASA projects using TransPAC

There are a number of ongoing collaborations between the National Aeronautics and Space Administration (NASA) in the USA and the Institute of Space and Astronautical Science (ISAS) in Japan which use TransPAC. NASA/ISAS use of the network is supported by JST and is limited to 20% of the JST funded portion of the bandwidth. The TransPAC team continues to explore opportunities for joint funding of the link with NASA.

- Data processing and distribution of ASCA data over the network
- Japan-US collaborations in developing ASTRO-E science instruments using the network
- Data processing and distribution of ASTRO-E ground test and flight data over the network
- The Geotail Data Analysis in Correlative Solar-Terrestrial Study
- Data processing of IRTS data over the network
- Exchange of data between Infrared Astronomical Satellites
- Support for GOIN (1999) and CEOS (1999+) demonstrations
- Tropical Rainfall Measuring Mission (TRMM) Science Projects

E. Program Plan (2000 — 2001)

The following information details the plans for the TransPAC project during the third award year (2000-2001) in the key areas of network infrastructure, network services, and user support services.

E.1. Network Infrastructure

Consistent with the two bandwidth expansions already accomplished in 1999 and 2000 we expect to expand TransPAC to at least OC-3 capacity (155Mbps) by October 2000. Some options being examined now may result in route diversity as well as additional bandwidth. As in previous years, our intention is to leverage the decreasing price of trans-Pacific bandwidth to secure increasing TransPAC bandwidth at a constant price.

E.2. Network Operations Center

In the past year, the Indiana University NOC has begun to provide NOC services for STAR TAP and the Euro-Link HPIIS networks. Funding support for non-TransPAC operations are provided by sub-awards in the STAR-TAP, and Euro-Link NSF grants. We expect to continue and expand these services for other international networking projects and connectors on an as-needed, but funded, basis.

24x7 NOC service for STAR TAP connectors now includes monitoring and support for optional layer 3 IPv4 routing, monitoring and performance data collection for QoS testbeds connected to the STAR-TAP, multicast, traffic measurement, performance measurement, Web cache, and IPv6 services. We expect to improve the organization, availability, and accessibility of this data and have tasked our new HPCC engineer with several related projects.

A collection of NOC tools will be implemented as follows:

- ***Animated Traffic Map***. This will allow users to view the utilization on the peering networks coming into the TransPAC/STAR TAP router. Traffic will be displayed on a graphical map representing the topology of the network. One can also view the history of traffic on a link and an animation of recent traffic.
- ***Network Traffic Statistics***. This will comprise traffic graphs that are based on high-resolution traffic data collected by a custom-written SNMP data collector located at Indiana University. This collector samples every peer on the TransPAC/STAR TAP router every three seconds. The graphs will show the data summarized at five-minute intervals. Daily traffic patterns and historical patterns will both be plotted as well.
- ***New version of the TransPAC NOC Web pages***. In the next year, the TransPAC NOC will unveil a new TransPAC Web page design, with a host of improvements.
- ***New Trouble Ticket System***. The current trouble ticket system used by the IU NOC for TransPAC and Abilene is based on a commercial system, Apriori. Web-based access to the trouble tickets is not provided outside of the NOC. In the upcoming year, the IU NOC will be moving to a new, more dynamic trouble ticket system. This will improve the means to record problems, send notification, compile statistics, analyze trends, and provide a greater functionality in reporting. All trouble tickets (TransPAC, STAR TAP, and Euro-Link) will use this new system.

E.3. User Services

The function of TransPAC User Services is to assist users in all aspects of interacting with TransPAC such as fielding initial requests for routing, monitoring projects and usage, and training in performance analysis and debugging. With the addition this year of the TransPAC applications engineer, the User Services group expects to provide increased levels of service in all of the above areas and to explore the possibility of offering new ones.

TransPAC and APAN will co-sponsor the NLANR/Internet2 Joint Techs meeting in Hawaii in January 2001.

As has been done in past years, the User Services group will conduct its annual census of the research and education users of the TransPAC network to update the project database. Detailed project information will be reported and we will offer assistance and solicit project status and feedback regarding the TransPAC network service.

During FY00-01, in conjunction with the January 2001 APAN, TransPAC, and NLANR Joint Techs meetings in Hawaii, we plan to sponsor a two-day Asia-Pacific and US Computational Grid Workshop. The purpose of the workshop will be to bring AP and US computation grid scientists and net workers together to energize international collaboration in grid computing technology development and utilization and to focus on TransPAC as a tool to enable international computational grid collaborations. TransPAC will be the primary sponsor of this event, with assistance from the Electronic Visualization Laboratory (EVL) at the University of Illinois – Chicago and Argonne National Laboratory.

E.4. Application Collaborations and Demonstrations

A continuing goal of TransPAC is to foster collaborations needed to develop and field international high performance network applications. This has been accomplished to date through Web-based information about existing collaborations, projects, and results; direct end-user support for application development and tuning; fostering new collaborations through participation in APAN and U.S. networking community activities; and sponsoring and supporting demonstration testbeds such as iGrid and CEOS. In the coming year we plan to focus more on direct support of science and engineering activities by attending discipline specific conferences to discuss TransPAC and issues involved in developing applications for international high performance networks.

TransPAC will continue support of and participation in the Internet2 Digital Video Network (I2 DVN), ResearchTV, and other related digital video projects. I2DVN is an initiative to develop enabling technologies for research and education, primarily to support three modalities of advanced digital video: video conferencing, video-on-demand, and live transmission on national research and education high performance networks.

TransPAC participation in digital library projects will grow in the coming year, particularly through extension of the Indiana University Variations Digital Music Library to Waseda University. Development of the data storage and distribution mechanism for the Atlas experiment at CERN (provisionally called GryPhyN for Grid Physics Network) may be extended to APAN through the CERN-STAR TAP connection.

E.5. Advanced Application Services Testbeds (Middleware)

Applications increasingly depend on middleware services. Within the context of TransPAC, we are exploring a number of middleware sets to facilitate the construction of distributed applications and systems on international long-haul networks. Middleware receiving particular attention as network-wide standards are:

- The Globus toolkit for resource allocation and distributed communication
- GARA API and testbed for DiffServ QoS
- CAVERNSoft for distributed immersive visualization
- The HPSS Consortium's HSM software for remote storage of very large data sets
- Java services for graphics, remote method invocation, and service management such as Java3D, RMI, and Jini
- Distributed component and object technologies such as SOAP, CCAT (Common Component Architecture Toolkit), and CORBA

E.6. Advanced Network Services Testbeds (QoS, Multicast, IPv6, and Web Cache)

TransPAC will continue to participate in DiffServ QoS and bandwidth broker testing through Qbone, EMERGE, and other QoS testbeds. Building on work already underway in the Department of Energy, we plan to explore extending the GARA QoS API testbed across TransPAC.

Multicast is becoming an important component of collaborative environments and digital video services. Activities to be undertaken in 00-01 to strengthen multicast support by TransPAC include:

- Continued testing of the multicast interconnect with Abilene
- Deploying tools for debugging, monitoring, and measuring multicast traffic more widely
- Coordinating additional native IP multicast interconnectivity in conjunction with other STAR TAP participants

IPv6 plans for the coming year include continuing participation in the 6REN/6TAP. An engineer from the Japan Ministry of Posts and Telecomm Communications Research Laboratory is expected to be in residence at Indiana University during the coming fiscal year to develop and conduct international IPv6 experiments and to assist in the development of research grade IPv6 applications over international networks, particularly TransPAC.

STAR TAP has proposed working with NLANR to provide and run a Web cache at the STAR TAP. TransPAC is actively participating in the deployment of this service and monitoring processes and will coordinate efforts between APAN and STAR TAP.

E.7. Performance Analysis and Measurement

Network performance analysis is an ongoing effort within TransPAC[18]. Projects for the coming year will focus on extending and refining current practices, connecting these with operational processes, and developing new analyses for data currently being collected.

E.8. Web-based Information

Descriptive information regarding TransPAC-based applications and collaborations based on surveys conducted annually for the last two years are online and will be maintained more frequently with full staffing now available in user services.

Technical information regarding application performance and host tuning for international high performance networks will be posted or updated as appropriate. Additional display of performance data, including enhanced views of the TransPAC-specific ANS Surveyor one-way delay and loss statistics and display of analysis of OC3mon data, will be enhanced.

E.9. HPIIS Team

Video conferencing will serve to strengthen the communication and collaboration among the HPIIS team members. IP-based desktop video and audio conferencing has been deployed and tested at Indiana University, the University of Tennessee – Knoxville, and the National Science Foundation. Considerable use of H.323 conferencing tools will be made during iGrid, and NetMeeting has been used extensively during application development and tuning for several TransPAC applications. Conferencing tools will be used to prepare for the join HPIIS review scheduled for October 2000.

Consideration is being given as well to deploying Access Grid technologies developed at NCSA as a secondary conferencing mechanism.

[18] *http://www.transpac.org/engineering/performance/*

Appendix A. Papers and Presentations, International Meetings and Conferences, December 1997 through May 1999

1997, December 13-14
Indiana University; Bloomington, Indiana, USA
TransPAC All-Hands International Meeting

1998, March 1
Tokyo, Japan
2nd Meeting of the TransPAC Consortium

1998, March 2
Tsukuba, Japan
APAN Committee and Working Group Meetings

1998, March 3-5
Tsukuba, Japan
Internet Workshop 1998 (IWS'98) and Worldwide Computing and Its Applications (WWCA'98) Conferences
Presentation: (IWS'98) TransPAC - A High Performance Network Connection for Research and Education between the vBNS and the Asia-Pacific Advanced Network (APAN); Doug Pearson

1998, April 9
Indiana University; Indianapolis, Indiana, USA
Internet2 and IU
Presentation: TransPAC - A High Performance Network Connection for Research and Education between the vBNS and the Asia-Pacific Advanced Network (APAN); Michael McRobbie

1998, June 23-24
Tokyo, Japan
Japan Science and Technology Corporation and Indiana University
Planning Meeting

1998, June 24-26
Tokyo, Japan
TransPAC-JP NOC Meeting

1998, June 30-July 2
Seoul, Korea
KRNET'98
Presentation: TransPAC – Policy-based Routing and Differentiated Services in TransPAC; Doug Pearson and Allen Robel

1998, July 1-3
Seoul, Korea
APAN Committee and Working Group Meetings

1998, July 21-24
Geneva, Switzerland
INET'98
Paper: A High Performance Network Connection for Research and Education between the vBNS and the Asia-Pacific Advanced Network (APAN); Michael McRobbie, et al
Presentation: A High Performance Network Connection for Research and Education between the vBNS and the Asia-Pacific Advanced Network (APAN); Michael McRobbie

1998, July 28-31
Chicago, Illinois, USA
7th International Symposium on High Performance Distributed Computing (HPDC-7 ’98)
Paper: A High Performance Network for Research and Education Applications Between the vBNS and the Asia-Pacific Advanced Network (APAN); Michael McRobbie, et al

1998, August 29-30
Indiana University; Indianapolis, Indiana, USA
TransPAC Engineering Meeting

1998, September 21
Washington DC, USA
NASA Policy Meeting
Presentation: TransPAC - Network Objectives and Policies; Doug Pearson

1998, September 24
Boulder, Colorado, USA
NASA Technical Meeting
Presentation: TransPAC; Doug Pearson

1998 September 26-29
San Francisco, California, USA
Internet2 Project Meeting and Applications Demonstrations

1998, September 26
San Francisco, California, USA
TransPAC Status Meeting

1998, November 7-13
Orlando, Florida, USA
SuperComputing'98 and iGrid Demonstrations

1998, December 7-11
Orlando, Florida, USA
IETF 43

1998, December 8
Orlando, Florida, USA
CCIRN QoS Working Group
Presentation: Proposed APAN I2 QBone Activities
Doug Pearson

1999, January 10-14
Chinese-American Networking Symposium
University of Maryland; College Park, Maryland, USA
Presentation: Indiana University: From Intranet to TransPAC; Chris Peebles

1999, February 17
Osaka University; Osaka, Japan
TransPAC Management Committee Meeting

1999, February 18-21
Osaka University; Osaka Japan
Internet Workshop 1999 (IWS'99);
Presentation: Internet2 and Other Research and Education Networks; Michael McRobbie

1999, March 22-25
Honolulu, Hawaii, USA
Global Observation Information Network'99 (GOIN'99) Conference

1999, April 6
Chicago, Illinois, USA
HPIIS Team Meeting

1999, April 28
Washington, DC, USA
Internet2 Member Meeting and Applications Demonstration

1999, May 17
Indiana University; Indianapolis, Indianapolis, USA
Meeting of Indiana University and members of Computer Network Information Center, Chinese Academy of Sciences; Indianapolis
Presentation: TransPAC; Steve Wallace and Doug Pearson

Appendix B. Detail for New and Continuing TransPAC Projects

1. New Projects

Joint program of Arctic atmosphere observations of GI/UAF and CRL/MPT

Japan: CRL (Communications Research Laboratory)
USA: University of Alaska Fairbanks - Geophysical Institute

Project contacts:
Yasuhiro Murayama (murayama@crl.go.jp)
International Arctic Environment Research Team
CRL – Tokyo, Japan

Project Web site: http://www.crl.go.jp/t/team5/ScienceplanE/

Project description: The present plan was initiated in 1992 as an international cooperative research project with the US centering primarily on the University of Alaska Fairbanks within the framework of the Japan-US Science Technology Cooperation Agreement.

Communications Research Laboratory (CRL; formerly Radio Research Laboratories) has made many contribution to international science over the years in the use of radio and optical waves and through its studies of the ionosphere and atmosphere. CRL applies these advanced radio wave and optical technologies in the development of techniques for measuring scientific properties of the global environment and atmosphere. Just as importantly, CRL also seeks to advance atmospheric sciences by demonstrating the use of instrumentation developed and fabricated, as well as by conducting observational studies and thus contributing to the scientific understanding of and the approach to solution of the global environmental issues. The major target of the atmospheric observations associated with this plan is the middle atmosphere from the stratosphere to the lower thermosphere (10-100 km), above Alaska.

"Our data transfer experiment of [the] computer network … started together with a new connection of [the] Arctic Region Supercomputing Center of University of Alaska to [the] Seattle GigaPOP [in] October 1999. This enabled our middle and upper atmosphere observation instruments in Alaska to connect other states, and thus Japan, with [a] high-speed link, through the APAN (Asia Pacific Advanced Network) project. For the *Joint program of Arctic atmosphere observations of GI/UAF and CRL/MPT*, TransPAC is working well in collaboration with APAN (Asia pacific advanced network), to improve our connectivity of Alaska-Japan for our scientific experiments."

-Yasuihro Murayama, CRL

Cultural Heritage in Virtual Reality

USA: University of Illinois at Chicago, University of Missouri
Japan: The University of Tokyo , Telecommunications Advancement Organization, NTT,

Project contacts:
Jason Leigh (spiff@evl.uic.edu) Electronic Visualization Laboratory, University of Illinois at Chicago

Project Web site: http://www.evl.uic.edu/cavern/lara

Project description: Using cultural heritage as an application driver, the goal of the Networked Virtual Environments Collaborative Trans-Oceanic Research (N*VECTOR) project is to link EVL's CAVE and Tokyo's CABIN in order to better understand the requirements of multiple media flows among sophisticated virtual reality displays over great distances.

CyberCAD: Internet Distributed Interactive Collaborative Design

USA: Indiana University
Singapore: National University of Singapore and Temasek Polytechnic

Project contacts:
Kim-Cheng Tan (kimcheng@tp.edu.sg), *Temasek Polytechnic*
Francis Eng-Hock Tay (mpetayeh@nus.edu.sg), *National University of Singapore*

Project Web sites: http://eicu.tp.edu.sg/APAN-GDM/ and http://ils.tp.edu.sg/apan/

Project description: The goal of the Global Design Manufacturing Project (GDM) is to create a design and manufacturing hub in a global environment through Internet by sharing design and manufacturing tools among educational institutions and industry.

The CyberCAD software component of GDM has a controller-observer architecture to support reliable point-to-point synchronous portable Collaborative Computer Aided Design (COCAD). It allows geographically dispersed designers to work and communicate together synchronously on 3D design models, regardless of platform.

Data and Information Access Link (DIAL)

USA: NASA Goddard Space Flight Center (GSFC)
Japan: National Space Development Agency (NASDA)/RESTEC

Project contact:
Ramachandran Suresh (suresh@rattler.gsfc.nasa.gov)
NASA ESDIS /RITSS, NASA Goddard Space Flight Center (GSFC)
USA

*Project Web sites:*http://dial.gsfc.nasa.gov and http://dial.eoc.nasda.go.jp

Project description: DIAL is a Web-based distributed system to search, access and visualize satellite remote sensing data for Global Change research. It allows data providers to easily serve their Earth science data directly to their users. DIAL provides traditional catalog services like metadata search, while also providing extended interactive data services like browsing, subsetting, subsampling, reformatting, and direct downloading. The power of DIAL has recently been enhanced by the addition of the EOSDIS "Version 0" protocol, which enables a project to set up a distributed system of DIAL servers.

In collaboration with NASDA and other institutions, NASA has DIAL servers set up to distribute satellite remote sensing data. NASA and NASDA also collaborate on the Tropical Rainfall Measurement Mission (TRMM); 3D data is transferred from NASA to NASDA using TransPAC/APAN, processed and visualized for the Web.

Distributed Simulation Analysis between Scientists Located in Germany, US, and Japan

Collaborators:
Arthurine Breckenridge (arbreck@sandia.gov), Rena Haynes (rahayne@sandia.gov)
Sandia National Laboratories
USA

Ulrich Lang, Uwe Woessner, Matthias Mueller
High Performance Computing Center Stuttgart (HLRS)
Germany

Project Web site: http://www.cs.sandia.gov/ilab

Project description: This application emphasizes distributed parallel supercomputing and a collaborative virtual-reality computation steering environment applied to Grand Challenge problems

GiDVN: Global Internet Digital Video Network

USA: International Center for Advanced Internet Research (iCAIR), Northwestern University
International: CANARIE Inc, CERN, APAN, KDD, APAN-KR, Seoul National University, SURFnet, DGSCA-UNAM, SingAREN, Royal Institute of Technology, Universitat Politecnica de Catalunya

Project contact:
Joe Mambretti (j-mambretti@nwu.edu)
International Center for Advanced Internet Research (iCAIR), Northwestern University

Project Web site: http://www.icair.org/inet2000

Project description: GiDVN projects are enhancing media capabilities for the next-generation Internet, enabling new applications to interoperate

2. Continuing Projects

Asia-US-Australia Collaboration in the Silicon Vertex Detector Project for the BELLE High Energy Physics Experiment at KEK

Japan: KEK (High Energy Accelerator Research Organization), Osaka University, Tokyo Metropolitan University, University of Tokyo, University of Tsukuba
Australia: University of Melbourne, University of Sydney
USA: University of Hawaii, Princeton University

Project contacts:
Professor H. Aihara (aihara@phys.s.u-tokyo.ac.jp)
Professor D. Marlow (marlow@puphep.princeton.edu)

Project Web sites: http://bsunsrv1.kek.jp/ and http:/www.kek.jp

Project description: The BELLE detector is the state-of-the-art detector to investigate CP violating phenomena with unprecedented precision at the KEK B meson factory. The CP (C=Charge conjugation, P=Parity) violation is a key to explain why the universe is dominated by the matter, not by the anti-matter. The primary goal of the BELLE detector is to identify the origin of the CP violation. The BELLE collaboration consists of more than 40 institutions from Japan, Korea, China, Taiwan, India, Russia, USA, Australia, and Europe.

At the heart of the BELLE detector a high precision particle trajectory detection system consisting of silicon microstrip sensors will be installed. This silicon system contains about 100K channels to be read out by a high-speed online data-taking system. To achieve required precision all electronics channels must be constantly monitored and calibrated.

An international collaboration was formed to design and build the silicon vertex detector. In addition, the generated data will be jointly analyzed by the participating institutions to obtain physics results in a timely manner.

APBionet: Asia-Pacific Bioinformatics Network

USA: Michigan State University
Japan: National Institute Genetics

Project contacts:
Prof. Hideaki SUGAWARA (hsugawar@genes.nig.ac.jp)
Center for Information Biology
National Institute of Genetics

Prof. Herman D. Hughes (hughes@cps.msu.edu)
Computer Science & Dir. of HSNP
Michigan State University

Prof. J. Tiedje (tiedjej@pilot.msu.edu)
Center for Microbial Ecology
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Michigan State University

Project Web site: http://www.cme.msu.edu/RDP

Project description: The APBionet was established to realize smooth information flow and sharing free from boundaries caused by physical distance, social system, technology, and culture. Broadband networks are indispensable to APBionet that consists of:

- fast and robust networks of databases and applications
- facilities for visualization of a large scale data and interactive simulation of life phenomena for the advanced study on life sciences and biotechnology
- distant learning systems based on multi-media servers to foster bioinformatics experts in Asia-Pacific region

RHIC Pioneering High-Energy Nuclear Interaction Experiment (PHENIX) High-energy Heavy-ion experiment

Spin Physics Research with Relativistic Heavy Ion Collider (RHIC) at BNL

RHIC PHENIX Heavy Ion Collaboration

Japan: University of Tokyo
USA: Brookhaven National Laboratory

Project contacts:
Hideki Hamagaki (hamagaki@cns.s.u-tokyo.ac.jp)
Center for Nuclear Study, University of Tokyo (CNS)

Sam Aronson (aronsons@bnl.gov)
Brookhaven National Laboratory, Upton, NY

Project Web site: http://www.phenix.bnl.gov/

Project description: These general titles cover a number of physics experiments involving the Relativistic Heavy Ion Collider (RHIC) and Pioneering High-Energy Interaction Experiment linking numerous universities in Japan with Brookhaven National Laboratory in the United States.

The PHENIX experiment is one of the two major experiments in the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. It aims to detect the signatures of Quark Gluon Plasma (QGP) deconfined phase, which is thought to exist in the early universe. More than 400 physicists, engineers, and students from eleven countries are currently participating in the PHENIX experiment. The participating institutions from Japan are: University of Tokyo, CNS-Tokyo, KEK, Tsukuba, Waseda, Kyoto, Hiroshima, Nagasaki Institute for Applied Science, Tokyo Institute of Technology and RIKEN.

Example data regarding network performance can be found at:
http://ccjsun.riken.go.jp/ccj/present/CHEP2000/sld015.htm

Web Cache Meta Network

Japan: NTT, Keio University, Nihon University
Korea: KAIST
USA: NLANR
and another 30 APAN and US institutions

Project contacts:
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NTT Labs
Kilnam Chon (chon@cosmos.kaist.ac.kr)
KAIST
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NLANR

Project Web site: http://cache.jp.apan.net/ and http://cache.kaist.kr.apan.net/

Project description: To get high effectiveness of Web cache, cache servers and primary Web servers should exchange their status information and teach other (e.g. object update information from primary servers, load status information from cache servers.) The goal of this project is to make a network to exchange those meta information. Currently we are experimenting with a hierarchical Web cache system between continents to get some operational data. NTT labs is developing a metadata exchange system (an alpha stage code is available).

As a step toward unified view of caching and replication, we are developing RepliCache (Large Object Cache) system. RepliCache will be located at GigaPoPs and it will serve large-bandwidth data (e.g., multimedia data) to users or collaborating caches. In the context of replication, resolution, and contents, we will cooperate with Internet 2 Distributed Storage Infrastructure project team.

Japan-US Collaboration on ICRF heating and Current Drive Experiments and Modeling

Japan: University of Tokyo
USA: Massachusetts Institute of Technology

Project contacts:
Professor Y. Takase (takase@phys.s.u-tokyo.ac.jp)
Dr. M. Greenwald (g@psfc.mit.edu)

Project Web site: http://www.psfc.mit.edu/cmod/

Project description: The ICRF heating experiments on the Alcator C-Mod Tokamak at MIT has been highly successful. With the additional power and current drive capabilities currently being added in collaboration with PPPL (Princeton Plasma Physics Laboratory), the emphasis of research will shift toward steady-state advanced Tokamak experiments using current drive and profile control. MIT is already preparing the infrastructure necessary to support remote collaborators.

Participation in these experiments by the University of Tokyo group, including planning of experiments, real-time participation, and data analysis became possible with the increased bandwidth provided by APAN. The University of Tokyo group, in collaboration performed theoretical modeling of various heating and current drive scenarios in 1998 with MIT physicists. The results indicate potential usefulness of the high harmonic fast wave for current drive in both conventional and spherical tokamaks.

Nucleic Acid Database

Japan: Japan Agency of Industrial Science
USA: Technology and Rutgers University

Project contacts:
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Director of RIPS center
Agency of Industrial Science and Technology

Prof. Helen M. Berman (berman@dnarna.rutgers.edu), Director
Department of Chemistry
Rutgers, The State University of New Jersey

Project Web site: ndbserver.rutgers.edu

Project description: The Nucleic Acid Database (NDB) Project was established to serve as a resource for researchers who study the structure of nucleic acids. It provides a repository for the coordinates of oligonucleotide crystal structures. In addition, the NDB provides information of general interest to researchers in the field, and develops and distributes standard geometric information for use in molecular refinement and modeling programs.

This project is supported financially by the National Science Foundation and the Department of Energy. In Asia, the NDB WWW site is mirrored at the Structural Biology Center at AIST, Japan. For mirroring, we frequently need to receive updates from NDB WWW site in US.

Development of Mirror Server by using High Speed Data Transfer in Genome Science

Japan: Ministry of Forestry and Fisheries
USA: Indiana University

Project contacts:
Yoshihiro Ugawa (ugawa@disc.dna.affrc.go.jp)
Akira Mizushima (goddila@maffin.ed.jp)
Don Gilbert (gilbertd@chipmunk.bio.indiana.edu)

Project Web site: None listed

Project description: DNA/protein biological sequence database is essential for advanced studies in genome research. These sequence data have been mutually collected between US, Japan and Europe since 1984. Software search engines such as FASTA/BLAST are used to find homology sequences. These require huge local disks to store these databases.

Some mirror servers have been developed to provide most recently updated data for DNA/protein biological sequence database. At present, however, these servers often fail due to the lack of existing network bandwidth. In this project, we will develop a reliable mirror server with high-speed data transfer in HPIIS.

In genome research the data of DNA database have been being increasing tremendously, including about 10% of Japanese contributions. However existing servers are mainly mirroring only US data to Japan. Therefore a bi-directional mirror server is helpful to update advanced data collected including in other countries and deliver them to researchers. This mirror server could not be established without a high-speed and reliable connection.

Japan-US Collaboration in Sloan Digital Sky Survey over the Network

USA: Johns Hopkins University and seven other institutions
Japan: University of Tokyo, Japan Promotion Group

Project contacts:
Professor S. Okamura (okamura@astron.s.u-tokyo.ac.jp)
Professor A. Szalay (szalay@tardis.pha.jhu.edu)

Project Web site: http://www.sdss.org

Project description: Sloan Digital Sky Survey (SDSS) is a project to carry out both imaging and spectroscopic surveys of half the northern sky using a dedicated wide-field 2.5-m telescope. The imaging survey with a large mosaic CCD camera will produce digital photometric maps of the sky in five color bands. These maps will be used to extract the position and various photometric parameters of about 100 million galaxies as well as nearly the same number of stars. Among the extracted objects, about 1 million galaxies and 100 thousand quasars are selected, for which medium resolution spectra will be obtained.

The SDSS is a collaborative project between the US and Japan involving seven US institutions and the Japan Promotion Group JPG). The observation, i.e., data taking, will be carried out at the Apache Point Observatory, New Mexico, where some online data processing is performed. The bulk of the data reduction will be done at FNAL and the master database will be maintained there. The JPG will also maintain the whole set of the above data in Japan except for the raw data. The JPG is planning to produce the merged pixel map noted above from the flat-fielded data. The data processing to construct the merged pixel map involves reference to the raw data as well as the flat-fielded data.

Significant scientific analyses of these data will often produce the result whose amount is not much less than the input catalog itself. Accordingly, the network capable of transferring some 10GB in a day is of critical importance in order to promote active timely discussion between the JPG and US astronomers spread over several institutions. Similar imaging data taken with the Subaru Telescope will sometimes be useful to interpret the result of the SDSS data analysis.

Bio-Mirror public service for high-speed access to biosequence data

Singapore: National University of Singapore
USA: Indiana University

Project contacts:
Tan Tin Wee (tinwee@pobox.org.sg)
Don Gilbert (gilbertd@chipmunk.bio.indiana.edu)

Project Web site: http://www.bio-mirror.net

Project description: This is a worldwide bioinformatic public service for high-speed access to up-to-date DNA/protein biological sequence databanks. In genome research, these databanks have been being growing tremendously, so much that distribution of them is hampered by existing Internet speeds. The Bio-Mirror project is devoted to facilitate timely access to important large data sets for this research. High-speed access is provided by Internet2 infrastructure of the Very High Speed Backbone Service(vBNS), Abilene, TransPAC, and the Asia-Pacific Advanced Network (APAN).

Currently available servers:

Australia
ftp://bio-mirror.au.apan.net/biomirrors/

China
http://bio-mirror.cn.apan.net/
ftp://bio-mirror.cn.apan.net/

Japan
http://bio-mirror.jp.apan.net/
ftp://bio-mirror.jp.apan.net/pub/biomirror/

Korea
http://bio-mirror.kr.apan.net/
ftp://bio-mirror.kr.apan.net/pub/biomirror/

Singapore
http://bio-mirror.sg.apan.net/
ftp://bio-mirror.sg.apan.net/biomirrors/

Thailand
http://bio-mirror.ku.ac.th/
ftp://bio-mirror.ku.ac.th/biomirror/

USA
http://www.bio-mirror.net/
ftp://bio-mirror.net/biomirror/

Current data sets: DNA biosequence data include GenBank, EMBL, and DDBJ. Protein biosequence data include SWISS-PROT*, TrEMBL, PIR. Other data include BLOCKS, ENZYME, PROSITE*, REBASE.

Data currently totals about 10 Gigabytes in compressed format, and are updated from the primary sources nightly. * Commercial restrictions on SWISS-PROT and PROSITE exist.

These servers are publicly available sites for high-speed access to up-to-date DNA/protein biological sequence databanks. High-speed access between the sites is provided by the network infrastructure developed by Very High Speed Backbone Service (vBNS), TransPAC (Trans-Pacific network), and Asia-Pacific Advanced Network (APAN), and these sites are well connected to national research and education networks within each country. DNA/protein biological sequence database is essential for advanced studies in genome research. These sequence data have been mutually collected between US, Japan and Europe since 1984.

Software search engines such as FASTA/BLAST are used to find homology sequences. These require huge local disks to store these databases. Some mirror servers have been developed to provide most recently updated data for DNA/protein biological sequence database. In present, however, these servers often fail due to the lack of existing network bandwidth. In this project, we will develop a reliable mirror server with high-speed data transfer over TransPAC.

In genome research the data of DNA database have been being increasing tremendously, including about 10% of Japanese contributions. However existing servers are mainly mirroring only US data to Japan. Therefore a bi-directional mirror server is to be helpful to update advanced data collected including in other countries and deliver them to researchers.

Trans-Pacific Telemicroscopy

Japan: Osaka University
USA: UCSD, SDSC

Project contacts:
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Mark Ellisman (mark@alex.ucsd.edu)
Youki Kadobayashi (youki@center.osaka-u.ac.jp)

Project Web sites: http://www-ncmir.ucsd.edu/CMDA/ and
http://www.uhvem.osaka-u.ac.jp/official/news.html

Project description: The National Center for Microscopy and Imaging Research (NCMIR) - an NIH-funded Resource - has been leading the efforts in the field of "Telemicroscopy" as part of an on-going research project started in 1992, the Collaboratory for Microscopic Digital Anatomy (CMDA). The CMDA contains a rich set of software tools that provide for remote operation of an electron microscope, the JEOL4000 IVEM, located at NCMIR in San Diego. Using CMDA tools, remote researchers can interactively steer this specialized microscope to investigate their specimens and collect high-resolution digital images of selected areas of the specimen. Additional CMDA tools allow for processing, analysis, and visualization of the acquired 2D and 3D datasets.

NCMIR has inspired similar efforts to be conducted by our collaborators at the Ultra-High Voltage Electron Microscopy (UHVEM) laboratory in Osaka University. The UHVEM laboratory has developed tools similar to the CMDA that provide for remote control of their unique electron microscope - the Hitachi H-3000, one of the most powerful electron microscopes in the world.

URL: http://www.npaci.edu/online/v3.10/telemicroscopy.html